Neutrosophic and Plithogenic Statistical Analysis in Educational Development

Fernando Castro Sánchez[1], Jorge Hernán Almeida Blacio[2], María Gabriel Flores Bracho[3], Danilo Rafael Andrade Santamaria[4] and Ricardo Sánchez Casanova[5].

[1] Universidad Regional Autónoma de los Andes (UNIANDES). Km 5 ½ vía a Baños. Ambato. Tungurahua. Ecuador
Email: ua.fernandocastro@uniandes.edu.ec
[2] Universidad Regional Autónoma de los Andes (UNIANDES). Avenida La Lorena, Santo Domingo. Ecuador
Email: us.jorgealmeida@uniandes.edu.ec
[3] Universidad Regional Autónoma de los Andes (UNIANDES). Juan de Salinas 612-500, Ibarra. Imbabura. Ecuador
Email: ui.mariaflores@uniandes.edu.ec
[4] Universidad Regional Autónoma de los Andes (UNIANDES). Calle Teniente Hugo Ortiz, Puyo. Pastaza. Ecuador
Email: up.daniloandrade@uniandes.edu.ec
[5] Vicedecano de Investigación y Posgrado, Universidad de la Habana , Cuba.
Email: ricardo.sanchez@matcom.uh.cu

Abstract. Education in the history of humanity briefly establishes the general characteristics of education over time. Throughout life, the student goes through more than 18 years in the classrooms, because education has rigorously changed throughout history, as a result of the evolution of some universities during the processes carried out until changing categories and an improvement in the evaluated indicators. On the other hand, governments and leading entities of education speak of the application of standards of educational quality, the efficiency of the educational system, and sustainability of financing and quality of spending to ensure that students develop knowledge, skills, and attitudes in specific situations, in different contexts for solving problems and interacting with the main dimensions, with their factors or sub-dimensions, limitations or critical nodes and challenges of education. This study analyzes the effects that affect educational development through the neutrosophic statistical study with the application of plithogenic sets.

Keywords: education, neutrosophic statistics, plithogenic sets

1 Introduction

This research collects the perspectives and experiences of teachers and analyzes the Ecuadorian educational system to determine how it influences the educational reality of the country. The educational changes made in recent years have not achieved the objectives set by the Ministry of Education and the Ministry of Higher Education, Science and Technology. Education is a right of people throughout their lives and an inescapable and inexcusable duty of the State. It constitutes a priority area of public policy and state investment, a guarantee of equality and social inclusion, and an essential condition for good living. Individuals, families, and society have the right and responsibility to participate in the educational process [1-8].

Education contributes to the achievement of great transformations of humanity and in turn, it is the educational transformations supported by philosophy that give meaning to human existence. Thus, it is not without reason that education has historically been the motor that drives all social processes. Hence we can say that it is crucial to address this issue [9-12].
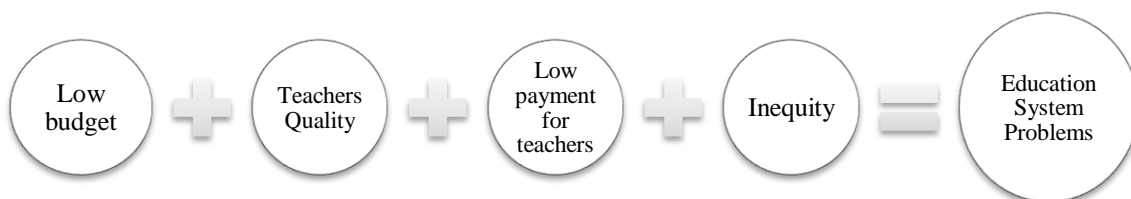

Figure 1. Problems of education systems

The Ministry of Education has assumed the leadership of the system and guarantees the right to education of Ecuadorians and their permanence in it. In the last 6 years, nearly 500,000 teachers were trained and although

investment in education has tripled, quality has declined [13]. Furthermore, dropouts and reprobation in education were higher, so redistribution of the State's budget invests in education, quality spending policies, and an accountability system are actual goals to be achieved. At present, a revision of the standards and the curriculum is being carried out to strengthen the quality of education, the more poverty decreases, the quality of life improves because basic needs are met [14, 15].

Although the quality of education in Ecuador has improved, it lacks highly trained professionals and technicians, and that is why on many occasions, there is a need for millionaire hiring of foreigners to take those positions that need a certain degree of knowledge. In addition, this shortage decreases the development of our economy and all national life, because to a large extent, the main problem of national education is the little budget that is assigned to education in the country [16-18].

The actual society demands to have a higher quality education, an imperative of the demanding world in which we are immersed, which has created the urgent need that the work of man is much more effective, for which greater preparation is required. This is an active task of a psycho-physical-social order that allows understanding the new realities according to the level of inner maturation of the subjects. It is a reality that belongs to the space-time becoming of all people [19, 20]. The Ecuadorian educational system has progressed in recent times, but it has some obstacles and critical nodes to resolve. To think about the foundations of education in history and the transformations in current Ecuadorian education implies determining its entelechy, understanding the limitations, achievements, and challenges that the educational problem brings along [21, 22]. For the analysis of the development of education, this study defines:

- Problematic Situation: effects on educational development
- Main objective: define the main factors that affect development in education
- Specific objectives:
  ✓ Determine the dimensions of the analyzed variable
  ✓ Analyze the effects at each stage of the process
  ✓ Carry out the neutrosophic statistical measurement and modeling of the variable
  ✓ Determine the interrelation of each dimension in the plithogenic set of education
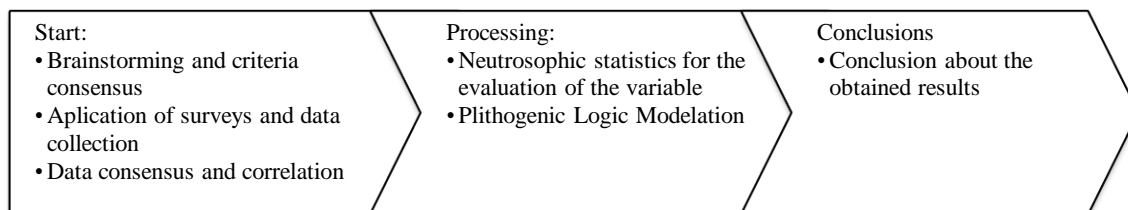 ✓ Present potential solutions to mitigate the impact of the factors on the variable

Figure 2: Stages of the study of educational development

2 Materials and methods

Neutrosophic probabilities and statistics are a generalization of classical and imprecise probabilities and statistics. The Neutrosophic Probability of an event E is the probability that event E will occur [23], the probability that event E does not occur, and the probability of indeterminacy (not knowing whether event E occurs or not). In classical probability nsup≤1, while in neutrosophic probability nsup≤3 +. The function that models the neutrosophic probability of a random variable x is called the neutrosophic distribution: $NP(x) = (T(x), I(x), F(x))$, where T (x) represents the probability that the value x occurs, F (x) represents the probability that the value x does not occur, and I (x) represents the indeterminate or unknown probability of the value x.

