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Use of Neutrosophy in the Evaluation of a Health Education Program for Undergraduate Medical Students

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Abstract. The study of problems that contribute to health education in university students is increasingly demanded by the scientific community, as it contributes to the prevention of diseases and thus encourages healthy lifestyles. In correspondence with the bibliographic review carried out in this research, it was found that this topic has been addressed by various scientific disciplines, but undoubtedly it is still required to deepen the link with Neutrosophy. Based on these arguments, the present research aims to apply Neutrosophy in the evaluation of a health education program for undergraduate medical students of the Regional Autonomous University of the Andes, in the Republic of Ecuador. During the development of this study, theoretical, empirical and statistical methods were taken into account, particularly descriptive neutrosophic statistics. The results obtained allow asserting that the program presented has a high level of relevance and can be applied in university educational practice.

Keywords: neutrosophic linguistic scale, neutrosophic statistics, medicine, health education.

1 Introduction

According to the World Health Organization (1948), health is considered to be a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Health is understood in this case as a positive concept, in which social, personal, and physical aspects are reflected.

Another material that gives a vision of the concepts and contents that are needed to know about this topic is the Director Program for Health Promotion and Education, which states that: Health education is the process of permanent education based on the reports and actions aimed at acquiring knowledge, healthy habits, and skills that enable and facilitate negative behavior changes and the strengthening of others in the process of promoting healthier lifestyles [1].

According to Álvarez, [1] who considers that health education "is teaching that aims to lead the individual and the community, to a process of changing attitudes and behavior, for the application of means that allow them to preserve and improve their health". It is also an action that tends to make them responsible for both their own health and that of the social group to which they belong.

Health education seeks to incorporate a culture based on making students personally responsible, through the incorporation of knowledge, attitudes, and healthy habits. In addition, it allows decisions to be made to facilitate the care of the health of others, and integrate it with Physical Education in the educational environment, to favor the harmonious growth of their personality, developing an educational and socio-cultural process [2].

These topics must be recognized by university students, so that they can acquire the knowledge of health education, being able to have personal and collective hygiene habits and demonstrate a pleasant personal appearance at all times, exert a transforming action on caring for the environment, and become aware of its importance for the preservation of their health [3].

There is a wide range of studies and knowledge on health education in the university context. The main researchers have directed their studies from approaches such as pedagogical, gnoseological, and health, just to mention a few. However, the use of Neutrosophy has been little systematized in the scientific bibliography, aspects that will be used to carry out the analysis presented in this research.

That is why the present investigation has the objective to apply Neutrosophy in the evaluation of a health education program for undergraduate medical students of the Autonomous Regional University of the Andes, in the Republic of Ecuador.

2 Methodology

The research starts from the postulates of neutrosophy, which have been systematized by researchers such as [4] [5] [6], who agree that this is a new branch of philosophy, which opened a new field of research in metaphilosophy, and which studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra. It was created by Professor Florentin Smarandache in 1995.

Etymologically neutrosophy (from the French *neutre* and the Latin *neuter* meaning neutral and the Greek *sophia*, knowledge) is the knowledge of neutral thoughts. It forms the basis for neutrosophic logic, neutrosophic sets, neutrosophic probability, and neutrosophic statistics.

According to the aspects discussed above, each of the analyses of this research will be carried out, both statistical and in the selection of the sample and the use of neutrosophic linguistic scales. Which will be discussed below.

2.1 Study subjects

In correspondence with the criteria of the authors discussed above, the sample selection criteria proposed by Smarandache [4] are assumed, who considers that a neutrosophic sample is a chosen subset of a population, a subset that contains some indeterminacy: either with respect to several of its individuals (which may not belong to the population we are studying, or may only partially belong to it) or with respect to the subset as a whole. While classical samples provide accurate information, neutrosophic samples provide vague or incomplete information.

Where the letter p = means the approximate proportion of the reference population, the letter q = refers to the proportion of the reference population that does not present the research (1 -p). The desired confidence level for the statistician (Z), this letter is indicative of the level of confidence that will be had in the true value of the parameter in the population found in the calculated sample. For its part, absolute precision is represented by the letter (d). Which in turn means the desired width of the confidence interval on either side of the true value of the difference between the two proportions (in percentage points). While the N refers to the size of the population.

That is why Smarandache also says that any sample is neutrosophic since it can be considered that its determination is equal to zero. A neutrosophic population is a population that has not determined the membership of its members (that is, it is not known with certainty whether some individuals belong to the population or not) [4], [22], [23, 26].

Being consistent with the selected formula and to increase the validity of the research, a confidence level between 90 and 95% is desired, z= [1.642, 1.99], d= [0.04, 0.2] and p = [0.5, 0.43] , N=40. The result called the neutrosophic sample n= [10.1, 30.9], indicates that the sample must be in values between 10 and 32 medical students of the Autonomous Regional University of the Andes, in the Republic of Ecuador.

