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The use of Soft Computing for measuring the Quality of Education:

Sergio Valdés-Pasarón, Bogart Yail Márquez, Juan Manuel Ocegueda-Hernández
1 Baja California Autonomous University
Calzada Universidad 14418, Tijuana, Baja California, México.
{svaldes, bmarquez , jmocegueda}@uabc.edu.mx

ABSTRACT

Fuzzy logic has been considered as a strategy to define the values of the complex realities that define every aspect of education and to demonstrate formalized educational issues. This is because the quality of education has awakened the interest of investigators worldwide because they can be the answer of Education problems, and because some countries spend more resources in funding education compared to others which leads to higher levels of growth. This article proposes a new methodology using fuzzy logic to measure the quality of education by using quantitative and qualitative values with the hopes to develop criteria for the quality of education in a way closer to the realities of Latin American countries.

KEYWORDS

Soft Computing, Fuzzy Logic, Education, Economic Growth.

1 INTRODUCTION

Human capital theory emerges from the contributions of Mincer (1958) [1], Schultz (1961) [2] and Becker (1964) [3], they considered education as an investment to be made by individuals which allows them the ability to increase their human capital endowment. This investment increases their productivity and, in the neoclassical framework of competitive markets in which this theory is developed, your future income. Thus, establishing a causal relationship between education, productivity and income, so that an increase of education produces a higher level of income and greater economic growth.

In 1960 Gary Becker developed the pure model of human capital, its main hypothesis is based on the fact that a education increases so does the productivity of the individual who receives it [3].

Becker In his study reaches two important conclusions. The first deals with theories of income distribution, rising yields a simple model that emerges from Human capital, this can be described as:

$$Gi=f(QNi, Ei) \quad (1)$$

Where: G returns, QN innate or natural qualities, E is education or characteristics acquired through investment in human capital, i is a person.

Becker arrives to an interesting conclusion in this first part of his study and as outlined in his article, "*Human Capital*" pp.62 and 63, one can assume that there is a whip positive correlation between the natural qualities and the level of educational investment.

In the purpose to satisfy all the expectations and needs of a society as a

whole in terms of education this is linked to a series of qualitative and quantitative variables which together gives us an insight as to the differences in quality of Education, by just mentioning various aspects we can refer to: the ratio of students per teacher numbers, the access that students have to technology and by appropriately spending their budget they are able to allocate to the authorities of various countries or the percentage of Gross Domestic Product (GDP) spent on education.

In recent years numerous studies have found that the there is a difficulty in the criteria of variables used to measure elements of education or the factors related to it. These variables include; schooling rates, and the average number of years purchased, for example, the years that an person studies,(what is purchased The number of years a person studies or the average number of years a person has to pay for education but these variables are imperfect measures of the educational component of human capital since they measure the component of quantity, not quality taking a weakening of the value between these comparisons [4-6].

The quality of education has begun to become a high concern among researchers of education because they believe that the expectations and needs of human beings depends on factors like the quality of curricula for which they are prepared, the infrastructure of the country in education, the academic environment which is developed, the faculty and the relationship between teachers and students, among some. Despite this being clearly identified it still remains a difficult task to select the most appropriate indicators to determine which of them have a greater impact on the quality of education [4].

The motivations to incorporate these indicators to improve the quality of education imply that the factors vary from year to year. For instance, in Latin American countries education systems vary widely in terms of the organization of resources, teacher preparation, student-teacher ratio in classrooms, access to technology and education spending per student among other factors, these have high rates of variability among the different countries of Latin America.

The analysis is based in the influence of some qualitative and quantitative variables in the quality of education. Following the approach of Jong-Wha Lee and Robert j. Barro using an educational production function with the use of fuzzy logic, estimated the impact of different factors on the quality of education [5, 7].

The hegemony of the positivist epistemological paradigm in the social sciences has been hindering theoretical constructions that are approximate to reality without reducing their complexity, dismissed with this-not-scientific phenomena such as subjectivity, culture, health, social system and education.

There has recently emerged from different disciplinary fields, a number of theories that come close to the social reality and is able to approach it in all its complexity. These, have a clear epistemological emphasis.

One theory of complexity is that of fuzzy sets as a mathematical formalization of a logical model of imprecise, uncertain, fuzzy, and blurry [8, 9].

Soft Computing with words is a necessity when the available information

is too imprecise to justify the use of numbers and phrases when there is a tolerance for imprecision which can be exploited to achieve tractability, robustness, low solution cost, and better rapport with reality; Thus fuzzy logic, has been developed by seeking to shape the way how the brain handles incorrect information [10].