Neutrosophic Statistics is the analysis of neutrosophic events and deals with neutrosophic numbers, the neutrosophic probability distribution [24], neutrosophic estimation, neutrosophic regression, etc. It refers to a set of data, which is formed totally or partially by data with some degree of indeterminacy and the methods to analyze them. Neutrosophic statistical methods allow the interpretation and organization of neutrosophic data (data that can be ambiguous, vague, imprecise, incomplete, or even unknown) to reveal the underlying patterns [25]. In short, the Neutrosophic Logic [26, 27], Neutrosophic Sets, and Neutrosophic Probabilities and Statistics have a wide application in various research fields and constitute a new reference of study in full development [28-49].

225

The Neutrosophic Descriptive Statistics includes all the techniques to summarize and describe the characteristics of the neutrosophic numerical data [50]. Neutrosophic Numbers are numbers of the form where a and b are real or complex numbers [51], while "I" is the indeterminacy part of the neutrosophic number N.

$$N = a + bI.$$

The study of neutrosophic statistics refers to a neutrosophic random variable where X_l y $X_u I_N$ represents the corresponding lower and upper level that the studied variable can reach in an indeterminate interval $[I_l, I_u]$. Following the neutrosophic mean of the variable when formulating:

$$X_N = X_l + X_u I_N; \ I_N \in [I_l, I_u] \tag{1}$$

$$\text{Where } \bar{x}_a = \frac{1}{n_N} \sum_{i=1}^{n_N} X_{il} \ \bar{x}_b = \frac{1}{n_N} \sum_{i=1}^{n_N} X_{iu} \ n_N \in [n_l, n_u] \tag{2}$$

is a neutrosophic random sample. However, for the calculation of neutral frames (NNS) it can be calculated as follows:

$$\sum_{i=1}^{n_N} (X_i - \bar{X}_{iN})^2 = \sum_{i=1}^{n_N} \begin{bmatrix} \min \begin{pmatrix} (a_i + b_i I_L)(\bar{a} + \bar{b} I_L), (a_i + b_i I_L)(\bar{a} + \bar{b} I_U) \\ (a_i + b_i I_U)(\bar{a} + \bar{b} I_L), (a_i + b_i I_U)(\bar{a} + \bar{b} I_U) \end{pmatrix} \\ \max \begin{pmatrix} (a_i + b_i I_L)(\bar{a} + \bar{b} I_L), (a_i + b_i I_L)(\bar{a} + \bar{b} I_U) \\ (a_i + b_i I_U)(\bar{a} + \bar{b} I_L), (a_i + b_i I_U)(\bar{a} + \bar{b} I_U) \end{pmatrix} \end{bmatrix}, I\epsilon[I_L, I_U] \tag{3}$$

Where $a_i = X_l b_i = X_u$. The variance of the neutrosophic sample can be calculated by

$$S_N^2 = \frac{\sum_{i=1}^{n_N} (X_i - \bar{X}_{iN})^2}{n_N}; \ S_N^2 \epsilon [S_L^2, S_U^2] \tag{4}$$

The neutrosophic coefficient (NCV) measures the consistency of the variable. The lower the NCV value, the more consistent the factor's performance is. NCV can be calculated as follows [52].

$$CV_N = \frac{\sqrt{S_N^2}}{\bar{X}_N} \times 100; \ CV_N \epsilon [CV_L, CV_U] \tag{5}$$

Mathematical modeling through neutrosophic logic to plithogenic logic

Neutrosophic sets were introduced in the literature by F. Smarandache since fuzzy intuitionistic sets could only handle incomplete information, but not the indeterminate and inconsistent information, which commonly exists in fuzzy systems. The term neutrosophy means knowledge of neutral thought and this neutrality represents the main distinction between fuzzy logic and fuzzy intuitionist [27]. In neutrosophic sets, the indeterminacy is explicitly quantified through a new parameter I. True membership (t), indeterminate membership (I), and false membership (F) are independent of each other and the sum between them satisfies the inequalities $0 \le T + I + F \le 3$. In fuzzy intuitionistic sets, the uncertainty depends on the degree of membership and the degree of non-membership [26]. In neutrosophic sets, the indeterminacy factor (I) is independent of the true and false values. There are no restrictions between the degree of truth, the degree of indeterminacy, and falsehood [24, 53-55].

If U is a universe of discourse, a Neutrosophic Set (NS) is characterized by three membership functions $uA(x), rA(x), vA(x) : X \to]0-, 1+[$, which satisfy the condition $0 \le -\inf uA(x) + \inf rA(x) + \inf vA(x) \le \sup uA(x) + \sup rA(x) + \sup vA(x) \le 3 +$ for all $x \in X$. $uA(x), rA(x)$ and $vA(x)$ are the membership functions of truth, indeterminacy, and falsehood of x in A, respectively y your images are standard or non-standard subsets of $]0-, 1+[$.

When approaching the perspective of indeterminacy and contradiction, as is the case with Gödel's incompleteness theorem, he states that any proposition in a mathematical axiom system will present a degree of truth (T), falsehood (F), and indeterminacy (I). Neutrosophy, therefore, establishes a unique solution for the existence of paradoxes in philosophy [50]. Plithogenic advocates for the connections and unification of theories and ideas in varied fields of science [56].

Plithogeny is the dynamics of various types of opposites, and/or their neutrals, and/or non-opposites and their organic fusion. Plithogeny is a generalization of dialectics (dynamics of a type of opposites: <A> and <antiA>), neutrosophy (dynamics of a type of opposites and their neutrals: <A> and <antiA> and <neutA>) , since Plithogeny

studies the dynamics of many types of opposites and their neutrals and non-opposites (<A> and <antiA> and <neutA>, <B> and <antiB> and <neutB>, etc.), and not opposites (<C>, <D>, etc.) all together. As an application and particular case derived from Plithogeny, the plithogenic set is an extension of the classical set, fuzzy set, fuzzy intuitionist set, and neutrosophic set, and has multiple scientific applications [56].

