



## 2-Tuple Linguistic Neutrosophic Numbers and Variance Analysis to Examine Citizenship Formation in the General Studies Programs at the Universities of Lima

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**Abstract.** At all stages of their academic lives, students can benefit from the knowledge gained through collaborative learning. After completing basic training, you will have the opportunity to review historical understanding concepts. Its purpose is to promote the exploration of concepts such as democratic citizenship that can be linked to direct experience of republican history and academic study. The purpose of this study was to examine the relationship between civic education human rights and civic training using Neutrosophic analysis of variance and 2-tuple linguistic neutrosophic numbers. It is assumed that historical awareness and reflection on the natural environment, developed institutionally, in any case with the participation of people, is an indispensable element of education. Nowadays they are not only a complement but also a mandatory part of civic education. On the other hand, from a political point of view, we try to understand historical understanding as a contribution and investigative experience to the general research of Lima universities. Therefore, this study focuses on comparing the differences in the conceptions of civic and democratic education among university students in Lima in their general education programs. Therefore, a qualitative analysis of the data will be carried out to extract relevant meanings from the proposed categories.

**Keywords:** 2-tuple linguistic neutrosophic numbers, Variance Analysis, Citizenship Formation.

### 1. Introduction

Numerous studies have been carried out in the field of civic education at both the public and university levels. However, to date no specific studies have been carried out on careers in Peruvian universities. Therefore, it is important to have a solid foundation before beginning your studies at a liberal arts college. This exploratory study aimed to understand the structure of the program, identify teacher profiles and teaching methods, and the personal experiences of students during the learning process [1,2].

In the Peruvian context, several universities have established research units that cover professions directly related to civic education [3]. Among them, the proposal of the mayor of the Universidad Nacional Mayor de San Marcos stands out, who has developed an extensive training program for the city. This program includes four courses that cover all specialties of primary and secondary education: "Social and civic education", "Education and sustainable development", "Educational projects". education and sustainable development" and "Country reality".

For general education programs at universities in the capital Lima with a work permit, the study period varies from 2 to 4 university cycles. It has been suggested that general education courses or equivalent credits should be taught from an early age [4]. A surprising aspect of this approach is the importance of comprehensive education, as in the case of the mayor of the Universidad Nacional Mayor de San Marcos, who promotes an educational model that emphasizes the importance of common education. In the current educational management system, collaborative research is organized at the departmental level, unlike the previous organization headed by the Vice Chancellor of Pre-University Education (VRAP). This reflects the desire of universities to prepare ethically competent citizens capable of solving social problems [5].

In short, civic education is a fundamental responsibility of the Peruvian educational system for the development of society. While there are differences in how each school does this, they should all have the same goal. Therefore, the main objective of this study is to compare the concepts of civic and democratic education in the general research of the faculties of education of the universities of Lima [6].

## 2. Related Works

### 2.1 Mathematical Framework for 2-Tuple Linguistic Neutrosophic Numbers

The structure  $(t, i, f)$  consists of a space  $S$  with a set of operational axioms (or laws) (governing it), such that the space or at least one of its axioms represents the uncertainty.  $t$  represents the degree of correctness,  $i$  represents the degree of uncertainty, and  $f$  represents the degree of falseness. [7,8].

The 2-tuples linguistic model allows the calculation of words without loss of information based on the concept of symbolic translation.

**Definition 1** ([9]): *The symbolic translation* of a linguistic term is a numerical value in the range  $[-0.5, 0.5]$ , which represents the difference between the amount of information represented equal to the value  $b \in [0, g]$  is obtained from the nearest symbol and value operation  $i \in \{0, \dots, g\}$ .

From this concept, a model has been developed to represent linguistic information using a pair of values or 2 tuples. This presentation model defines a set of functions that support operations on two data sets.

**Definition 2** ([10]): being  $S = \{s_0, s_1, \dots, s_g\}$  a set of linguistic terms and  $\beta \in [0, g]$  This is a value that represents the result of a symbolic operation. Then, using the following function, you will obtain a linguistic set of two numbers that represent information equivalent to  $\beta$ :

$$\Delta: [0, g] \rightarrow S \times [-0.5, 0.5]$$

$$\Delta(\beta) = (s_i, \alpha) \quad (1)$$

$i = \text{round}(\beta)$  and  $\alpha = \beta - i, \alpha \in [-0.5, 0.5]$  "round" is the usual rounding operator,  $s_i$  This is the index label closest to  $\beta$ .