Fuzzy sets were introduced by Zadeh L.A. in 1965 [9, 11] for processing / handling information and lack of clarity affected data / uncertainty not probabilistic. They were designed to mathematically represent vagueness and uncertainty in Linguistics; by providing formalized tools to work with the inherent imprecision in many problems; It can be considered as a generalization of classical set theory.The fuzzy logic is close to the functioning of the human thought; applications of the fuzzy logic are rapid and cost effective, the process does not require a mathematical model and it's quite easy.

The other hand the case of "the quality of education" can easily be modeled; uncertain and indefinite information can be used; with cheap sensors, it brings flexibility to the measurement of the process. It allows the definition of concepts or correctness values in a graded way.

2 MEASUREMENT OF QUALITY

2.1 How to measure the quality of education

Several factors have been incorporated to measure aspects involving the quality of education [12], Hanushek and Kim proposed to measure education using skills learned from the test or tests used internationally [13], for example, the Program for International Assessment Students of the OECD (PISA acronym in English) or in the case of Mexico, National Assessment of Academic Achievement in Schools (LINK), which are intended to assess how far students near the end of their compulsory education acquired, to some degree, the knowledge and skills necessary for full participation in society.

The results of these tests show a relationship between the quality of education with the growth of gross national product (GNP) per capita. This suggests that the quality of education is a factor of great importance for the analysis of the relationship between human capital and economic growth [7, 14, 15].

However these results have not yet reached a consensus on how to measure qualitative and quantitative jointly due to the heterogeneity in the capture of such data. But, given the difficulty that exists in measuring the quality of education (CE) believes that the main contribution of this work would build a model to measure the quality of education in quantitative and qualitative, eliminating the heterogeneity in the ways of measuring this indicator and reach a final consensus on this controversial issue.

2.2 Fuzzy Logic

The concept of Fuzzy Logic, was conceived by Lotfi Zadeh a professor at the University of California at Berkeley, who disagreed with the classical sets (crisp sets), which allows for only two options; membership or not an item to the all presented as a way of processing information about allowing partial memberships joint as opposed to the classic called Fuzzy Sets [16].

Fuzzy logic versus conventional logic can work with information that is not entirely accurate, so that conventional assessments, which propose that an element always belongs to a certain degree to a set while at the same time never quite belonging to it. This allows for there to be established an efficient way to work with uncertainties, and to put knowledge in the form of rules to a quantitative level, feasible to be processed by computers [17].

If we make a comparison between the classical and fuzzy logic we can say that classical logic provides a logical parameters between true or false, that is, using binary combinations of 0 and 1, 0 if false and 1 if true. Now if we take into account that the fuzzy logic which introduces a function that expresses the degree of membership of an attribute or variable to a linguistic variable taking the values between 0 and 1, this is called fuzzy set and can be expressed mathematically :

$$A = \{x / \mu A(x) \forall x \in X\} \qquad (2)$$

Linguistic variable - membership function. By measuring the quality of education, we can analyze the components that make up the whole and if we analyze depending on how much public expenditure there is on education according to classical logic we would be able to know good quality or poor quality regardless of the income distribution of students or the percentage of the generations that come at a higher level, i e if option one then BC = 1 or if the second option MC = 0.

If we use fuzzy logic it is not necessarily the scanned object that has two states because there are other states in which we could label it for example:

Excellent quality EQ = 1, GQ = 0.8 Good quality, medium quality MQ= 0.5, bad quality BQ = 0.1 and too Bad quality TBQ = 0.

3 METHODOLOGY

Our methodology is to analyze the indicators used by the United Nations Educational Scientific and Cultural Organization (UNESCO) to measure the education of the countries that have the following input variables to consider.

a) Education expenditure as a percentage of Gross Domestic Product (EXPGDP). This variable represents the percentage of gross domestic product that countries devote to education spending.

b) Government Public Expenditure on Education (GPEE). This variable represents the total government spending for education.

c) Distribution of Public Spending by Level of Government (DPSLG). This variable represents the distribution of educational levels (primary, secondary or tertiary) of the total allocation to the education of government expenditure.

d) Pupil- Teacher Ratios (PTR). This variable represents the number of students by teachers at different educational levels.

e) Income rate to last grade of primary (TIUGP). Represents the rate of students who manage to take the primary level in its entirety.

f) Percentage of students who continue to secondary school (SSPE). This variable represents the percent of students who continue their secondary studies completed once a primary school.

g) Expenditure per pupil as a percentage of GDP Per Capita (EPP GDP). Represents the average expenditure per student relative to per capita gross domestic product.
h) Average per pupil expenditure (APPE). Represents the average expenditure per pupil.
i) Average of primary schools at lease one computer for the use of the students (APSC).
j) Average of primary schools at lease one computer connected to Internet (APSCI).

