



# Determining the Relationship between Interculturality and Bilingualism in Bilingual Teaching in Peru Based on Plithogenic Statistics

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**Abstract.** The development of this research was propitiated as its main goal to determine the level of relationship that exists between interculturality and bilingualism in bilingual teachers of regular basic education in the rural area of Callería, Ucayali, Peru, during 2023. The study was developed through simple random sampling, in the population that is made up of 581 bilingual teachers. The sample comprises 174 of these teachers, to whom two questionnaires were applied as data collection instruments prepared from the survey technique; thus concluding that there is a direct and significant relationship between interculturality and bilingualism. We determined that the use of traditional statistical methods is insufficient to carry out a complete study because there is uncertainty in the data collected since we wanted to consider the degree of mastery of the language by each teacher. The study is based on plithogenic statistics because this theory is dedicated to studying the indeterminacy in complex phenomena, where several factors influence the object of study. The plithogenic statistics is an extension of Multivariate Statistics.

**Keywords:** Interculturality, bilingualism, Plithogeny, Plithogenic Statistics, Single-Valued Neutrosophic Number, Plithogenic Neutrosophic Probability, Spearman Rho coefficient.

## 1 Introduction

The analysis of educational processes must start from an understanding of the historical and social conditions in which they occur. In this sense, intercultural education is found within the context of the political, social, economic, and cultural projects of globalization. Globalization, with its face of internationalization, has fragmented cultural identities and transformed customs, traditions, and ways of life. Faced with such acculturation processes, we find ourselves today in the 21st century with a "crisis of progress" in which the universe of techniques, markets, and finances is dissociated on the one hand, and the inner universe, that which we call our identity, on the other.

Interculturality in a pluricultural and multilingual society emphasizes its attention on the communication search, also on the recognition of existing cultural differences, and not forgetting the roots that gave rise to our national culture.

Communication is conceived as sharing, interaction, the action of sharing values, and a way of establishing links and relationships between people. Communication, from this perspective, is the basic process for the construction of life in society; it is the activating mechanism of dialogue and coexistence between subjects. In this context, communication can be considered the concrete and objective manifestation of the permanent processes of reconstruction of the different contexts of reality that we build and cultivate in everyday life. Thus, communication is the only way we have to get in touch with others and, even when we do not realize how much we depend on it, it constitutes the center of our existence.

In Latin America, interculturality was born under the auspices of related educational modalities called ethno-education, indigenous education, and/or intercultural bilingual education, in response to policies of extermination, assimilation, and forced integration directed at different indigenous peoples, which were developed by the national

States of the region. From there, it initially emerged as a proposal for recognition and reparation of the fundamental rights of these peoples, and throughout the 20<sup>th</sup> century, it was assumed from different paradigms (compensatory, integrationist, democratizing, resistance) and emphases regarding the way of approaching Indigenous school education.

There are still tendencies or thoughts in the different schools, that teachers tend to associate and approach interculturality more as a content - mainly languages and certain knowledge and practices of the main indigenous cultures officially recognized in the country - than as an educational approach. Therefore, interculturality as part of a study carried out, was associated with the teaching of languages such as *Mapuzugun* or *Aymara*, or certain aspects of the cultures of these or other indigenous peoples present in the country, but not to an approach to the teaching-learning process that implies, for example, putting these worldviews into dialogue with the worldview of the hegemonic culture in the national educational system, on an equal footing in terms of its legitimacy, or problematizing one's own culture based on the different cultural perspectives that are present in the school, to mention just a few ways in which the intercultural educational approach could materialize.

The process of globalization essentially ignores the human aspect, giving significant weight to innovation in educational processes as a necessary element for the formation of people and groups, which is why innovation is required to encompass not only what is traditionally understood, but also advance to intercultural training as a human quality.

All of this implies that the planet is immersed in a maelstrom of diffusion, development, and consolidation of neo-positivist and neo-liberal economic unidimensional philosophical currents; of information and communication technologies (ICT) and computing; of new scenarios, challenges and uncertainties; of mass education; of educational currents based on systemic educational technology; as a context of tendencies and causalities, in which diverse cultures of humanity develop, and on which educational models with tendencies towards cultural homogeneity and at the same time heterogeneity of reality and society, opposed to interculturality, impact.