Note that  $\Delta^{-1}: \langle S \rangle \rightarrow [0, g]$  it is defined as  $\Delta^{-1}(s_i, \alpha) = i + \alpha$ . Hence,  $\langle S \rangle$  It is identified by its numerical value  $[0, g]$ .

2-tuple Linguistic Neutrosophic Number (2TLNN) is defined for solving problems based on single-valued neutrosophic numbers and the 2-tuple linguistic model [11]

The score and accuracy functions allow us to classify 2TLNN [12].

If  $l_1 = \{(s_{T_1}, a), (s_{I_1}, b), (s_{F_1}, c)\}$  then the scoring function and precision  $l_1$  are respectively determined as follows:

$$S(l_1) = \Delta \left\{ \frac{2t + \Delta^{-1}(s_{T_1}, a) - \Delta^{-1}(s_{I_1}, b) - \Delta^{-1}(s_{F_1}, c)}{3} \right\}, \Delta^{-1}(S(l_1)) \in [0, t] \quad (3)$$

$$H(l_1) = \Delta \left\{ \frac{t + \Delta^{-1}(s_{T_1}, a) - \Delta^{-1}(s_{F_1}, c)}{2} \right\}, \Delta^{-1}(H(l_1)) \in [0, t] \quad (4)$$

### 1. Discussion and Results

Nearly 50 professors from public universities in Peru participated in the research carried out as part of this work.

Details of the teacher survey are presented in Tables 1 and 2.

**Table 1:** Proposed research in the teaching of citizenship and human rights

ARTICLE
1. How much time do you spend teaching citizenship and human rights at university?
2. What teaching methods do you use to address civil and human rights during your university studies?
3. How to integrate the principles of civic education and human rights in your educational project?
4. What resources and materials do you use to teach civic education and human rights at the university?
5. What challenges do you face when teaching citizenship and human rights in an academic context?
6. What strategies are used to encourage the active participation of students in civic and human rights education?
7. How do you assess your students' progress and understanding of civil rights and human rights?
8. Do you think that teaching about citizenship and human rights at university should be mandatory in all university programs?
9. What specific civil rights and human rights issues do you think are most relevant to students today?
10. What suggestions would you make to improve the training and support of citizenship and human rights teachers at universities?
11. What do you think about the role of education for citizenship and human rights in the comprehensive training of university students?
12. How do you integrate cultural diversity and inclusion into your civil rights and human rights courses?
13. Do you think higher education in civil rights and human rights should adapt to political and social changes?
14. How important is it to provide civic and human rights education that prepares students to actively participate in society?
15. Do you notice any differences in the way students learn civics and human rights compared to other subjects?
16. What do you think about the integration of digital technology in university citizenship and human rights education?
17. Do you think teacher training programs should include additional training in citizenship and human rights?
18. How do you engage your students in critical thinking about social justice and human rights in your lessons?
19. What experiences or teaching methods are most effective for teaching citizenship and human rights in universities?
20. How do you see the future of teaching citizenship and human rights in universities?

**Table 2:** Proposed research on citizenship education in universities.

ARTICLE
1. What is the definition of "civic education" in a university context?
2. What do you think of the role of universities in training active and motivated citizens?
3. What areas of knowledge do you think are necessary to promote civic education among university students?
4. What teaching methods do you use to promote civic education during your university studies?
5. How do you integrate ethics and citizenship into your higher education program?
6. What challenges do you face in promoting civic education among students?
7. How can you improve your students' civic skills?
8. Do you think it is important for students to participate in extracurricular activities related to civic education? AS?
9. What resources and materials do you use to support civic education in university courses?
10. What strategies do you use to encourage your students' civic and social engagement outside of the classroom?
11. What do you think motivates students to get involved in civic and social issues?
12. How do you see cultural diversity and inclusion in promoting civic education at the university?
13. What role does community service play in students' civic education?
14. Do you think civic education should be a mandatory subject in all university programs?
15. How do you think civic education contributes to the personal and professional development of university students?
16. What suggestions would you make to improve the promotion of civic education in universities?
17. Do you think civic education should be more integrated into academic programs or extracurricular activities?
18. What challenges do you see in measuring the impact of civic education on students?
19. How do you collaborate with other faculties or departments to promote civic education at the university?
20. What changes would you like to see in university policies or structures to strengthen students' civic education?