Finally, the indicators were grouped into three groups to make a better interpretation as a whole, the first group of variables was grouped into Economic Factors which are: Education expenditure as a percentage of Gross Domestic Product, Government Public Expenditure on Education and Distribution of Public Spending by Level of Government. The second variables was grouped into Resources and development Factors which are: Pupil- Teacher Ratios, Income rate to last grade of primary, Percentage of students who continue to secondary school, Expenditure per pupil as a percentage of GDP Per Capita, Average per pupil expenditure and the last group include the Technologic Factors which are: Average of primary schools at lease one computer for the use of the students and average of primary schools at lease one computer connected to Internet.

3.1 Equations

The relationship between the quality of education and its determinants can be analyzed by a production function of education as:

$$Q=f(EF, R) + U \quad (3)$$

Where Q represents the quality of education, EF represents the economic factors:
R resources used in schools and U are unmeasured factors that may affect the quality of education.
The system, which is posed in three blocks is also associated with the process to use fuzzy logic techniques. Blocks are broadcast, and desdifution inference.
It is important to know the inputs and outputs of the system. The former is formed by the variables and are taken into account in the representation intended by the system. The output is a particular result.
The input variables from a selection process that involves knowing the context of the problem being addressed. As an illustration, the module dealing with MATLAB fuzzy logic, considering the following input and output given the linguistic variables: very bad, bad, average, fair, good, very good, the linguistic variables are made to the perception of education of a particular country.
The figure 1 show 3D interactive graphic shows the relationship between economic variables and resources with regard to the quality of education, noting that the interaction between economic factors and resources no impact in a large measure the quality of education and the figure 2 show 3D interactive graphic shows the relationship between economic factors and the technological

factors on the quality of education, noting that technological factors that are impacting the quality of education in a significant way.

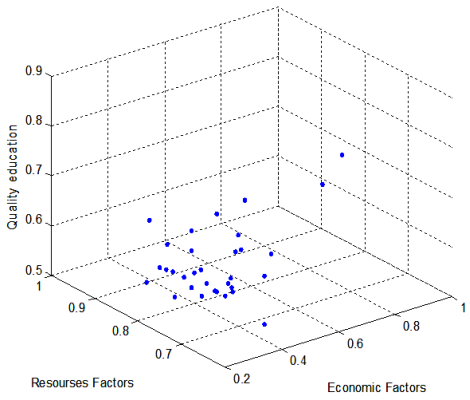

Figure 1. Relationship between Economic Factors and Resources Factors

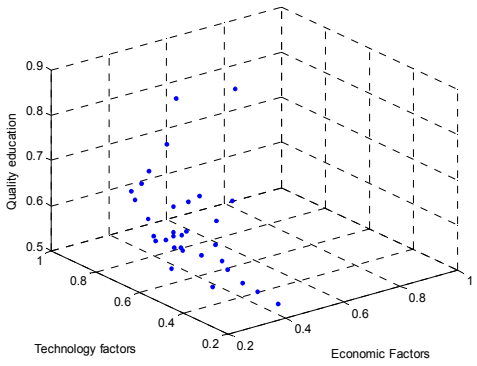

Figure 1. Relationship between Technology factors and Economic Factors.

The figure 3 show 3D interactive graphic shows the relationship between the factors of resources and the technological factors on the quality of education, noting that combined resources and technological factors are that are impacting the quality of education in a significant way.

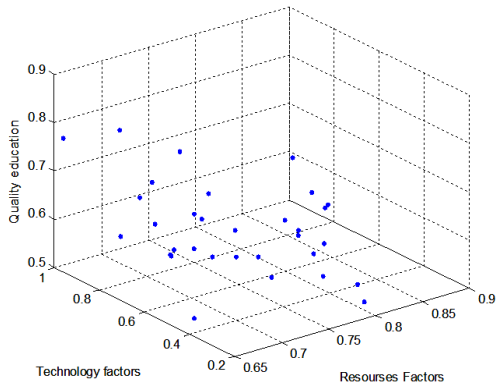

Figure 3. Relationship between Technology factors and Resources Factors.

