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Neutrosophic Iadov for measuring of user satisfaction in a virtual learning environment at UNIANDES Puyo

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Abstract. In present, the university education promoted by the Regional Autonomous University of Los Andes, Ecuador, is supported by a Virtual Learning Environment. This is the fundamental reason that originated this research, for knowing if the use of the Virtual Learning Environment has either a positive or negative effect on the teaching-learning process in this university, especially in the Puyo campus. To carry out this work we consider the academic cycle April-August 2018. A survey was conducted in a unique environment and was applied to teachers and students, such that their opinion on the use of this tool is investigated. The processing of data of the survey was based on the neutrophic Iadov technique. Iadov technique consists of a set of three closed questions, and in addition an undetermined number of open questions that are processed by a logical tree that combines every triple of possible answers with a number that serves to logically evaluate such a combination. Neutrosophic Iadov generalizes the Iadov technique in order to take into account the indeterminacy that is typical of any evaluation. Therefore, this method is more accurate than its precedent.

Keywords: Virtual Learning Environment, higher education, neutrosophic Iadov technique, computer assisted instruction.

1 Introduction

The social, political, economic and cultural conditions that characterize 21st century societies have permitted, among other things, the emergence of the so-called culture of the digital society, see [1]. Ecuadorian society and the world in general have experienced profound changes in the way of working, relating and learning, largely due to the influence of technology in daily life. All these changes are even reflected in the smallest aspect of our life and one of the most important places is university, since it is the institution that is responsible for training the new professionals required by the working world.

According to Cano's criteria ([2]) in order to improve the quality of university education, we have to profoundly transform the procedures focused on student learning with the aim of providing them, throughout their time at the institution, with a complete as possible training and, of course, to favor its professional insertion in the workplace from the platform of an organizational model of university orientation, and formally institutional tutorial action. In this context, the teaching practice of every teacher is the closest level to the student, from a multidimensional perspective, as it is shown in Figure 1.

According to Fados ([3]), teaching cannot be understood as a simple transmission of information, but as a more complex process that concerns on how to provoke personal development in an intentional and organized context. While learning is understood as a process by which an organism changes its behavior as a result of experience. Thus, maturation and development cannot be considered learning.

In the "Diagnosis of Virtual Higher Education in Ecuador" carried out by UNESCO in 2002, it was established that 72% of Ecuadorian universities already offered distance and semi-full-time programs with increasing tendency, which leads us to deduce that all this offer of vocational training will necessarily have to rely on some virtual learning platform to meet student demand, see [4].

The impact of communication networks on training and education is one of the biggest changes that have taken place in Educational Institutions, in this new training context, terms such as "virtual training", "virtual classroom" or "virtual training environments" begin to emerge, see [4].
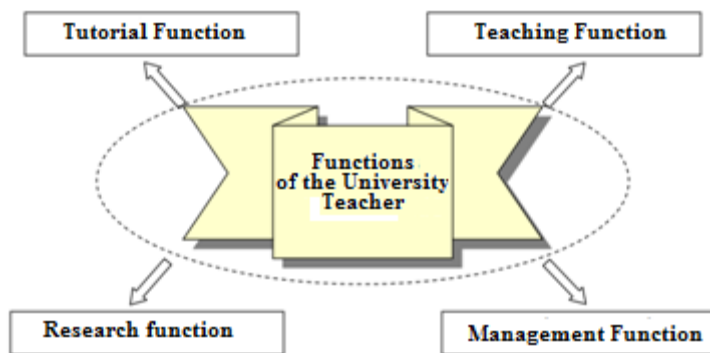

Figure 1: Functions of the university teacher. Source [2].

According to Colina et. al. ([5]) ICTs offer excellent possibilities to overcome the limitations of space and time, where students interact with the teacher, establishing their own style that allows them to generate cognitive learning strategies in new spaces such as virtual environments of learning and if we add to this that nowadays university students are skilled about using new technologies, together with their great capacity for learning and the modern teacher is receptive to its usage, we have the ideal scenario to implement a Virtual Learning Environment in UNIANDES Puyo.

For Toala Dueñas et al. ([4]) in educational institutions and moreover in universities, the use of ICTs is being offered as means of study, in addition, in the full-time modality, several teachers incorporate virtual platforms for the reception of chores. UNIANDES Puyo is not far from this reality and in the semi-full-time and full-time modalities a considerable percentage of their teachers largely use this tool in their classes since several years ago.