So, (P, a, V, d, c) is called a plithogenic set

1. Where "P" is a set, "a" is an attribute (multi-dimensional in general), "V" is the range of values of the attribute, "d" is the degree of membership of the attribute value of each element x to the set P with respect to some given criteria ($x \in P$), and "d" means "d_F" or "d_{IF}" or "d_N", when it is a degree of fuzzy membership, an intuitionistic fuzzy membership, or a degree of neutrosophic membership, respectively, of an element x to the plithogenic set P;
2. "c" means "c_F" or "c_{IF}" or "c_N", when it is a fuzzy attribute value contradiction degree function, intuitionistic fuzzy attribute value contradiction degree function, or neutrosophic attribute value contradiction degree function, respectively.
3. Functions $d(\cdot,\cdot)$ and $c(\cdot,\cdot)$ are defined according to the applications that experts need to solve.
4. Then, the following notation is used:
5. $x(d(x,V))$, where $d(x,V) = (d(x,v),$ for all $v \in V), \forall x \in P$.
6. The attribute value contradiction degree function is calculated between each attribute value regarding the dominant attribute value (denoted by v_D) in particular, and with regard to other attribute values as well.
7. The attribute value contradiction degree function c evaluated between the values of two attributes is used in the definition of plithogenic aggregation operators (intersection (AND), union (OR), implication ($\Rightarrow$), equivalence ($\Leftrightarrow$), inclusion (partial order), and other plithogenic aggregation operators that combine two or more degrees of values of the attribute based on a t-norm and a t-conorm. Most plithogenic aggregation operators are linear combinations of a fuzzy t-norm (indicated by) with a fuzzy t-conorm (indicated by), but nonlinear combinations can also be constructed. $\wedge D$ and $\vee D$ [57].

If the t-norm is applied on the value of the dominant attribute denoted by, and the contradiction between and is, then it is applied on the value of the attribute as follows:

$$[1 - c(v_D, v_2)] \cdot t_{norm}(v_D, v_2) + c(v_D, v_2) \cdot t_{conorm}(v_D, v_2), \tag{6}$$

Or, using symbols:

$$[1 - c(v_D, v_2)] \cdot (v_D \wedge_F v_2) + c(v_D, v_2) \cdot (v_D \vee_F v_2), \tag{7}$$

Similarly, if the t-conorm applies to the value of the dominant attribute denoted by v_D, and the contradiction between v_D and v_2 is $c(v_D, v_2)$, then v_2 applies to the value of the attribute as follows

$$[1 - c(v_D, v_2)] \cdot t_{conorm}(v_D, v_2) + c(v_D, v_2) \cdot t_{norm}(v_D, v_2), \tag{8}$$

Or, using symbols:

$$[1 - c(v_D, v_2)] \cdot (v_D \vee_F v_2) + c(v_D, v_2) \cdot (v_D \wedge_F v_2), \tag{9}$$

The plithogenic neutrosophic intersection is defined as:

$$(a_1, a_2, a_3) \wedge_P (b_1, b_2, b_3) = \left(a_1 \wedge_F b_1, \frac{1}{2}[(a_2 \wedge_F b_2) + (a_2 \vee_F b_2)], a_3 \vee_F b_3\right), \tag{10}$$

The plithogenic neutrosophic junction is defined as:

$$(a_1, a_2, a_3) \vee_P (b_1, b_2, b_3) = \left(a_1 \vee_F b_1, \frac{1}{2}[(a_2 \wedge_F b_2) + (a_2 \vee_F b_2)], a_3 \wedge_F b_3\right), \tag{11}$$

In other words, if something applies to membership, the opposite applies to non-membership, while in indeterminacy the average between them is what applies. Plithogenic neutrosophic inclusion is defined as follows:

Since the degrees of contradiction are:

$c(a_1, a_2) = c(a_2, a_3) = c(b_1, b_2) = c(b_2, b_3) = 0.5,$

We apply

$a_2 \geq [1 - c(a_1, a_2)]b_2$ o $a_2 \geq (1 - 0.5)b_2$ o $a_2 \geq 0.5b_2$, while $c(a_1, a_3) = c(b_1, b_3) = 1$

So, having the opposite is true for $a_1 \leq b_1$ if and only if

$a_3 \geq b_3$, therefore $(a_1, a_2, a_3) \leq_P (b_1, b_2, b_3)$ if and only if $a_1 \leq b_1, a_2 \geq 0.5b_2,$ y $a_3 \geq b_3$.

Next, an algorithm for the resolution of this research is presented where Plithogeny will be merged with the algorithm of Neutrosophy. From this moment on, expressions 2 to 8 must be applied to execute the operations of the classical algorithm with plithogenic numbers. For the elaboration of a single decision matrix, the median of

the plithogenic numbers is calculated for each combination, for all specialists. The median is calculated using the following formula:

$$\text{median}_{i=1}^{m}\{PN_i\} = (\text{median}_{i=1}^{m}\{T(PN_i)\}, \text{median}_{i=1}^{m}\{I(PN_i)\}, \text{median}_{i=1}^{m}\{F(PN_i)\}), \tag{12}$$

Where PN_i, are plithogenic numbers, $T(PN_i)$ are their true components, $I(PN_i)$ are their indeterminate components and $F(PN_i)$ are their false components. In other words, Equation 8 means that the median of a set of plithogenic numbers is defined as the plithogenic number of the medians of its components. To compare the relationships between the quadrants, the following formula is used to blur a neutrosophic number [58]:

$$S([T, I, F]) = \frac{2+T-I-F}{3} \tag{13}$$

- Determine for each line of the pairwise comparison matrix, a weighted sum based on the sum of the product of each cell by the priority of each alternative or corresponding criterion.
- For each line, divide its weighted sum by the priority of its corresponding alternative or criterion
- Determine the Λmax mean of the result of the previous stage.
- Calculate the consistency index (CI) for each alternative or criterion

$$CI = \frac{\Lambda_{max}-m}{m-1} \tag{14}$$

Where m is the number of alternatives

- Determine the Random Index (RI) from table 2
- Determine the consistency ratio index (the ratio between the consistency index and the random index)

3 Results

3.1 Data

Development in education has been one of the challenges for governments to achieve the professional level demanded. For the modeling of this work, a group of experts was created to analyze the data collected in the information collection stage. As a consensus, the experts determined for the modeling:

Set: Education, $=\forall F_{V_n}\{F_{V_1}, F_{V_2}, F_{V_3}\}$

Subsets:
- System efficiency, $=\forall F_{V_{1n}}\{F_{V_{11}}, F_{V_{12}}, F_{V_{13}}\}$
- Educational quality, $=\forall F_{V_{2n}}\{F_{V_{21}}, F_{V_{22}}\}$
- Sustainability of financing and quality of spending, $=\forall F_{V_{3n}}\{F_{V_{31}}, F_{V_{32}}\}$

Variable: Development in education. Code (E)