This research selects 32 undergraduate students who will be users of the health education program presented. All of them passed their third year and were randomly selected using the Tombola technique.

2.2 Instruments used

In the investigation, methods and techniques of the sciences, in general, were used, such as those of a theoretical nature such as the analytical-synthetic, and the inductive-deductive, which facilitated the work with the bibliography selected for the present investigation.

Within the empirical ones, the survey and the user criteria were used, for the latter, the recommendations of authors such as Matos, and Matos, Brito, who consider it important to consult those who will benefit from a certain proposal, are followed [7] [8].

These consulted bibliographic sources [7], [21], [24], [25], [26], [27], [28] consider that the user criterion refers to *"the opinions expressed by the subjects who become users or direct beneficiaries of a proposal, who are or will be responsible for the application of such results in the immediate or mediate future"*. In addition, they defend the criterion that it is a method of a qualitative nature and include it at the empirical level. (p.46).

Within the mathematical statistics, neutrosophic descriptive statistics are used, and within this, the percentage calculation.

2.3 Neutrosophic method

Within the neutrosophic techniques used, the Neutrosophic Likert scales, where the values under consideration are composed of PA (x), IA (x), NA (x), where PA(x) denotes a positive membership, IA(x) is indeterminate, and NA(x) is negative. The user can assess whether the health education program belongs to the three sets of satisfaction criteria.

This scale used single-value neutrosophic numbers (SVNS) [4], [5]. For this case study, the universe of discourse, an SVNS on which is an object with the following form [12], [13], [14].

Where With for all x

The interval [0, 1] represents the true, undetermined, and false memberships of x in A, respectively. For convenience, an SVN number will be expressed as A, where a, b, c, and $+b +c \leq 3$

To represent inconsistent, imprecise, and uncertain information from the real world, the membership of indeterminacy is represented independently together with the membership of truth and falsehood in the set of neutrosophy, this has been recommended by several researchers such as [4], [5], [15], [16], [20]. The interval represents the true, undetermined, and false memberships of x in A, respectively.

$$A = \{\langle x, u_a(x), r_a(x), v_a(x)\rangle : x \in X\}d \quad (1)$$

Where

$u_a(x): X \to [0,1], r_a(x): X \to [0,1]\ y\ \ v_a(x): X \to [0,1]$

With

$0 \leq u_a(x), r_a(x), v_a(x) \leq 3, \qquad \forall\, x \in X$

The intervals $u_a(x), r_a(x)$ and $v_a(x)$ denote the true, indeterminate, and false memberships of x in A, respectively.

For convenience, an SVN number will be expressed as A, where a, b, c [0,1], and +b +c ≤ 3.

Linguistic term	SVN numbers
Excellent (E)	(1,0,0)
Very good (VG)	(0.70,0.35,0.28)
Good (G)	(0.50,0.50,0.49)
Regular (R)	(0.40,0.85,0.75)
Bad (B)	(0,1,1)

Table 1: Linguistic terms of the scale

Let A = (T, I, F) be a single-valued neutrosophic number, a score function S related to a single-valued neutrosophic value, based on the degree of truth membership, the degree of indeterminacy membership and the degree of belonging to falsehood is defined by [4], [17]:

The scoring function for single-valued neutrosophic sets is proposed to make the distinction between the numbers.

Its execution algorithm basically exploits the notion of distance measurements between any two entities and based on this, the clusters are formed. The most commonly used distance formula for these values is the Euclidean:

$$\mathrm{d(A-B)} = \sqrt{\frac{1}{3}\sum_{i=1}^{n}[P_A(x_i)-P_B(x_i)]^2 + [I_A(x_i)-I_B(x_i)]^2 + [N_A(x_i)-N_B(x_i)]^2} \quad (2)$$

Neutrosophy, as already discussed, was proposed by Smarandache [9] for the treatment of neutralities. This has formed the basis for a series of mathematical theories that generalize classical and fuzzy theories such as neutrosophic sets and neutrosophic logic [12].

For the implementation of the research, the neutrosophic model proposed in the methodological steps presented below is used.

Step 1. Select the researchers and who can be the receiving users

Step 2. Preparation of a preliminary survey

Step 3. Explain in the survey questionnaire it is necessary to detail and explain to the users what is to be evaluated

Step 4. Determination of the procedure to follow for the collection of information

Step 5. Information processing and analysis

Components of the program for health education

Components	Contents	Actions
System of objectives	General and specific	Identification of general and specific objectives
Block 1. Orientation	Healthy lifestyles Nutritional orientation	Conduct orientation seminars Conduct educational talks

	Toxic habits	
Block 2. Systematization	Systematic educational activities Community educational intervention	Systematization of significant experiences Organization of community forums

Table 2: Summary of the components of the health education program.