As input, establishing the factors that influence: EXPGDP, GPEE, DPSLG, PTR, TIUGP, SSPE, EPPGDP and APPE

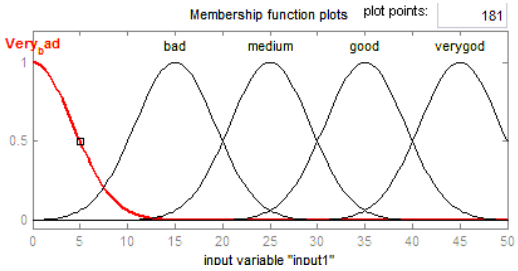

Figure 4. . Membership function

As output, look for the linguistic value that determines a country's education. The functions of each component are:

a) Fuzzification interface; transform variables into fuzzy variables. For this interface must be defined ranges of variation of input variables and fuzzy sets associated with their membership functions.

b) Knowledge Base; contains the linguistic rules of control and information relating to the membership functions of fuzzy sets.

c) Inference engine; makes the task of calculating the output variables from input variables, by the rules of fuzzy inference controller and, delivering output fuzzy sets.

d) Defuzzification interface; gets a diffuse overall output from the aggregation of fuzzy outputs and performs the defuzzification.

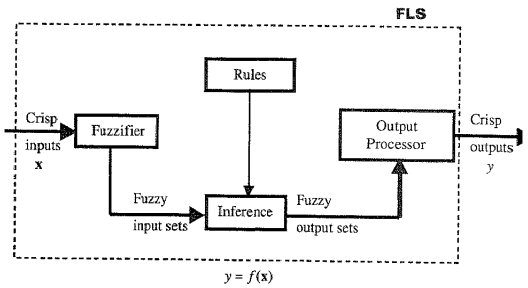

Figure 5. Fuzzy logic system

To create the fuzzy inference system that calculates the role of education quality, we used the Fuzzy in (Matlab, 2009). Each indicator of education was considered a linguistic variable. Each of these is associated with three fuzzy sets with membership functions of the variable "real" to the set. Each set was labeled with the linguistic labels of "very good", "good", "medium " "bad" and "very bad" to rate the educational value of the indicator considered. The degree of membership of an element in a fuzzy set is determined by a membership function that can take all real values in the range [0.1]. A total of 8 variables defined input and output which corresponds to the quality of education that a country has,
it also has the same linguistic labels very good, "" good "," medium "" bad "and" very bad "to describe education.

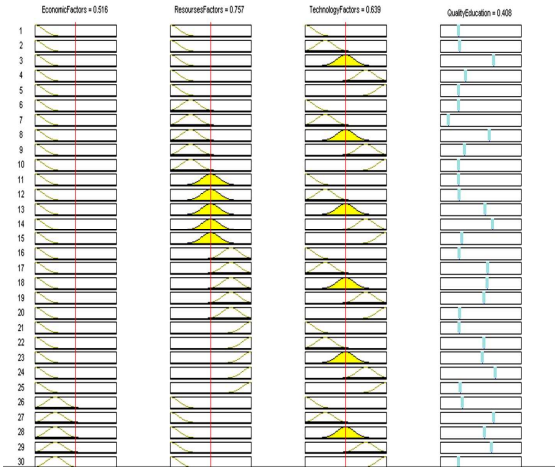

Figure 6. Generated rules

Using Simulink [18] can be seen using block diagrams the relationship between the observed variables, and the quality of education.

Simulink is an application that allows you to build and simulate models of physical systems and systems of control by means of block diagrams. The behavior of these systems is defined using transfer functions, mathematical operations, elements of Matlab and predefined signals of any kind.

The following graphs shows the behavior of indicators grouped and how they affect the quality of education, in the case of economic factors are affecting these to some extent in quality and not all economic indicators affect directly the quality of education. In the other hand we have the Resources Factors and technological factors that are impacting significantly the quality of education but must be careful not to replace the human factors as this would diminish the quality of education.

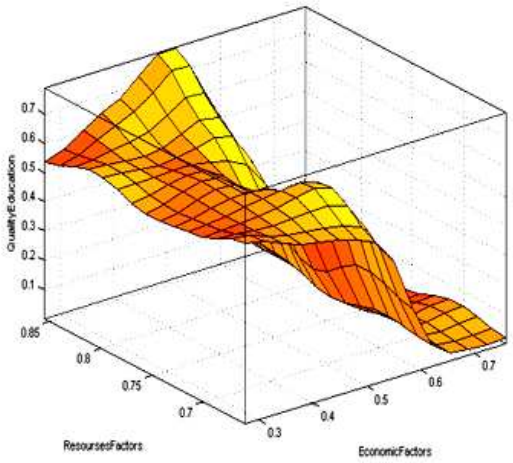

Figure 7. Relationship between Resourses factors and Economic Factors.