Factors (F): Impacts on the development of education (Figure 3)

Sample: 145 days

Scale: [0, 6] (See table 1)

Linguistic Expression	Scale	Phytogenic number (T, I, F)	$S([T, I, F]) = \frac{2+T-I-F}{3}$
Poor Importance (PI)	0	(0.12, 0.92, 0.97)	0.08
Fewer important (FI)	1	(0.17, 0.87, 0.92)	0.13
Low Importance (BI)	2	(0.42, 0.67, 0.82)	0.31
Medium important MDI	3	(0.67, 0.62, 0.72)	0.44
Important (I)	4	(0.72, 0.37, 0.52)	0.61
Most Important (MI)	5	(0.92, 0.27, 0.12)	0.84
Very important (VI)	6	(0.97, 0.07, 0.03)	0.96

Table 1: Linguistic expression for determining the level of importance of the factor on the variable
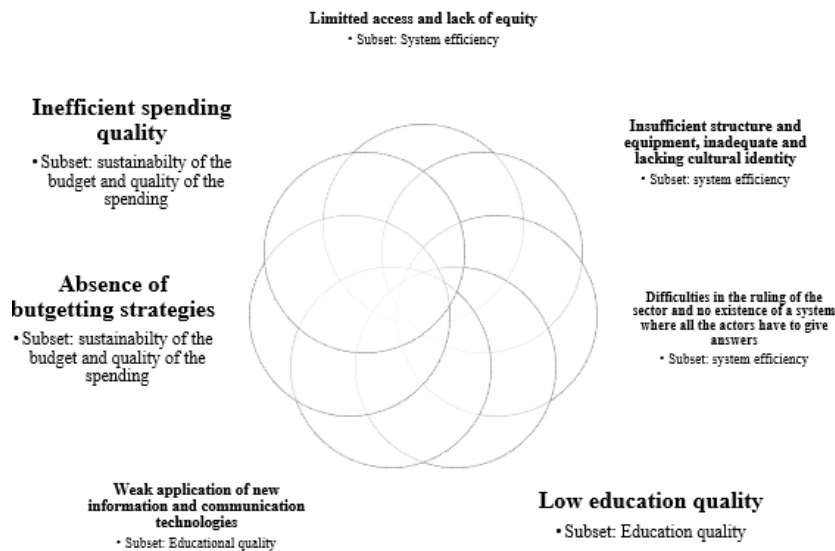
Figure 3. Plithogenic set of development in education

To model the neutrosophic statistics of the neutrosophic set, it is suggested to code the name of the variable and its representation in graphs and tables.

3.2 Method development

Stage I. Neutrosophic statistical analysis

By modeling the variable with the use of neutrosophic statistics, the absolute frequencies are obtained to determine the level of involvement in the development of education, $F_n = \{F_{V_{11}}, F_{V_{12}}, F_{V_{13}}, F_{V_{21}}, F_{V_{22}}, F_{V_{31}}, F_{V_{32}}\}$ in a sample of 145 days of research (Table 2). It is noted:

- For the *System Efficiency* dimension, the factor $F_{V_{12}}$ has an incidence of 35.2%. It shows that insufficient infrastructure and equipment, inadequate and lacking cultural identity, are positioned as an element that slows down the efficiency of the educational system.
- For the educational quality dimension, the factor $F_{V_{21}}$ has an incidence of 51.4%. It shows that the low quality of education is positioned as a factor that affects the development of education.
- For the dimension Sustainability of financing and quality of spending, the factor $F_{V_{31}}$ has an incidence rate of 51.9%. It shows that the absence of financing strategies is positioned as a financial factor that hinders educational development.

To obtain the level of incidence of each factor in its dimension, as the measure of indeterminacy for modeling, a scale of $0 \le F_{V_n} \ge 1$, was set, so that the relative membership level within the subset is determined, as well as the neutrosophic set from the neutrosophic frequency $F_n = \{F_{V_{11}}, F_{V_{12}}, F_{V_{13}}, F_{V_{21}}, F_{V_{22}}, F_{V_{31}}, F_{V_{32}}\}$ (table 3).

Days	Neutrosophic frequencies						
	System Efficiency			Educational quality		Sustainability of financing and quality of spending	
	V11	V12	V13	V21	V22	V31	V32
1	[3 ; 5]	[2 ; 5]	[2 ; 5]	[2 ; 3]	[1 ; 1]	[3 ; 3]	[1 ; 4]
2	[1 ; 4]	[0 ; 3]	[1 ; 1]	[0 ; 0]	[1 ; 3]	[1 ; 4]	[0 ; 3]
3	[3 ; 5]	[3 ; 6]	[3 ; 3]	[2 ; 5]	[0 ; 0]	[3 ; 3]	[3 ; 6]
4	[2 ; 5]	[2 ; 3]	[2 ; 3]	[0 ; 1]	[1 ; 4]	[3 ; 6]	[2 ; 2]
5	[2 ; 2]	[2 ; 3]	[1 ; 3]	[2 ; 3]	[0 ; 0]	[1 ; 3]	[2 ; 4]
6	[2 ; 5]	[0 ; 0]	[0 ; 1]	[3 ; 5]	[2 ; 2]	[3 ; 5]	[3 ; 4]
7	[2 ; 2]	[0 ; 0]	[3 ; 3]	[1 ; 2]	[1 ; 4]	[1 ; 3]	[1 ; 4]
8	[2 ; 3]	[3 ; 5]	[3 ; 6]	[1 ; 1]	[2 ; 2]	[0 ; 0]	[1 ; 3]
9	[1 ; 1]	[0 ; 0]	[3 ; 3]	[2 ; 3]	[1 ; 2]	[0 ; 1]	[2 ; 4]
10	[3 ; 4]	[0 ; 3]	[0 ; 2]	[1 ; 4]	[1 ; 3]	[1 ; 1]	[1 ; 3]
11	[3 ; 3]	[2 ; 5]	[3 ; 5]	[1 ; 4]	[0 ; 3]	[1 ; 3]	[1 ; 1]
12	[2 ; 4]	[1 ; 4]	[0 ; 3]	[0 ; 1]	[2 ; 4]	[1 ; 3]	[2 ; 5]