Our focus is also on bilingualism, which broadly refers to the ability to express oneself in two languages. When a person is fluent in more than one language, he or she is called bilingual. Bilinguals are people who can, to any degree, understand or produce written or spoken expressions in more than one language. We can see that they have a very high command of both languages, both written and spoken. They demonstrate comprehension skills and/or abilities, depending on the experience in which they are called to use both languages.

Bilingualism is therefore a phenomenon that is studied from two major perspectives: psycholinguistics and sociolinguistics. From the psycholinguistic perspective, the interest is in the bilingual subject considered individually and the emphasis is placed on the psychological processes involved in bilingual learning and behavior, that is, all those factors that have an impact on the capacity and mastery of the different languages that the subject acquires. From the sociolinguistic perspective, the interest is focused on the linguistic community, on the social group where the use of the different languages converges, and the determinants that influence the interrelation of these considering their historical evolution and their social, demographic, and cultural context.

In the context of bilingual classes, in Peru, its educational system adopted a coordinated bilingualism, under the criterion of the relationship between language and thought; since it has different cognitive units for the linguistic units depending on whether they are in L1 or L2. In this sense, the academic training process of education professionals does not respond to the challenges of the 21<sup>st</sup> century, which requires integration to face globalization, especially based on social needs and intercultural processes.

This paper aims to statistically demonstrate that there is a direct and significant relationship between interculturality and bilingualism in bilingual teachers of regular basic education in the rural area of Callería. To meet this objective, Plithogenic Statistics methods are applied [1]. Neutrosophy is the branch of philosophy that studies neutrality, which contains the neutral, the unknown, the contradictory, the erroneous, the inconsistent, and the paradoxical, among others. More recently, F. Smarandache created the Plithogeny theory where the dynamic relationship between different concepts is captured, with what Smarandache called the AntiConcepts and the NeutroConcepts (which are neither Concepts nor Anticoncepts) [2-4]. This replaces the traditional dialectic which contains only Concepts and AntiConcepts.

The Plithogenic Statistics generalizes the Neutrosophic Statistics, where not only data or parameters are taken into account in the form of intervals as in the latter one, but also any set where there is indeterminacy, either in the form of intervals or discrete values, or mixed [5-8]. The Plithogenic Statistics generalizes multivariate statistics.

This article uses Plithogenic techniques Statistics to determine the relationship between interculturality and bilingualism. We considered using plithogenic statistics because it allows us the study complex phenomena, where multiple factors cannot be studied in a simplified way. Interculturality and language phenomena are these types of phenomena since they depend on culture, psychology, sociology, education, and politics, among many other concepts that interact with each other to emerge in complex situations.

The article is divided into a Materials and Methods section, where the main concepts of Plithogenic Probability

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and Plithogenic Statistics are explained. The next section is devoted to presenting the results of the study. The article concludes with a Conclusions section.

## 2 Materials and Methods

The Plithogenic Probability of an event is composed of the probabilities of the event occurring for all the random variables or parameters that constitute it [6, 9-15]. The Plithogenic Probability based on the Plithogenic Variation Analysis, is multi-dimensional. It could be said that it is a probability of sub-probabilities, where each sub-probability refers to the behavior of a variable by assuming that the event is produced by one or more variables. Each variable is represented by a Probability Distribution (Density) Function (PDF).

According to the classification of F. Smarandache, the Subclasses of Plithogenic Probability are as follows:

- (1) **Classical MultiVariate Probability:** If all PDFs are classical.
- (2) **Plithogenic Neutrosophic Probability** is defined when the PDF is expressed in the form of  $(T, I, F)$ , where  $T$  is the probability that the event occurs,  $I$  is the probability of indeterminacy that the event occurs and  $F$  is the probability that the event does not occur. Such that the following is fulfilled:  $T, I, F \in [0, 1]$ ,  $0 \leq T + I + F \leq 3$ .
- (3) **Plithogenic Indeterminate Probability:** When all PDFs have indeterminate data or arguments.
- (4) **Plithogenic Intuitionistic Fuzzy Probability:** When PDFs have the form  $(T, F)$  where  $T, F \in [0, 1]$ ,  $0 \leq T + F \leq 1$ .
- (5) **Plithogenic Picture Fuzzy Probability:** When PDFs have the form  $(T, N, F)$ .  $T, N, F \in [0, 1]$ ,  $0 \leq T + N + F \leq 1$ ; where  $T$  is the probability that the event occurs,  $N$  is the neutral probability that the event occurs or not, and  $F$  is the probability that the event does not occur.
- (6) **Plithogenic Spherical Fuzzy Probability:** When PDFs have the form  $(T, H, F)$ .  $T, H, F \in [0, 1]$ ,  $0 \leq T^2 + H^2 + F^2 \leq 1$ ; where  $T$  is the probability that the event occurs,  $H$  is the neutral probability that it occurs or not, and  $F$  is the probability that the event does not occur.
- (7) **Plithogenic (fuzzy-extension) Probability:** when we have that all PDFs are in the form of (fuzzy-extension set) style.
- (8) **Plithogenic Hybrid Probability:** When some PDFs are in one of the above styles and others are in other styles.

Plithogenic Statistics (PS) comprises the analysis and observations of the events studied by the Plithogenic Probability.

Plithogenic Statistics generalizes the classical Multivariate Statistics, which in turn allows an analysis of many output variables that are neutrosophic or indeterminate. It is also a multi-indeterminate statistic.

Various Subclasses of Plithogenic Statistics are the following:

- Multivariate Statistics,
- Plithogenic Neutrosophic Statistics,
- Plithogenic Indeterminate Statistics,
- Plithogenic Intuitionistic Fuzzy Statistics,
- Plithogenic Picture Fuzzy Statistics,
- Plithogenic Spherical Fuzzy Statistics,
- and in general: Plithogenic (fuzzy-extension) Statistics,
- and Plithogenic Hybrid Statistics.

On the other hand, Plithogenic Refined Statistics are the most general form of statistics that studies the analysis and observations of the events described by the Plithogenic Refined Probability.

In classical inference statistics estimates the population's average of the variable from the sample's average.

When we have a classical random variable, the exact sample size is known and all elements of the sample belong 100% to the population. However, this does not reflect the dynamics of a population such as the student population, which is the example illustrated by F. Smarandache, where there is fluctuation of students within courses, in addition to the fact that the membership of each student varies depending on whether he or she is studying a course full-time, part-time or over-time [1].

In a Neutrosophic Population, each element has a triple probability of membership equal to  $(T_j, I_j, F_j)$  such that  $0 \leq T_j + I_j + F_j \leq 3$ .

If we assume we have the dataset  $(T_j, I_j, F_j)$  for  $j = 1, 2, \dots, n$ , where  $n$  is the sample size, then the average

probability for all data in the sample is calculated by Equation 1.

$$\frac{1}{n} \sum_{j=1}^n (T_j, I_j, F_j) = \left( \frac{\sum_{j=1}^n T_j}{n}, \frac{\sum_{j=1}^n I_j}{n}, \frac{\sum_{j=1}^n F_j}{n} \right) \quad (1)$$

### 3 The Plithogenic Study

The concepts (variables) on which this research is based are:

#### Variable 1: Interculturality

Interculturality is the set of political, social, legal, and educational processes generated by the interaction of cultures in a relationship of reciprocal exchanges caused by the presence in the same territory of human groups with different origins and histories. This variable can be operationalized through the dimensions: of “intercultural skills”, “intercultural knowledge”, and “intercultural attitudes”.

#### Variable 2: Bilingualism

Bilingualism is not the perfect and identical command of two languages, but the ability to use two or more languages in different contexts and with different modalities. This variable can be operationalized through the dimensions of “language” and “communication”.