In 1988, UNESCO, in its world report on education, points out that virtual learning environments constitute a totally new form of educational technology and offers a complex series of opportunities and tasks to educational institutions around the world; see [6][1].

According to Estrada in [6], among the characteristics of virtual learning environments we can mention:
- It promotes various ways of accessing and producing knowledge,
- It offers a new learning, communicational and work scenario so that the school is no longer the exclusive environment for training,
- It takes time, discipline, and perseverance to work in Virtual Learning Environment,
- Communication skills and autonomous learning are needed,
- Reflective thinking is favored.
- Provides new possibilities for interaction between teachers and students and between students.
- Facilitates the distribution and management of information.

The use of ICTs in the training of higher education provides multiple advantages in improving teacher quality, which is materialized in aspects such as access from remote areas, flexibility in time and space for the development of teaching or learning activities. Also, the possibility of interacting with the information by the different agents involved in these activities ([7][2]), so we can highlight:
- Breakage of space-time barriers in teaching and learning activities,
- Open and flexible training processes,
- Improves communication between the different agents of the teaching-learning process,
- More personalized teaching,
- Quick access to information,
- Possibility to interact with the information,
- Raises the interest and motivation of students,
- Improvement of educational effectiveness,

- Allow the teacher to have more time for other tasks,
- Complementary activities to support learning.

The set of knowledge and skills that today's professional needs to develop are very broad, and time is short. UNIANDES is aware of this reality and provides technological tools including the Virtual Learning Environment, which support and facilitate student work. But are students and teachers aware of the benefits obtained by using the Virtual Learning Environment? In response to this question, this paper seeks to know the positive or negative impact of the use of the Virtual Learning Environment in the teaching-learning process at UNIANDES Puyo in the last academic period, that is, April-August 2018. For this, we applied the neutrosophic Iadov technique.

The Iadov technique was created by its author to establish the level of satisfaction for the profession of pedagogical careers. Then, some authors including González ([8]) applied it to assess the satisfaction of pedagogical professional training. In [9] a modification of this technique is made and it is proposed as an alternative for the diagnosis of professional motivation in physical education teachers[3].

The Iadov technique constitutes an indirect way for the study of satisfaction when performing certain activities is based on the analysis of a questionnaire that has a specific internal structure unknown to the interviewee, [8-10][4]. Closed questions are established through the so-called "Iadov Logic Chart". The original proposal of the Iadov method does not allow an adequate management of the indeterminacy nor the management of the importance of the users. The introduction of the neutrosophic estimation seeks to solve the problems of indeterminacy that appear universally in the evaluations of the surveys and other instruments, by taking advantage of not only the opposing positions but also the neutral or ambiguous ones, see [11-14][5, 6]. Under the principle that every idea <A> tends to be neutralized, diminished, balanced by other ideas, in clear rupture with binary doctrines in the explanation and understanding of phenomena.

The purpose of this paper is to study student satisfaction at the Regional Autonomous University of Los Andes in Puyo, Ecuador on Virtual Learning Environment usage, for this end, the neutrosophic Iadov technique is applied. We use this technique because in addition to having the advantages offered by the classic Iadov technique, we also take into account the indeterminacy of the measurements, when modelling with Neutrosophy.

This paper is divided with the following structure; Section 2 describes the fundamental concepts that will be used for this study. Section 3 presents the results obtained from applying the neutrosophic Iadov technique for the study we are interested in carrying out. The last section contains the conclusions of the paper.

2 Basic Concepts

Throughout this section we describe the main definitions necessaries to apply the neutrosophic Iadov technique, which basically consists in processing a survey containing three closed questions. The results are assessed according to the "Iadov Logic Chart", where a number is given for every possible triple of responses. The interviewed does not know the interrelationship among the three questions. Finally, in case of doubt about the meaning of the answers, or simply to collect more information, many open questions can be asked as well. See in the following the formal definitions.

Definition 1. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X. A *neutrosophic set A* in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. Where, $T_A(x)$, $I_A(x)$, $F_A(x) \subseteq]^-0, 1^+[$, i.e., they are real standard or nonstandard subsets of the interval $]^-0, 1^+[$. These functions do not satisfy any restriction, i.e., the following inequalities hold:

$^-0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$.