13	[1 ; 2]	[0 ; 3]	[0 ; 1]	[2 ; 3]	[3 ; 4]	[3 ; 6]	[3 ; 3]
14	[2 ; 2]	[3 ; 6]	[2 ; 3]	[0 ; 2]	[2 ; 2]	[3 ; 3]	[3 ; 4]
15	[1 ; 2]	[0 ; 1]	[1 ; 3]	[2 ; 4]	[1 ; 3]	[2 ; 2]	[1 ; 1]
16	[0 ; 0]	[1 ; 2]	[3 ; 3]	[1 ; 1]	[1 ; 4]	[1 ; 3]	[2 ; 4]
17	[1 ; 3]	[0 ; 2]	[1 ; 3]	[0 ; 2]	[3 ; 6]	[2 ; 2]	[2 ; 2]
18	[0 ; 2]	[2 ; 4]	[1 ; 2]	[2 ; 5]	[0 ; 3]	[3 ; 6]	[3 ; 3]
19	[0 ; 3]	[0 ; 2]	[0 ; 3]	[1 ; 3]	[0 ; 2]	[1 ; 1]	[3 ; 4]
20	[3 ; 5]	[3 ; 6]	[2 ; 3]	[0 ; 0]	[2 ; 4]	[3 ; 4]	[0 ; 2]
0-145	[153 ; 293]	[134 ; 312]	[143 ; 282]	[145 ; 299]	[130 ; 283]	[177 ; 347]	[151 ; 322]

Table 2. Neutrosophic frequency for each plithogenic subset in educational development

Of the neutrosophic frequencies observed for development in education, for a sample of 145 days analyzed, there is a total indeterminacy level of:

Subset V$_1$, $V_{11} = 140, V_{12} = 178, V_{13} = 139$, with representativeness levels of [72.01% ; 81.73%],

Subset V2, $V_{21} = 154, V_{22} = 153$, with representativeness levels of [70.57% ; 81.63%],

Subset V3, $V_{31} = 170, V_{32} = 171$, with representativeness levels of [64.27% ; 69.88%].

It is highlighted that the problems of insufficient infrastructure and equipment, inadequate and without cultural identity affect 81.63 in the development in education, in the days of greatest incidence.

From the results of the modeling, it is observed that the incidence relationship between each factor associated with its dimension affects the development of education (table 3).

For the analysis of the representative mean as a function of $\bar{x} = \in [\bar{x}_L; \bar{x}_U]$, the values of the neutrosophic means of the factors are calculated and for the study of the variations of the subsets V1, V2, V3, they are determined by the values of the neutrosophic standard deviation $S_N \in [S_L; S_U]$, to determine in which factor there is greater coherence and precision when measuring the neutrosophic set $CV_N \in [CV_L ; CV_U]$ (Figure 4)
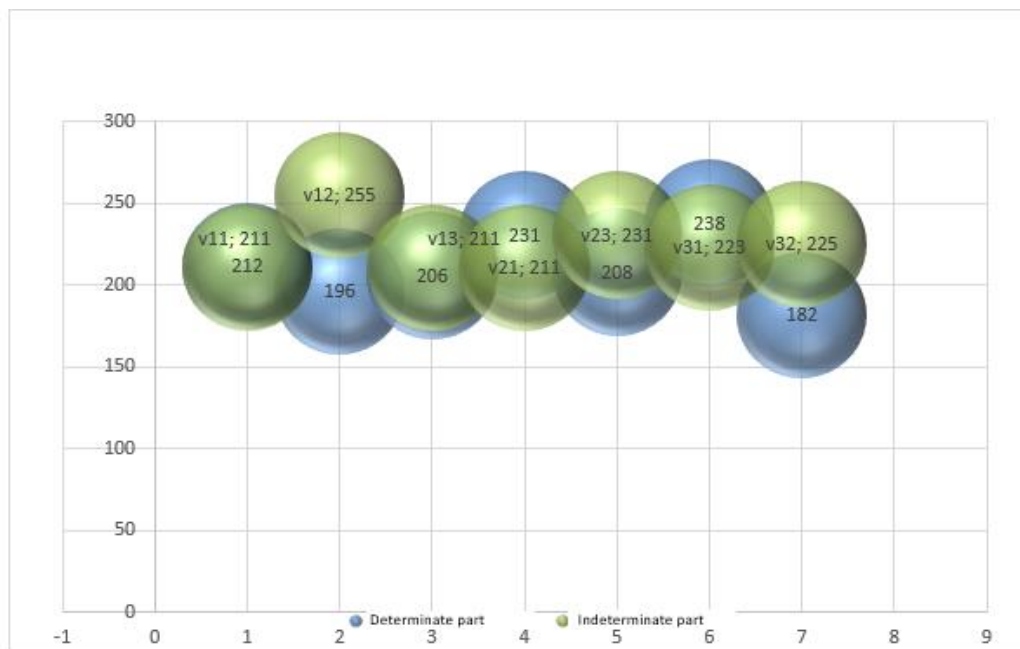

Figure 4. Neutrosophic bubble graph and its plithogenic interrelation of each factor and dimension.

Comparative analysis

The modeling of the neutrosophic statistics defines the associated indeterminacy factor for $\bar{x} = \in [\bar{x}_L; \bar{x}_U], S_N \in [S_L; S_U]$ and $CV_N \in [CV_L ; CV_U]$ in the form of neutrosophic numbers (Table 3). From the results obtained, it is observed that for the CV_{NV} values for the:

Subset V1, from 0.493 to 0.637with the indeterminacy measure of [21.3% ; 45.0%],
Subset V2, from 0.504 to 0.509with the measure of indeterminacy from [34.0% ; 40.8%],
Subset V3, 0.438 to 0.492with the measure of indeterminacy from [31.0% ; 35.0%].

COD	Dimension	COD	Sub-dimension or factor	Scale	Phytogenic number (T, I, F)	dn (x; Vn)	Attribute value	$\bar{x}_N$	YN	CVN
V1	System Efficiency	v11	Limited access to education and lack of equity	[0; 6]	(0.72, 0.37, 0.52)	0.3	I	1,391 + 2,664 I;I ∈ [0; 0; 47.8]	0.686 + 2.386 I;I ∈ [0; 0; 71.2]	0.493 + 0.896 I;I ∈ [0; 0; 45.0]
		v12	Insufficient infrastructure and equipment, inadequate and lacking cultural identity	[0; 6]	(0.92, 0.27, 0.12)	0.4	M: YES	1,218 + 2,836 I;I ∈ [0; 0; 57.1]	0.82 + 2.425 I;I ∈ [0; 0; 66.2]	0.673 + 0.855 I;I ∈ [0; 0; 21.3]
		v13	Difficulties in the governance of the sector and lack of an accountability system for all actors in the system	[0; 6]	(0.72, 0.37, 0.52)	0.3	I	1.3 + 2,564 I;I ∈ [0; 0; 49.3]	0.72 + 2.22 I;I ∈ [0; 0; 67.6]	0.554 + 0.866 I;I ∈ [0; 0; 36.0]
V2	Educational quality	v21	Low quality of education	[0; 6]	(0.97, 0.07, 0.03)	0.51	VI	1,318 + 2,718 I;I ∈ [0; 0; 51.5]	0.664 + 2.077 I;I ∈ [0; 0; 68.0]	0.504 + 0.764 I;I ∈ [0; 0; 34.0]
		v23	Weak application of new information and communication technologies	[0; 6]	(0.67, 0.62, 0.72)	0.49	MDI	1,182 + 2,573 I;I ∈ [0; 0; 54.1]	0.602 + 2.212 I;I ∈ [0; 0; 72.8]	0.509 + 0.86 I;I ∈ [0; 0; 40.8]
V3	Sustainability of financing and quality of spending	v31	Lack of financing strategies	[0; 6]	(0.97, 0.07, 0.03)	0.51	VI	1,609 + 3,155 I;I ∈ [0; 0; 49.0]	0.705 + 2.128 I;I ∈ [0; 0; 66.9]	0.438 + 0.674 I;I ∈ [0; 0; 35.0]
		v32	Poor quality of spending	[0; 6]	(0.67, 0.62, 0.72)	0.49	MDI	1,373 + 2,927 I;I ∈ [0; 0; 53.1]	0.675 + 2.11 I;I ∈ [0; 0; 68.0]	0.492 + 0.721 I;I ∈ [0; 0; 31.8]