Table 1 contains the details of each dimension mentioned above:

**Table 1.** Variables used in the study, their dimensions, and definitions.

VARIABLE	DIMENSIONS	INDICATORS
Interculturality	Intercultural Knowledge	Identify the local culture and that of students whose parents come from other cultures: stories, beliefs, songs, games, instruments, etc.
		Describe general characteristics of the cultures from which the parents or grandparents of their students come, such as geographic location, physical features, ways of speaking, cultural manifestations, etc.
		Identify how cultures of regional origin are formed throughout history according to thoughts, beliefs, and ideas.
		Identify words from other cultures (names, foods, beliefs, etc.).
	Intercultural Attitudes	Shows openness to other cultural manifestations different from one's own.
		Show empathy towards other cultural realities.
		It shows an appreciation of the implications of cultural diversity in society.
		Shows willingness to resolve conflicts.
	Intercultural Skills	Participate positively in group activities that involve interaction between peers from different cultural manifestations, such as games, making murals, or storytelling.
Recognizes foreign cultural practices and manifestations.		
Identify the negative aspects of discrimination or prejudice towards different cultural manifestations.		
Bilingualism	Language	Recognizes the code systems of his/her language.
		Rules of use.
		Values the use of his/her language in different contexts.
		Uses his/her native language and second language to communicate, taking into account the contexts.
	Communication	Makes use of different types of communication in his/her daily activities.
		Recognizes the different ways of communicating in his/her family and community, also considering the moments.
		Uses assertive and respectful forms of communication to achieve goals and objectives.
		Assess the development of his/her writing using various connectors appropriately, allowing for a clear sentence.
		Communicates ideas coherently and accurately, using both his/her native language and his/her second language.

There is a population of 581 bilingual teachers of Regular Basic Education from the district of Callería. The sample is made up of 174 teachers selected by simple random sampling. Each of them was asked to evaluate how they perceived each of the dimensions corresponding to the two variables studied. For this purpose, a linguistic measurement scale was used, where each linguistic value has an associated Single-Valued Neutrosophic Number (SVNN) in the form of (T, I, F).

**Table 2.** The linguistic scale and the Single- Valued Neutrosophic Numbers were used in the survey of the study carried out.

Linguistic Value	Associated Single-Valued Neutrosophic Number
Unfavorable	(0.1,0.1,0.8)
Moderately Favorable	(0.55,0.1,0.35)
Favorable	(0.8,0.1,0.1)

Table 3 contains a summary of the results of the surveys regarding interculturality:

**Table 3.** General results obtained from the survey on interculturality and its dimensions.

	Interculturality		Intercultural knowledge		Intercultural attitudes		Intercultural skills	
	f	%	f	%	f	%	f	%
<b>Unfavorable</b>	0	0	10	5.7	0	0	5	2.9
<b>Moderately favorable</b>	165	94.8	164	94.3	170	97.7	159	91.4
<b>Favorable</b>	9	5.2	0	0	4	2.3	10	5.7
<b>Total</b>	174	100	174	100	174	100	174	100

Table 4 summarizes the results regarding bilingualism:

**Table 4.** General results obtained from the survey on bilingualism and its dimensions.

	Bilingualism		Language		Communication	
	f	%	f	%	f	%
<b>Unfavorable</b>	15	8.6	15	8.6	15	8.6
<b>Moderately favorable</b>	135	77.6	135	77.6	145	83.3
<b>Favorable</b>	24	13.8	24	13.8	14	8.0
<b>Total</b>	174	100	174	100	174	100

From these tables, the first plithogenic probabilities are obtained:

If  $x$  is a teacher of the population which is studied, we have the Plithogenic Neutrosophic Probability as follows:

$$PNP_{Intercult}(x) = ((0.52435, 0.1, 0.37565); (0.55575, 0.1, 0.34425); (0.5512, 0.1, 0.3488)),$$

$$PNP_{Biling}(x) = ((0.5458, 0.1, 0.3542); (0.5307, 0.0999, 0.36835)).$$

That is, we infer from  $PNP_{Intercult}(x)$  that the probability of  $x$  having intercultural knowledge is approximately 52%, with 10% of indeterminacy and 37.6% of falsehood. For intercultural attitudes, this is expressed in approximately 56%, 10% of indeterminacy, and 34% of dissatisfaction. For intercultural skills, there is practically 55% probability, 10% of indeterminacy, and around 35% of non-occurrence.