3 Results

Before applying the survey to the selected users, who in this case are the medical students at the Autonomous Regional University of the Andes, a brochure with the entire program was given to them a week before so that they could study it. Subsequently, it is applied to a survey to know its level of relevance.

Results of the users to question 1 of the applied survey

Question 1	Excellent 6	Very Good 5	Good 4	Regular 3	Bad 2
How do you assess the system of objectives of the health education program presented?	11 (34.3%)	8 (25.2%)	6 (18.7%)	4 (12.5%)	3 (9.3%)

Table 3: Results of the assessment of the patients regarding question 1.

In correspondence with the results of Table 3, the categories with the highest score were the most indicated by the university students. Well, 11 for 34.3% of the total sample value the components of the program as excellent. On the other hand, 8 of them for 25.2% value it as Very good. While 6 for 18.7%, estimated that these are Good. On the other hand, they value it as Regular only 4 for 12.5%, and a minority of the students consider that the program is qualified as Bad. This is reflected in 3 students for 9.3%.

Question 2	Excellent 6	Very Good 5	Good 4	Regular 3	Bad 2
How do you rate the blocks of the health education program	19 (59.3%)	4 (12.5%)	4 (12.5%)	3 (9.3%)	2 (6.4%)

Table 4: Results of the assessment of university students regarding question 2 of the survey

The results of question 2 of the survey applied to university students, it is evident as in the previous one that there is a regularity that the students indicate in their majority the categories with the highest score. This is reflected in the fact that only 19 for 59.3% stated that the health education program presented is of excellence, while 4 for 12.5% rated it as Very good, the same number rated it as good (4 for 12.5%) For their part, only 3 for 9.3% value it as regular and only a minority of 2 students for 6.4% state that the program is bad. A result that coincides with what was expressed in the previous question.

Question 3	Excellent 6	Very Good 5	Good 4	Regular 3	Bad 2
How do you value the contents and actions of the health education program?	21 (65.6%)	5 (15.6%)	3 (9.6%)	1 (3.1%)	1 (3.1%)

Table 5: Results of the assessment of university students regarding question 3 of the survey

Table 5 illustrates the results of the students' responses to question 3 of the survey. Where it is appreciated that

the majority of university students consider that the program is Excellent (22 for 65.6%), while 5 for 15.6% consider that it is Very Good, only 3 for 9.6% consider that this is Good and the two lowest categories of the scale had 1 student respectively (Regular 1 for 3.1 and Bad 1 for 3.1). What has been assessed so far makes evident the relevance of the program presented according to the criteria of the users [18], [19], [29].

Conclusion

From the analysis carried out, it becomes evident that health education has been systematized from different approaches and perspectives. However, the use of Neutrosophy for the assessment of the relevance of a program has been little treated in the specialized bibliography on this subject.

Through the use of a linguistic neutrosophic scale and with the help of the user criterion technique, the relevance of a health education program in medical university students was demonstrated.