Table 3. Neutrosophic measures with levels of indeterminacy for each plithogenic subset of development in education

231

Although the need to use the lowest percentage level of indeterminacy to obtain accurate and homogeneous results influences with a greater degree and a low level of indeterminacy than the other factors in the development of education. For each determining factor in the pertaining subset and its hierarchy level in the plithogenic set as established:CV_N

- Low quality of education
- Insufficient infrastructure and equipment, inadequate and lacking cultural identity
- Lack of financing strategies

Stage II. Development of mathematical modeling through neutrosophic logic to plithogenic logic in the development of education

Plithogenic set: Development of education (table 3)

The plithogenic set is defined for three subsets V1, V2, and V3

That is why a plithogenic set is defined that consists of 7 attributes, each of these attributes contain possible values (table 3), with their respective plithogenic particularities and possible values in the linguistic expression to determine the level of importance of the factor on the variable (table 1).

The multi-attribute of dimension 3 has cardinality 3x2x2 = 12.

The degrees of contradiction between the values for each attribute are defined below:

c_N (v_{11}, v_{12}) = c_N (v_{12}, v_{13}) = 0.3

c_N (v_{21}, v_{22}) = 0.1

c_N (v_{31}, v_{32}) = 0.1

As we can see, the dominant values for each attribute are: v_{12}, v_{21}, and v_{31}

When v21, v12, and v31 are activated, all the other nodes are activated, which means that the incidence value caused by the low quality of education in the institutions is influenced by the deterioration of the infrastructure and insufficient, inadequate equipment and without identity cultural, has a negative influence by projecting itself as a dominant value within the plithogenic set of education, in such a way that it constitutes an impairment in professional and educational growth preceded by the absence of financing strategies.

To determine a level of solution, it is necessary to know which subsets to act on through the relationship and the level of importance, as follows:

- Educational quality and System Efficiency
- Educational quality and absence of financing strategies
-

V_{12}	V_{21}	V_{31}
M: YES (0.92, 0.27, 0.12)	VI (0.97, 0.07, 0.03)	VI (0.97, 0.07, 0.03)

Low quality of education (v21) and insufficient infrastructure and equipment, inadequate and lacking cultural identity (v12)

Neutrosophic Plithogenic Union	$S([T,I,F]) = \frac{2+T-I-F}{3}$	Evaluation
(a1, a2, a3) $\vee_p$ (b1, b2, b3) = (a1∧D b1, $\frac{1}{2}$[(a2∧Db2) + (a2∨D b2)], a3∧D b3)	0.9061	It is in a sublevel

(a1, a2, a3) ∨p (b1, b2, b3) = (0.892, 0.17, 0.004)

between I and
MI

Low quality of education (v21) and absence of financing strategies (v31)

Neutrosophic Plithogenic Intersection	$\delta([T, I, F]) = \frac{2+T-I-F}{3}$	Evaluation
(a1, a2, a3) ∧p (b1, b2, b3) = (a1∧D b1,$\frac{1}{2}$[(a2∧Db2)+ (a2∨D b2)], a3∨D b3) (a1, a2, a3) ∧p (b1, b2, b3) = (0.94, 0.07, 0.059)	0.9372	It is on a sublevel between MI and VI

Table 4. Evaluations between v_{12}, v_{21}, and v_{31}

There is a stronger relationship between the subsets of educational quality and sustainability of financing and quality of spending [in its attribute (v21) and (v31)] than between educational quality and system efficiency, taking into account the most predominant factors. A relationship is obtained one degree closer to more important than very important according to the plithogenic neutrosophic union and intersection operator. So the solutions must be focused on solving the factors (v21) and (v31) that affect the development of education.

Partial solutions:

- To increase the quality of education in the different localities of the country, it is necessary the creation of an institute that is in charge of designing, experimenting, and gradually disseminating the educational innovations that are required.

- The governing bodies on educational development must promote and finance projects for the educational sector to promote professional development.

- It must be understood that education is one of the main development tools of a country, providing opportunities for the population and allowing progress towards a more equitable and egalitarian country.

Conclusions

- Ecuador has presented innumerable advances in education, however, like most countries in the region, there is still a long way to go, and one of them is the educational quality that is still deficient.

- Neutrosophic statistics revealed that among the factors that most affect educational development are the low quality of education; insufficient infrastructure and equipment, inadequate and without cultural identity, and absence of financing strategies, corresponding to the dimension it belongs.

- The analysis of the mathematical modeling through the neutrosophic logic to the plithogenic logic determined within the plithogenic set of development in education, which subsets were compromised by directly influencing educational development. The relationship between the subsets of educational quality and sustainability of financing and quality of spending was at a sub-level between MI and VI. Objectively, these nodes must be influenced to reduce their incidence and activation of the remaining nodes.

References

[1] Asamblea.Nacional.Constituyente, "Ley Orgánica para Prevenir y Erradicar la Violencia Contra las Mujeres," ed. Quito: Corporación de Estudios y Publicaciones, 2018.
[2] D. C. Vera, A. V. T. Suntaxi, G. C. I. Alcívar, J. E. Ricardo, and M. D. O. Rodríguez, "Políticas de inclusión social y el sistema de ingreso a las instituciones de educación superior del ecuador," *Dilemas Contemporáneos: Educación, Política y Valores,* vol. 6, 2018.