Definition 2. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X. A *Single Valued Neutrosophic Set* (SVNS) A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. Where, $T_A(x)$, $I_A(x)$, $F_A(x)$: $X \rightarrow [0, 1]$ such that: $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. A *single valued neutrosophic number* (SVNN) is symbolized by $<T,I,F>$ for convenience, where T, I, F $\in [0, 1]$ and $0 \leq T + I + F \leq 3$.

Therefore, $A = \{\langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in X\}$ or what is the same $A = \langle T_A(x), I_A(x), F_A(x) \rangle$, for every $x \in X$.

Let A and B be two SVNSs, the following operations are defined:

4. $A \subseteq B$ if and only if $T_A(x) \leq T_B(x)$, $I_A(x) \geq I_B(x)$ and $F_A(x) \geq F_B(x)$. And, $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$.

5. $A \cup B = \langle \max(T_A(x), T_B(x)), \min(I_A(x), I_B(x)), \min(F_A(x), F_B(x)) \rangle$, for every x∈X.

6. $A \cap B = \langle \min(T_A(x), T_B(x)), \max(I_A(x), I_B(x)), \max(F_A(x), F_B(x)) \rangle$, for every x∈X.

A scoring function s: $[0,1]^3 \rightarrow [0,3]$ can be read in Formula 1. Here we apply an adapted scoring function which is defined for sorting alternatives in Decision Making, see [15].

$$s(a_j) = 2 + T_j - F_j - I_j \qquad\qquad (1)$$

Where a_j is an alternative evaluated with the SVNN (T_j, I_j, F_j).
Additionally, the definition of precision index $a: [0,1]^3 \rightarrow [-1, \ 1]$, which is given in Equation 2.

$$a(a_j) = T_j - F_j \qquad\qquad (2)$$

Here we shall utilize Equation 2 for calculations.
Definition 3. The *Neutrosophic Logic* (NL) is the generalization of the fuzzy logic, where a logical proposition P is characterized by three components:
NL(P) = (T,I,F)   (3)
Where the neutrosophic component T is the degree of truthfulness, F is the degree of falsehood, and I is the degree of indeterminacy ([15-16]).

Table 1 summarizes a scale of satisfaction that associates a number with a linguistic expression, a SVNN and a score obtained by calculating Equation 2. Therefore, we have the elements sufficient to measure the satisfaction of the interviewed. The scores are slightly different of those used in [11][7].

Number	Expression	SVNN	Score (Precision function)
1	Clear satisfaction	(1, 0, 0)	1
2	More satisfied than dissatisfied	(1, 0.25, 0.25)	0.75
3	Not defined	(0.5, 0.5, 0.5)	0
4	More dissatisfied than satisfied	(0.25, 0.25, 1)	-0.75
5	Clear dissatisfaction	(0,0,1)	-1
6	Contradictory	(1,0,1)	0

Table 1: Individual satisfaction scale.

An essential element for applying this technique is the "Iadov Logic Chart" represented in Table 2.

4. Question 3	1. Question 1								
	Yes			I don't know			No		
	2. Question 2								
	Yes	I don't know	No	Yes	I don't know	No	Yes	I don't know	No
Very satisfied.	1	2	6	2	2	6	6	6	6
Partially satisfied.	2	2	3	2	3	3	6	3	6
I don't care.	3	3	3	3	3	3	3	3	3
More unsatisfied than satisfied.	6	3	6	3	4	4	3	4	4
Not at all satisfied.	6	6	6	6	4	4	6	4	5
I don't know what to say.	2	3	6	3	3	3	6	3	4

Table 2: A generic logic table by V.A. Iadov to measure the relationship among the three closed questions.

One example of aggregation operator used for aggregate SVNNs is the *Weighted Average* operator (WA),

which is shown in Equation 4, see [17][8].

$$WA(a_1, a_2, \cdots, a_n) = \sum_{i=1}^{n} w_i a_i \qquad (4)$$

Where, $a_i = (T_i, I_i, F_i)$ are SVNNs representing the evaluation of the alternatives, and $w_i \in [0, 1]$ for every i = 1, 2, …, n; which satisfy the condition $\sum_{i=1}^{n} w_i = 1$. The w_is represent the importance or weight of every alternative.

For measuring the group agreement, it is defined the Group Satisfaction Index (GSI) in [8], which is calculated as the Weighted Average operator.