Regarding language skills, there is approximately a 56% probability of occurrence, 10% of indeterminacy, and 35% of non-occurrence, while regarding communication, there is a probability of approximately 53% of occurrence, almost 10% of indeterminacy, and 37% of non-occurrence.

Let us do a logical calculation, where the probabilities of each variable are aggregated using the following n-norm given both,  $x = (T_x, I_x, F_x)$  and  $y = (T_y, I_y, F_y)$  [16, 17]:

$$N(x, y) = (\min(T_x, T_y), \max(I_x, I_y), \max(F_x, F_y)) \quad (2)$$

Therefore, the aggregated probability for Interculturality is (0.52435, 0.1, 0.37565), and for Bilingualism is (0.5307, 0.1, 0.36835). These results indicate that the opinion on both variables is around moderately favorable.

Let us now analyze the relationship between both variables. Table 5 contains the summary of applying the Spearman Rho coefficient between Interculturality and Bilingualism. In this case, we reduce the multivariate statistics to the different univariate statistics.

**Table 5.** Application of correlation tests using Spearman's Rho coefficient between interculturality and bilingualism.

Spearman's Rho	Interculturality	Value	Interculturality	Bilingualism	
		Significance (Bilateral)	(1.000, 1.000, 1.000)	(0.502, 1.000, 0.486)	(0.000, 0.000, 0.000)
		N	-	174	174
	Bilingualism	Correlation coefficient	(0.502, 1.000, 0.486)	(1.000, 1.000, 1.000)	(1.000, 1.000, 1.000)
		Significance (Bilateral)	(0.000, 0.000, 0.000)	-	-
		N	174	174	174

Table 6 shows the results of applying Spearman's Rho coefficient to determine the relationship between interculturality and language.

**Table 6.** Application of correlation tests using Spearman's Rho coefficient between interculturality and language.

Spearman's Rho	Interculturality	Value	Interculturality	Language	
		Significance (Bilateral)	(1.000, 1.000, 1.000)	(0.529, 1.000, 0.467)	(0.000, 0.000, 0.000)
		N	-	174	174
	Language	Correlation coefficient	(0.529, 1.000, 0.467)	(1.000, 1.000, 1.000)	(1.000, 1.000, 1.000)
		Significance (Bilateral)	(0.000, 0.000, 0.000)	-	-
		N	174	174	174

Table 7 shows the correlation between interculturality and communication:

**Table 7.** Application of correlation tests using Spearman's Rho coefficient between interculturality and communication.

Spearman's Rho	Interculturality	Value	Interculturality	Communication	
		Significance (Bilateral)	(1.000, 1.000, 1.000)	(0.498, 0.999, 0.501)	(0.000, 0.000, 0.000)
		N	-	174	174
	Communication	Correlation coefficient	(0.498, 0.999, 0.501)	(1.000, 1.000, 1.000)	(1.000, 1.000, 1.000)
		Significance (Bilateral)	(0.000, 0.000, 0.000)	-	-
		N	174	174	174

Applying Equation 2 to the Spearman Rho values that appear in Tables 5-7, the value obtained is (0.498, 1.000, 0.501). The result is a moderate and direct correlation between the two variables studied.

## Conclusion

With this article, we set out to study whether there is a relationship between the concepts of interculturality and bilingualism in Peruvian bilingual schools. To do so, we took as an object of study a sample of size 174 from a population of 581 bilingual teachers of Regular Basic Education in the area of the Callería district in Peru. The teachers were asked to fill out questionnaires determining their opinions on interculturality and bilingualism within their educational centers. For the evaluation, we used a linguistic scale with values associated with Single-Valued Neutrosophic numbers. In the processing of the data obtained, we use the Plithogenic Statistics. In general, it was found that the highest probability is that the teacher has an average performance in each of the variables; in addition, the correlation between both variables is moderate and direct with the application of the Spearman Rho coefficient adapted to the Plithogenic Neutrosophic Probabilities.

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Received: June 28, 2024. Accepted: August 21, 2024