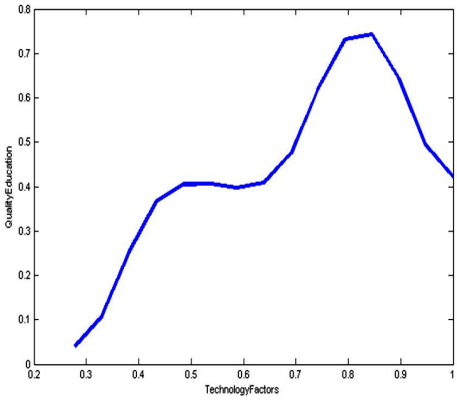

Figure 8. Results Technology factors.

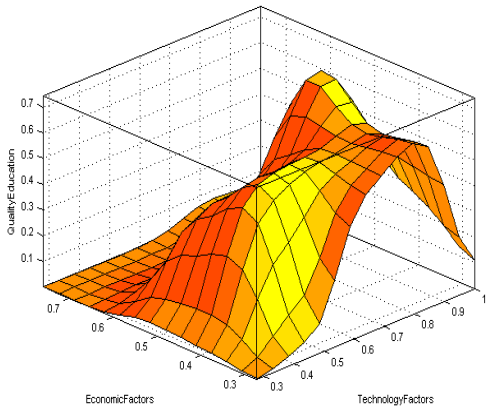

Figure 8. Relationship between Technology factors and Economic Factors.

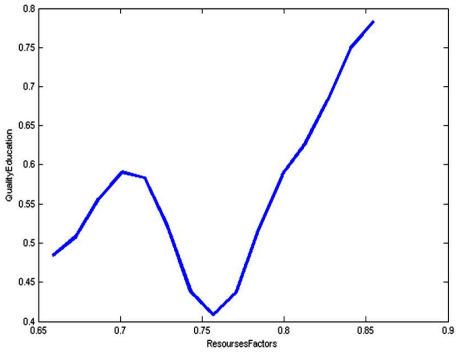

Figure 8. Results Recourses Factors.

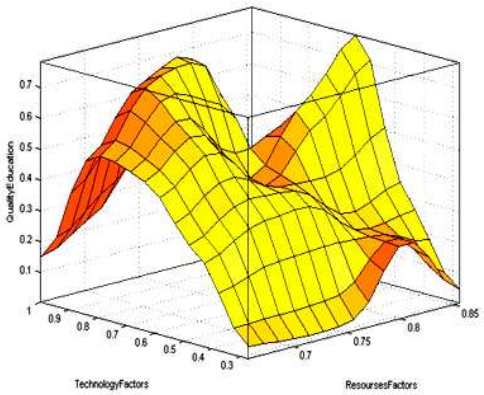

Figure 9. Relationship between Technology factors and Resources Factors.

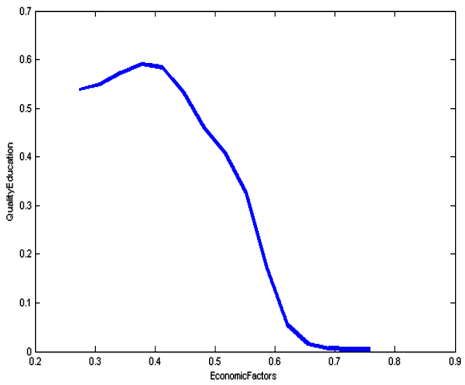

Figure 8. Results Economic Factors.

4 RESULTS

The use of new tools and methodologies for economic theory gives us as output: each level was rated high and low quality of education depending on the limit values "good" and "bad" for all indicators, which do not always coincide with the upper and lower value ranges, it depends if an indicator that is preferred with low or high. The results are shown in Figure 3, where there is the Global Rating education on a value of 1 as the most high. You can see that the higher education is the options if the value of GPEE and EXPGDP is practically the same, while for the other options are appraised lower values being less important technology. In the case of PTR and EPP GDP this show much difference between the cases of low and high quality of education, this is because the ranges of values that can have different indicators are great.

5 CONCLUSIONS

The methodology developed for obtaining a function of the quality of education is easy to manage; view and can serve for multiple different sensitivity analysis of changes in the values of education indicators. The great advantage of the methodology based on fuzzy logic is that you can handle an unlimited number of indicators expressed in any unit of measurement. Like any other methodology, it is strongly dependent on the accuracy with which the indicators have been calculated or determined. This paper shows the potential of fuzzy logic to describe particular systems and public policies to determine that the education of a country to be "good "or "bad ".

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