In the following we describe the algorithm to use the neutrosophic Iadov technique:

9. The interviewed person is asked on his/her opinion, and he/she gives the answers for the three closed questions.
10. Thus, for each triplet of responses given by the interviewed person, we shall have a number from 1 to 6, which is selected of the Iadov Logic chart, see Table 2.
11. The selected number is the final evaluation of the person's opinion, which can be associated with its corresponding SVNN, in the third column of Table 1. However, we use the corresponding score in the last column of Table 1 for calculations.

12. Equation 4 is applied to aggregate the scores obtained of every person. Here we assume $w_i = \frac{1}{n}$ for all i.

    This is the so-called GSI.
13. To interpret the obtained GSI, we select from Table 1, the linguistic term having a closest score to GSI.

    When GSI is equally closest to two different values, the selection is made by means of the score function given in Equation 1.

14. In case that the final score is 0, we have to resort to the answers to the open questions.

3 Results

In this section we present the results of applying the neutrosophic Iadov technique to study the acceptance of Virtual Learning Environment. For this, we applied a survey to the participants in to 25 teachers and 261 students of UNIANDES Puyo, for both cases we did not distinguish the modality of studies because we want to know the level of satisfaction of using the Virtual Learning Environment in the teaching-learning process and the suggestions teachers and students have to improve this service.

The applied survey has two models according to the role of action: teachers and students. The selected teachers worked during the academic period April - August 2018. In total 25 teachers answered the questions, which teach different subjects in the modality of full-time and semi-full-time studies, which have access to the Virtual Learning Environment. On the other hand, the students considered for the study, belong to all the studies that are offered in the extension of Puyo. 261 students answered the questions, who regularly attend classes in the full-time courses, semi-full-time courses, and who have user account s in the Virtual Learning Environment.

The materials used in the research are, Office 365 forms and the Virtual Learning Environment implanted in UNIANDES Puyo to which all teachers and students have access. Teachers have access to virtual classrooms with the role of tutor teacher. In this way they have their own spaces where they can generate the contents of their subjects independently, with the requirement to comply with the structure of the virtual classroom established in the "Regulations for teachers in the use of virtual learning environment".

To carry out the research, it was necessary to design two survey models, one for teachers and one for students, in both cases we seek to know the degree of satisfaction of using the Virtual Learning Environment through answers to closed questions.

Both, teachers and students were notified and invited to participate in the survey using an electronic message

from the Virtual Learning Environment itself, they conducted the questionnaire anonymously electronically using Office 365 forms, in which they answered questions regarding the degree of satisfaction with the Virtual Learning Environment usage. Each type of questionnaire was analyzed individually, generating a global result by form model, with this analysis the positive or negative impact of the use of the Virtual Learning Environment in UNIANDES Puyo during the academic period April-August 2018 is measured.

The closed questions applied to teachers were the following:
1. Do you frequently use the Virtual Learning Environment to teach your classes?
2. Do you think the Virtual Learning Environment is useful for your classes?
3. How do you feel about the result of the Virtual Learning Environment regarding the independent work of students?

The closed questions to the students were the following:

1. Do you frequently receive classes supported by the Virtual Learning Environment?
2. Do you think that the use of the Virtual Learning Environment is useful for your independent study?
3. How do you feel about the management of the Virtual Learning Environment?

The possible answers for questions 1, 2, and 3 respectively were, (Yes, No), (Yes, I don't know, No), and (Very satisfied, Partially satisfied, I don't care, More unsatisfied than satisfied, Not at all satisfied, I don't know what to say).

The open questions asked to teachers and students were the following:

1. Tell and explain what are the difficulties encountered in using the Virtual Learning Environment.
2. Suggest some improvements that you would apply to using the Virtual Learning Environment.

The neutrosophic Iadov technique was applied. Scale shown in Figure 2 was considered for the interpretation of the final result.
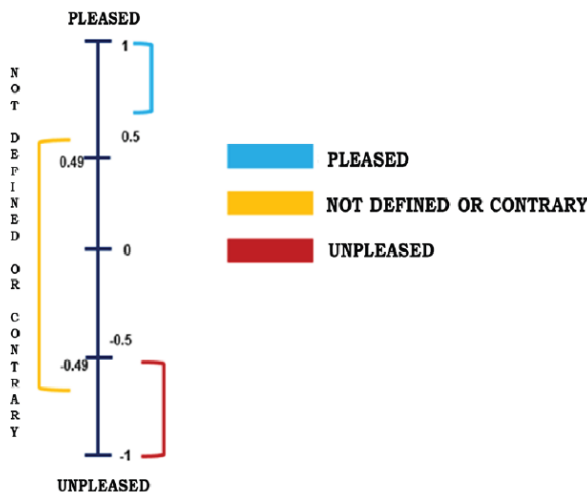

Figure 2: Scale of Group Satisfaction Index, according to [4].