[3] C. Contreras and M. Anahis, "Proceso de titulación, pertinencia en la carrera de comunicación social de la facultad de ciencias jurídicas sociales y de la educación en la universidad técnica de Babahoyo," Babahoyo: UTB, 2018, 2018.

[4] G. Á. Gómez, J. V. Moya, J. E. Ricardo, and C. V. Sánchez, "La formación continua de los docentes de la educación superior como sustento del modelo pedagógico," *Revista Conrado,* vol. 17, pp. 431-439, 2021.

[5] J. E. Ricardo, J. J. D. Menéndez, and R. L. M. Manzano, "Integración universitaria, reto actual en el siglo XXI," *Revista Conrado,* vol. 16, pp. 51-58, 2020.

[6] J. E. Ricardo, Á. B. M. Vásquez, R. A. A. Herrera, A. E. V. Álvarez, J. I. E. Jara, and N. B. Hernández, "Management System of Higher Education in Ecuador. Impact on the Learning Process," *Dilemas Contemporáneos: Educación, Política y Valore,* 2018.

[7] I. I. Orozco Fernández and J. Estupiñán Ricardo, "Atención a la diversidad como premisa de la formación del profesional en comunicación social," *Dilemas Contemporáneos: Educación, Política y Valores,* vol. 6, 2018.

[8] J. E. RICARDO, *Estrategia de Gestión en la Educación Superior; pertinencia e impacto en la interrelación de los procesos académicos, de investigación científica y de vinculación con la sociedad en el periodo enero 2016-mayo 2018 en la Facultad de Ciencias Jurídicas, Sociales y de la Educación de la Universidad Técnica de Babahoyo en Ecuador*: Infinite Study, 2018.

[9] I. Bedoya, *Epistemología y Pedagogía. Ensayo histórico crítico sobre el objeto y método pedagógicos*. Bogotá, Colombia: Ecoediciones, 2003.

[10] Organización de las Naciones Unidas. (2021, 2021). *Incorporando los ODS en los planes de estudio de educación superior*. Available: https://www.un.org/

[11] Unesco, "Las Tic en la Educación UNESCO," ed, 2013.

[12] C. A. Santillan Mora, "El uso inadecuado de la tecnología y su incidencia en el aprendizaje de los estudiantes de la Escuela de Educación Básica Jorge Icaza Delgado del cantón Babahoyo, Provincia de Los Ríos," BABAHOYO: UTB, 2019, 2019.

[13] H. A. Macías, C. Ortiz Viáfara, and M. A. Rodríguez Tovar, "Medio ambiente, sociedad, ética y educación: reflexiones desde la disciplina contable," 2020.

[14] A. Sacristán, *Sociedad del conocimiento, tecnología y educación*: Ediciones Morata, S. L. , 2013.

[15] M. Contreras. *Educación como base fundamental para el progreso* Available: https://www.monografias.com/docs115/educacion-base-progreso-ecuador/educacion-base-progreso-ecuador.shtml

[16] R. Uzcátegui and R. Junguittu, *Historia, historia de la educación y su enseñanza*. Venezuela: Saber UCV, 2017.

[17] A. Moreira, "Historia del sistema educativo del Ecuador. Monografías 1-24," 2013.

[18] M. d. E. Ecuador. (2018). *Educación: Más recursos en beneficio del país. Informe Ministerio de Educación*. Available: https://educacion.gob.ec/educacion-mas-recursos-en-beneficio-del-pais/

[19] M. Knobel. (1964) El desarrollo y la maduración en psicología evolutiva. *Revista de Psicología, 1, 1-5*.

[20] A. G. Serón, *Enseñanza y sociedad de conocimiento sociológico de la educación*: Siglo XXI de España Editores, S.A, 2011.

[21] A. G. Serón;. (2020;). *Enseñanza y sociedad de conocimiento sociológico de la educación*. Available: https://elibro.net/en/lc/uniandesecuador/titulos/106309?fs_q=educacion%20y%20sociedad&fs_language=8&fs_edition_year=2020;2019;2018&prev=fs

[22] ONU, "Un enfoque de la educación para todos basado en los derechos humanos.," ed. New York: División de Comunicaciones, UNICEF.: New York: División de Comunicaciones, UNICEF., 2008.

[23] S. H. S. Al-Subhi, I. Pérez Pupo, R. García Vacacela, P. Y. Piñero Pérez, and M. Y. Leyva Vázquez, "A New Neutrosophic Cognitive Map with Neutrosophic Sets on Connections, Application in Project Management. ," *Neutrosophic Sets and Systems,* vol. 22. , pp. 63-75, 2018.

[24] F. Smarandache, *An introduction to the Neutrosophic probability applied in quantum physics*: Infinite Study, 2000.

[25] W. B. Vasantha, I. Kandasamy, and F. Smarandache, "Algebraic Structure of Neutrosophic Duplets in Neutrosophic Rings < Z U I>,< Q U I> and < R U I.> " *Neutrosophic Sets and Systems, ,* vol. 23, pp. 85-95, 2018.

[26] E. J. H. Antepara, *Competencies Interdepencies Analysis based on Neutrosophic Cognitive Mapping*: Neutrosophic Sets and Systems, 2017.

[27] Al-subhi, Salah Hasan, et al. "Triangular Neutrosophic Cognitive Map for Multistage Sequential Decision-Making Problems." International Journal of Fuzzy Systems 23.3 , 2021.

[28] A. S. Molina, W. A. C. Calle, and J. D. B. Remache, "The application of Microsoft Solution Framework Software Testing using Neutrosophic Numbers," *Neutrosophic Sets and Systems,* vol. 37, pp. 267-276, 2020.

[29] A. Abdel-Monem and A. Abdel Gawad, "A hybrid Model Using MCDM Methods and Bipolar Neutrosophic Sets for Select Optimal Wind Turbine: Case Study in Egypt," *Neutrosophic Sets and Systems,* vol. 42, pp. 1-27, 2021.

[30] M. E. Á. Tapia, D. C. M. Raúl, and C. N. M. Vinicio, "Indeterminate Likert Scale for the Analysis of the Incidence of the Organic Administrative Code in the current Ecuadorian Legislation," *Neutrosophic Sets and Systems,* vol. 37, pp. 329-335, 2020.

[31] C. E. Ochoa Díaz, L. A. Colcha Ramos, M. J. Calderón Velásquez, and O. Pérez Peña, "Knowledge-based Hiring Recommender Model for Occasional Services in the Public Sector," *Neutrosophic Sets and Systems,* vol. 37, pp. 176-183, 2020.