References

[1] R. Álvarez. Educación para la salud. México: Manual Moderno, 2005
[2] R. Borrero. Estrategia didáctica para dirigir la educación para la salud en la secundaria básica. (Tesis doctoral). La Habana. 2008
[3] C. Carvajal. Temas de educación para la salud y educación de la sexualidad. La Habana. Editorial Pueblo y Educación. 2003
[4] F. Smarandache. "Introduction to Neutrosophic Statistics". Ed. Infinite Study, 150, 2014
[5] F. Smarandache. "Neutrosophic Overset, Neutrosophic Underset, and Neutrosophic Offset. Similarly for Neutrosophic" Over-/Under-/Off-Logic, Probability, and Statistics. 2016
[6] M. Leyva & F. Smarandache. "Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre". Ed. Infinite Study.187, 2018
[7] Brito, E. La formación continua de los profesionales de natación artística en Cuba. (Tesis doctoral) Universidad de Ciencias de la Cultura Física y el Deporte. La Habana. 2017
[8] Matos, Z., y Matos, C. El método de criterio de usuarios. Su utilización en la investigación educativa. Guantánamo, Cuba: Instituto Superior Pedagógico "Raúl Gómez García".2006
[9] F. Smarandache, "of Neutrosophic Numbers". Critical Review, Vol. 13, 2016. 13: p. 103. 2016
[10] N.B Hernández. Validation of the pedagogical strategy for the formation of the competence entrepreneurship in high education through the use of neutrosophic logic and Iadov technique. Neutrosophic Sets & Systems, 2018. 23.
[11] Y M Gordo Gómez, D M Ramírez Guerra, L A Zaldívar Castellanos, R González Piña. Análisis del emprendimiento comunitario en las actividades físico-terapéuticas desde la Universidad. Neutrosophic Computing and Machine Learning, Vol. 8, 2019
[12] Smarandache, F., A Unifying Field in Logics: Neutrosophic Logic. Philosophy, 1999: p. 1 -141.
[13] Jansi, R., Mohana, K., & Smarandache, F. (2019). Correlation Measure for Pythagorean Neutrosophic Fuzzy Sets with T and F as Dependent Neutrosophic Components. Neutrosophic Sets and Systems, 30(1), 16.
[14] O. Mar, I. Santana, and J. Gulín, "Algoritmo para determinar y eliminar nodos neutrales en Mapa Cognitivo Neutrosófico," Neutrosophic Computing and Machine Learning, vol. 8, pp. 4-11, 2019.
[15] R. G. Ortega, M. Rodríguez, M. L. Vázquez, and J. E. Ricardo, "Pestel analysis based on neutrosophic cognitive maps and neutrosophic numbers for the sinos river basin management," Neutrosophic Sets and Systems, vol. 26, no. 1, pp. 16, 2019.
[16] S. A Edalatpanah, & Smarandache, F. (2019). Data envelopment analysis for simplified neutrosophic sets. Infinite Study.
[17] Y. G. Calva Vega, M. A. Torres Villamarín, F. P. Cañizares Galarza & J. C. Narváez Moncayo. "La ley orgánica de Servicio Público y los derechos sindicales de la clase obrera". Universidad y Sociedad, vol. 14 no. S3, pp 525-536, 2022.
[18] J. L. Maldonado Cando, M. A. Torres León, J. R. Santillán Andrade & G. F. Acurio Hidalgo. "La delincuencia generada por la violencia infantil". Universidad y Sociedad, vol. 14 no. S3, pp 513-524, 2022.
[19] M. E. Machado Maliza, M. E. Paredes Moreno & C. D. Siza Pillajo. "La administración de justicia en la población indígena, discriminación cultural". Universidad y Sociedad, vol. 14 no. S3, pp 504-512, 2022.
[20] Romero Fernández, A. J., Álvarez Gómez, G. A., & Estupiñán Ricardo, J. "La investigación científica en la educación superior como contribución al modelo educativo". Universidad Y Sociedad, vol. 13 no. S3, pp 408-415, 2021.
[21] Ricardo, J. E., Peña, R. M., Zumba, G. R., & Fernández, I. I. O. "La Pedagogía como Instrumento de Gestión Social: Nuevos Caminos para la Aplicación de la Neutrosofía a la Pedagogía". Infinite Study, 2018.
[22] Vera, D. C., Suntaxi, A. V. T., Alcívar, G. C. I., Ricardo, J. E., & Rodríguez, M. D. O. "Políticas de inclusión social y el sistema de ingreso a las instituciones de educación superior del Ecuador". Dilemas Contemporáneos: Educación, Política y Valores. Vol. 1 no. 19, pp 1-18, 2018.
[23] Leyva Vázquez, M. Y., Estupiñán Ricardo, J., Coles Gaglay, W. S., & Bajaña Bustamante, L. J. "Investigación científica. Pertinencia en la educación superior del siglo XXI". Conrado, vol. 17 no. 82, 2021.
[24] Ricardo, J. E. (2018). "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.
[25] Estupiñán Ricardo, J., Leyva Vázquez, M. Y., Marcial Coello, C. R., & Figueroa Colin, S. E. "Importancia de la preparación de los académicos en la implementación de la investigación científica". Conrado, vol. 17 no. 82, pp 337-343, 2021.
[26] von Feigenblatt, O. "Mediation for management: Dealing with Conflict in the Workplace". Innovaciones de Negocios,

vol. 18 no. 35, pp 113-119, 2021.
[27] S. A. Montecé Giler, T. J. Mendoza Palma, J. C. Nevarez Moncayo & E. L. Hernandez Ramos. "Limitación de acceso a los medicamentos para las personas que padecen enfermedades catastróficas". Universidad y Sociedad, vol. 14 no. S4, pp 241-251, 2022.
[28] I. X. León Rodríguez, E. A. Rojas Silva, L. C. Campaña Muñoz & P. A. Centeno Maldonado. "Violencia física a la mujer: una visión desde el cantón Santo Domingo en Ecuador durante el último trienio". Universidad y Sociedad, vol. 14 no. S4, pp 234-240, 2022.
[29] C. X. Galarza Castro, R. C. Ilaquiche Licta, E. J. Naranjo Luzuriaga & J. D. Bósquez Remache. "La facultad discrecional y la vulneración a la democracia directa en Ecuador". Universidad y Sociedad, vol. 14 no. S4, pp 225-233, 2022.

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