Table 3 contains the results of the survey for the teachers, whereas Table 4 contains the results for the students. Let us note the number of the obtained answers per triple is enclosed between parentheses.

	1. Do you frequently use the Virtual Learning Environment to teach your classes?	
	Yes	No
3.How do you feel about the result of the Virtual Learning Environment	2.Do you think the Virtual Learning Environment is useful for your classes?	

regarding the independent work of students?	Yes	I don't know	No	Yes	I don't know	No
Very satisfied.	1 (14)	2	6	6	6	6
Partially satisfied.	2 (6)	2	3	6	3	6
I don't care.	3	3	3	3	3	3 (1)
More unsatisfied than satisfied.	6	3 (1)	6	3	4	4
Not at all satisfied.	6	6	6 (1)	6	4	5
I don't know what to say.	2	3	6	6	3 (2)	4

Table 3: Logical picture of Iadov for the interviewed teachers.

Thus, we obtained GSI = 0.77083 which signifies teachers are more satisfied than dissatisfied.

	1.Do you frequently receive classes supported by the Virtual Learning Environment?					
	Yes			No		
3.How do you feel about the management of the Virtual Learning Environment?	2.Do you think that the use of the Virtual Learning Environment is useful for your independent study?					
	Yes	I don't know	No	Yes	I don't know	No
Very satisfied.	1 (84)	2	6	6	6	6
Partially satisfied.	2 (157)	2	3	6	3	6
I don't care.	3	3	3	3	3 (3)	3 (2)
More unsatisfied than satisfied.	6	3	6	3	4	4
Not at all satisfied.	6	6	6 (1)	6	4	5 (2)
I don't know what to say.	2	3 (2)	6	6	3 (9)	4 (1)

Table 4: Logical picture of Iadov for the interviewed students.

Then, we have GSI = 0.76245 and therefore students are more satisfied than dissatisfied, as well.

According to the scale in Figure 2, the interviewed students and teachers are pleased with the method.

The open questions in general confirmed the acceptance of the method. Some interesting results obtained from the answers to the open questions were the following:

Teachers and students indicate that lack of time is the main reason why they have not used the Virtual Learning Environment, followed by ignorance of its operation.

On the other hand, students have the feeling of being constantly working, this is because some teachers occupy the virtual classroom with homework and delivery times are very short. To solve this problem, they request a better dosage of tasks and their delivery times, including adding new add-ons to the Virtual Learning Environment so that there is a better communication between teachers and their students.

From the students' perspective, using a Virtual Learning Environment in academic training creates more flexible learning environments that facilitate lifelong learning, improves independent learning and self-learning, as well as collaborative and group learning of students. These criteria match with teachers' responses.

On the part of the teaching staff, the main suggestion to improve the Virtual Learning Environment has to do with more training in the use of the available tools. They also suggest creating virtual classrooms in advance.

Another aspect mentioned to improve, which has no direct relationship with the Virtual Learning Environment, but it is worth mentioning has to do with the quality of Internet service on the university campus of UNIANDES Puyo.

From the students' point of view, the Virtual Learning Environment facilitates its work within the teaching-

learning process, but the quantity of subjects and tasks to accomplish, together with the short delivery times, gives them the feeling of not resting.

Another aspect that students request is the quality of internet service, although this limitation is not dependent on the Virtual Learning Environment.

Conclusion

This paper was dedicated to the study of the acceptance of the Virtual Learning Environment at the Regional Autonomous University of Los Andes, Puyo extension in Ecuador. 25 teachers and 261 students from this study center were surveyed, who were asked three closed questions about their use and satisfaction with the Virtual Learning Environment. The study relied on the technique of neutrosophic Iadov, where it was shown that respondents are more satisfied than dissatisfied with this learning supplement. The advantage to using neutrosophic Iadov is that it takes into account contradictions and indeterminacies in the answers to the three closed questions. Additionally, the two open questions asked to students and teachers, allowed to determine the changes that are needed to improve the use of the Virtual Learning Environment, which is mainly related to the necessity of a previous training for using the Virtual Learning Environment.

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