[32] F. d. R. Lozada López, M. E. Villacreses Medina, and E. C. Villacis Lascano, "Measure of Knowledge in Students at Uniandes, Ecuador, on the Manifestations of Oral Cancer," *Neutrosophic Sets and Systems,* vol. 37, pp. 151-159, 2020.

[33] C. A. Escobar Suárez, R. Oliva Torres, and L. Espinoza Freire, "Neutrosophic Analysis of Complications Generated by Hypothyroidism during Pregnancy," *Neutrosophic Sets and Systems,* vol. 37, pp. 141-150, 2020.

[34] A. D. M. Manzano, J. Y. V. Villegas, L. M. O. Escobar, and L. T. Jiménez, "Neutrosophic Analysis of the Facultative Vote in the Electoral Process of Ecuador," *Neutrosophic Sets and Systems,* vol. 37, pp. 355-360, 2020.

[35] C. C. Guillot, D. R. M. Medina, and M. A. B. Ávalos, "Neutrosophic Evaluation of Depression Severity," *Neutrosophic Sets and Systems,* vol. 37, pp. 242-249, 2020.

[36] J. L. R. Villafuerte, L. D. T. Torres, and L. T. Jimenez, "Neutrosophic Hypothesis to validate a modification for Article 630 of the Integral Organic Criminal Code of Ecuador," *Neutrosophic Sets and Systems,* vol. 37, pp. 260-266, 2020.

[37] P. E. D. P. Franco, A. J. P. Palacio, and I. A. C. Piza, "Neutrosophic Hypothesis to validate a Reform Project to Article 87 of the General Organic Code of Processes of Ecuador," *Neutrosophic Sets and Systems,* vol. 37, pp. 316-322, 2020.

[38] N. V. Q. Arnaiz, N. G. Arias, and L. C. C. Muñoz, "Neutrosophic K-means Based Method for Handling Unlabeled Data," *Neutrosophic Sets and Systems,* vol. 37, pp. 308-315, 2020.

[39] A. J. P. Palacios, L. B. Bustamante, V. C. Armijo, and V. S. N. Luque, "Neutrosophic multicriteria method to evaluate the com-petencies of mayoral candidates," *Revista Asociación Latinoamericana de Ciencias Neutrosóficas. ISSN 2574-1101,* vol. 11, pp. 17-24, 2020.

[40] I. Pimienta Concepción, E. Mayorga Aldaz, L. Gabriel Flores, and E. González Caballero, "Neutrosophic Scale to Measure Psychopathic Personalities Based on Triple Refined Indeterminate Neutrosophic Sets," *Neutrosophic Sets and Systems,* vol. 37, pp. 61-70, 2020.

[41] G. A. Gómez, J. F. G. García, S. D. Á. Gómez, and F. Smarandache, "Neutrosophic Sociogram for Group Analysis," *Neutrosophic Sets and Systems,* vol. 37, pp. 417-427, 2020.

[42] P. A. Mena Silva, A. Romero Fernández, and L. A. Granda Macías, "Neutrosophic Statistics to Analyze Prevalence of Dental Fluorosis," *Neutrosophic Sets and Systems,* vol. 37, pp. 160-168, 2020.

[43] P. A. M. Silva, A. R. Fernández, and L. A. G. Macías, "Neutrosophic Statistics to Analyze Prevalence of Dental Fluorosis," *Neutrosophic Sets and Systems,* vol. 37, pp. 160-168, 2020.

[44] C. R. Martínez, G. A. Hidalgo, M. A. Matos, and F. Smarandache, "Neutrosophy for Survey Analysis in Social Sciences," *Neutrosophic Sets and Systems,* vol. 37, pp. 409-416, 2020.

[45] D. V. G. Mayorga, E. d. P. A. Escobar, and O. F. S. Montoya, "Neutrosophy Used to Measure the Legal and Socioeconomic Effect of Debtors," *Neutrosophic Sets and Systems,* vol. 37, pp. 295-301, 2020.

[46] J. M. Macías Bermúdez, G. K. Arreaga Farias, and L. Torres Torres, "Profiles of Human Trafficking Violence in Regions of Ecuador," *Neutrosophic Sets and Systems,* vol. 37, pp. 200-207, 2020.

[47] L. Wong Vázquez, Cueva Moncayo, María Fernanda., and L. P. Advendaño Castro, "Risk Factors Prioritization for Chronic Obstructive Pulmonary Disease," *Neutrosophic Sets and Systems,* vol. 37, pp. 49-60, 2020.

[48] D. Coka Flores, J. R. Cadena Morillo, C. G. Rosero Martínez, and W. Ortiz Aguilar, "Selection of Experts to Validate a Research Proposal Using a Neutrosophic Method," *Neutrosophic Sets and Systems,* vol. 37, pp. 71-80, 2020.

[49] A. Romero Fernández, E. Labrada González, and D. Loyola Carrasco, "Study on the Level of Knowledge in Dental Medical Emergencies of Dentistry Students through Neutrosophic Values," *Neutrosophic Sets and Systems,* vol. 37, pp. 90-107, 2020.

[50] F. Smarandache, *Neutrosophy, a new Branch of Philosophy*: Infinite Study, 2002.

[51] W. V. Kandasamy and F. Smarandache, "Fuzzy Neutrosophic Models for Social Scientists.," *Education Publisher Inc.,* 2013.

[52] F. Smarandache, "A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability: Neutrsophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability: Infinite Study.," 2005.

[53] G. Á. Gómez, J. V. Moya, J. E. Ricardo, and C. B. V. Sánchez, "Evaluating Strategies of Continuing Education for Academics Supported in the Pedagogical Model and Based on Plithogenic Sets," *Neutrosophic Sets and Systems,* vol. 37, pp. 16-23, 2020.

[54] F. Smarandache, "Plithogenic Probability & Statistics are generalizations of MultiVariate Probability & Statistics," *Neutrosophic Sets and Systems,* vol. 43, pp. 280-289, 2021.

[55] R. E. Atencio González, J. C. d. J. Arrias Añez, J. E. Coronel Piloso, and O. I. Ronquillo Riera, "Prioritization of the Social Approach of Employment Modeled by Plithogenic Sets " *Neutrosophic Sets and Systems,* vol. 37, pp. 184-192, 2020.

[56] F. Smarandache, *Physical plithogenic set. APS Annual Gaseous Electronics Meeting Abstracts*, 2018.

[57] M. Grida, Zaied, , *Novel Plithogenic MCDM Framework for Evaluating the Performance of IoT Based Supply Chain*. Neutrosophic Sets and Systems, 2020.

[58] M. G. M. E.-h. Abdel-Basset, A.; Smarandachec, F., *A novel model for evaluation Hospital medical care systems based on plithogenic sets,"* vol. 100,: Artif Intell Med, 2019.