Survey reliability was assessed using Cronbach's alpha, which was at least 0.933 for both surveys. Therefore, the fidelity of Neutrosophic is related to:

**(1,0,0) Beginning or new teachers:**

- Those just beginning their academic careers typically have less than three years of professional experience.

- You will be able to learn and adapt to the dynamics of the university.
- They tend to have lighter workloads and may need more guidance and support from more experienced colleagues.

(0.8,0.1,0.1) **Average instructor:**

- Includes people with three to ten years of university teaching experience.
- They have accumulated some teaching experience at the university level and are more familiar with classroom dynamics and organizational processes.
- Perhaps you are at some point in your career looking for opportunities to specialize or lead academic projects.

(0.6,0.1,0.3) **Verified or confirmed teachers:**

- Includes people with more than ten years of university teaching experience.
- He accumulated extensive experience in teaching, research and eventually held leadership positions in academia.
- they usually have

(0.4,0.1,0.5) **Famous or famous teachers:**

- These are individuals with exceptional achievements in graduate education, teaching, research, and/or community service.
- Recognitions were received at both the institutional and national or international levels in their respective fields.
- You may hold academic leadership positions, direct important research programs, or receive awards and recognition for your work.

Each interviewee does not have the same amount of work and experience.

Each of these values is converted to a weight value using Equation 4:

$$\varepsilon(w) = \frac{2+t-i-f}{3} \quad (5)$$

This is related to this  $w = (t, i, f)$ .

These weights indicate the performance of each study in relation to the university's research output.

Everything will be discussed in detail.  $G = \{g_1, g_2, \dots, g_{4691}\}$  Everyone will value the research equally  $w_i \ i = 1, 2, \dots, 4691$  These weights are normalized using formula 8.

$$\bar{w}_i = \frac{w_i}{\sum_{i=1}^{4691} w_i} \quad (8)$$

second scale  $S = \{s_0, \dots, s_4\}$  So its components mean:

- (i) Never ( $s_0$ ),
- (ii) Rarely ( $s_1$ ),
- (iii) Occasionally ( $s_2$ ),
- (iv) Consistently ( $s_3$ ),
- (v) Always ( $s_4$ ).

Each respondent was asked to express his or her opinion on the three linguistic meanings included in the scale  $S$ . The first value indicates the degree of agreement with the item, the second value indicates the degree of uncertainty, and the third value indicates the degree of disagreement.

For example,  $(s_3, s_2, s_0)$  This means that respondents agree that "Always" is true, are not sure that "Sometimes" is true, and are sure that "Never" is false.

Finally, the following process is summarized in Table 3:

**Table 3:** Research data processing process

<b>PROCEDURE FOR PROCESSING DATA OBTAINED AFTER THE INVESTIGATION</b>
<p>Input: Each search is assigned an appropriate weight. <math>\bar{w}_i</math> (<math>i = 1, 2, \dots, 4691</math>) The ownership of the company depends on the level of sales.</p> <p>Each survey evaluates each item based on three scalar values <math>S</math>.</p> <p>For each survey, there will be a decisive partner. <math>\bar{w}_i</math> Oh, <math>l_{ik} = \langle (s_{T_j}, a_j), (s_{I_j}, b_j), (s_{F_j}, c_j) \rangle</math> that's because <math>k = 1, 2, \dots, 36</math>. worth <math>k = 1, 2, \dots, 18</math> They are the scientific research elements of the university, the rest is the social responsibility of the university .</p> <ol style="list-style-type: none"> <li>1. For each subject, Formula 5 is applied to each weight and each grade level. We notice it with: <math>A_k = \langle (s_{T_j}, a_j), (s_{I_j}, b_j), (s_{F_j}, c_j) \rangle</math>.</li> <li>2. Formula 5 is used with equal weight to evaluate the ability to participate in the labor market <math>\omega_r = \frac{1}{18} OHA_k</math> <math>k = 1, 2, \dots, 18</math> Let's take a closer look at <math>L</math>, which is the general idea of this variable.</li> <li>3. Equation 5 with equal weights is used to assess gender equality. <math>\omega_r = \frac{1}{18} OHA_k</math> <math>k = 18, 19, \dots, 36</math> TO Tell us <math>P</math>'s general opinion on this variable.</li> <li>4. Furthermore, for each search <math>l_{ki} = \langle (s_{T_j}, a_j), (s_{I_j}, b_j), (s_{F_j}, c_j) \rangle</math> there is a weight. <math>\omega_r = \frac{1}{18}</math> TO <math>k = 1, 2, \dots, 18</math> Let me remind you <math>l_{Li}</math>. with weight <math>\omega_r = \frac{1}{18}</math> because <math>k = 18, 19, \dots, 36</math> equation 5 also holds . Put it that way <math>l_{Pi}</math>.</li> </ol> <p>Therefore, for each search there is also a <math>(l_{Li}</math> and <math>l_{Pi})</math>.</p> <ol style="list-style-type: none"> <li>5. For each couple <math>(l_{Li}, l_{Pi})</math> Some numbers are calculated using equation 9:  <math display="block">N = n_T - (4 - n_I) - n_F \quad (9)</math> </li> </ol> <p>For example, if survey items are linked to a variable (" civic education and human rights or " civic education ") is a trio: <math>l_{Li} = \langle s_4, s_3, s_0 \rangle</math> Therefore, the value of the relevant variable for this study is <math>4 - (4 - 3) - 0 = 3</math>. Thus, for each survey there is a pair of numerical values, one of which corresponds to " civic education and human rights " and the other to " civic education ." These pairs can be treated statistically using classical correlation measures such as Spearman's Rho.</p>

The results obtained from the study using this method are presented in Table 3 below:

Transform civic and human rights education Triple production  $((s_3, 0.1634), (s_4, -0.1658), (s_0, 0.0008))$ . This should be understood as follows: the public administration system is "always" positive, "never" negative and tends to be "always" positive.

Civic education creates a triad  $((s_3, -0.3226), (s_2, 0.2468), (s_0, 0.0008))$ , understood as follows: "sometimes" the manager's activities are positive, "never" they are negative, and "sometimes" they are usually positive.

Now let's look at the correlation behavior between two variables using Spearman's Rho coefficient and that's it.  $r_s = 0.538$ [17]. This is interpreted as the presence of an average positive correlation between two variables.

The analysis of the variables "citizenship and human rights education" and "civic learning" reveals valuable insights into the operational dynamics of universities and their impact on managerial staff performance. The study highlights a significant correlation between civic education and human rights awareness, suggesting that training programs promoting civic and ethical values can positively influence workplace behavior, organizational culture, and productivity. Spearman's Rho analysis confirms that investing in civic and human rights education enhances administrative staff's civic training, fostering a stronger work ethic, sensitivity to community needs, and respect for rights. These findings underline the importance of integrating civic education into university curricula, implementing targeted programs, and cultivating an institutional culture of inclusion, respect, and civic engagement, thereby advancing governance and ethical responsibility across the academic community.

#### 4. Conclusion

This study examines the relationship between civic education and the activities of university leadership groups, as well as its connection to citizenship education, using 2-tuple linguistic neutrosophic numbers to analyze and quantify the variables. The findings reveal that civic education significantly impacts managerial behavior, with neutrosophic calculations providing nuanced insights into the degree of influence, underscoring the value of training programs that promote civic and ethical values to enhance organizational culture and the work environment. Additionally, a positive correlation was identified between civic education and citizenship education, with 2-tuple linguistic neutrosophic analysis confirming the strength and consistency of this relationship. These results highlight the importance of investing in initiatives that integrate civic education into university structures, fostering a more inclusive and ethical institutional culture.

Future research should expand the scope of analysis to include diverse university contexts and employ 2-tuple linguistic neutrosophic methods in longitudinal studies to evaluate the long-term effects of civic education programs on organizational culture and leadership. Exploring interdisciplinary approaches, such as integrating civic education with environmental ethics or digital citizenship, can address emerging societal challenges. Additionally, leveraging digital tools for implementing civic education and applying advanced neutrosophic models to assess their effectiveness can provide valuable insights. These efforts will deepen the understanding of civic education's role in fostering ethical, inclusive, and high-performing academic environments.

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