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Neutrosophic Assessment of Personality Traits

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Abstract. This paper addresses the importance of understanding the personality traits of teachers and their impact on the educational process. It mentions the existence of stable personality traits and variable personality states that vary over time. It also refers to the five-factor personality model (FFM), which includes the domains of Extraversion, Affability, Conscientiousness, Neuroticism, and Openness to Experience. The study is carried out in the context of Higher Education Institutions (HEIs) in Ecuador, where professors perform functions related to teaching, research, extension, and academic management. It is noted that emotional contagion between teachers and students can be relevant in this environment. The paper presents a qualitative analysis based on a Neutrosophic Cognitive Map (NCM) of nine personality traits: Empathy, Openness to Experience, Introversion, Emotional Stability, Kindness and Respect, Flexibility, Excessive Authoritarianism, Neuroticism and Egocentrism. The causal relationships between these traits are highlighted, emphasizing the importance of empathy as a central factor. It discusses how traits such as empathy, kindness, patience, and emotional stability contribute to a positive and productive learning environment. Furthermore, it is noted that the modification of negative traits, such as excessive authoritarianism and egocentrism, can improve the professional development of teachers and benefit students in the long term. Finally, this study is compared with previous research, and it highlights that the results may vary. For example, a study that did not find significant relationships between personality traits and teaching performance is mentioned, while this study suggests that excessive authoritarianism and egocentrism can affect communication with students and the quality of training.

Keywords: professional development, personality traits, neutrosophic cognitive maps, teachers, empathy.

1 Introduction

Most personality theories suggest that personality can be described using several entities that all have a unique stable component, personality traits, and also variable aspects, personality states, that fluctuate from moment to moment [1]. One predominant model for conceptualizing personality traits is the five-factor model (FFM), which consists of five broad domains that capture overarching patterns of personality. At the higher order, the domains are labeled: Extraversion vs. introversion, affability vs. antagonism, consciousness vs. undependability or disinhibition, neuroticism vs. emotional stability, and openness vs. closedness to experience [2]. Recent handbooks on personality development offer a more comprehensive perspective on the stability and change of other personality constructs, such as life narratives, motives, and values [3]. One of the trait theories that has generated more consensus is that developed by Costa and McCrae (1985), known as the five-factor model [4, 5]. According to this, the basic elements of personality would be neuroticism, extraversion, openness to experience, affability, and conscientiousness.

- Neuroticism: assesses emotional stability or instability; psychological distress; unrealistic ideas; non-adaptive coping responses.
- Extraversion: evaluates the amount and intensity of interaction between people; the level of activity; the need for stimulation and the ability to enjoy.
- Openness to experience: evaluates actively seeking and valuing experience for oneself; tolerance and exploration of the unknown.
- Affability: assesses the quality of one's interpersonal orientation along a continuum from compassion to rivalry.
- Conscientiousness: evaluates the degree of organization of the individual; perseverance and motivation in goal-oriented behavior.

In Ecuador, the functions of teachers from a Higher Education Institution (HEI) revolve around four axes: teaching (activities related to inter-learning), research (activities leading to the search for theoretical or practical knowledge), extension (activities aimed at social projection), and academic management. The selection process, in itself, has to do with the requirements of the Law that regulates the Higher Education processes of each country and with the specific training required for the subject to be taught in each institution. Some studies have shown that an emotional contagion occurs between the teacher and the student. HEIs could benefit from knowing the personality traits of their teachers to be able to insert them in a relevant way in the activities or functions in which they will be able to perform with excellence, thus improving their efficiency, and responding to one of the objectives regarding education. The present study aimed to know the teachers' personality traits that could influence the development of their students.

2 Material and Methods.

2.1 Theoretical methods:

The documentary research method, bibliographic research, and observation were used, as well as the inductive/deductive method to conduct the hermeneutic method. This method allows establishing and analyzing different perspectives and comparing them with the literature consulted. A bibliographic search was carried out on the elements of the teacher's personality to know the influence of these traits in the teaching process.

2.2 Methods for processing information:

Neutrosophic Cognitive Maps (NCMs) were introduced by [6] in 2003. NCMs are an integration of fuzzy cognitive maps (FCMs) introduced by Kosko in 1986 and neutrosophic sets (NSs) introduced by Smarandache in 1995 [7]. This technique overcomes the inability of traditional FCMs to represent indeterminacy. The inclusion of indeterminacy establishes that neutrality and ignorance are also forms of uncertainty. [7] explains that FCMs is a technique that has received increasing attention due to its possibilities to represent causality. The following is a set of definitions necessary to work with NCMs. First, the original definition of neutrosophic logic is shown below as defined in [8].

Definition 1. [9] Let N be a neutrosophic evaluation set. v: $N = \{(T, I, F): T, I, F \in [0,1]\} \rightarrow$ N is a mapping of a group of propositional formulas onto N, that is, each sentence is associated with a value p∈N, as set out in Equation 1, that is, p is T% true, I% indeterminate, and F% false.

$$v(p) = (T, I, F) \tag{1}$$

Therefore, neutrosophic logic is a generalization of fuzzy logic, based on the concept of neutrosophic according to [10, 11].

Definition 2. [12, 13] Let K be the ring of real numbers. The ring generated by K∪I is called a neutrosophic ring if the indeterminacy factor intervenes in it, where I satisfies *I2 = I, I+I = 2I* and, in general, *I+I+...+I = nI*, if *k ∈K, then kI = kI, 0I = 0*. The neutrosophic ring is denoted by *K(I)*, which is generated by K∪Yo, that is, *K(I)* = <K∪i>, where <K∪I>denotes the ring generated by K and I.

Definition 3. A neutrosophic matrix is a matrix *A = [aij]ij i =1, 2, ..., m and j = 1, 2, ..., n; m, n≥I*, such that each $a_{ij} \in K(I)$,where *K(I)* is a neutrosophic ring, see [14]

An element of the matrix may be in the form a+bI, where "a" and "b" are real numbers, while I is the indeterminacy factor. The usual neutrosophic matrix operations can be extended from the classical matrix operations.

For example,

$$\begin{pmatrix} -1 & I & 5I \\ I & 4 & 7 \end{pmatrix} \begin{pmatrix} I & 9I & 6 \\ 0 & I & 0 \\ -4 & 7 & 5 \end{pmatrix} = \begin{pmatrix} -21I & 27I & -6 + 25I \\ -28 + I & 49 + 13I & 35 + 6I \end{pmatrix}$$

Furthermore, a neutrosophic graph is a graph that has at least one indeterminate edge or one indeterminate node [8, 15]. The neutrosophic adjacency matrix is an extension of the adjacency matrix in classical graph theory. $a_{ij} = 0$ means that nodes i and j are not connected, $a_{ij} = 1$ means that these nodes are connected and $a_{ij} = I$, means that the connection is indeterminate (it is unknown whether it is or not). Fuzzy set theory does not use such notions. On the other hand, if indeterminacy is introduced into a cognitive map as referred to in [16], then this cognitive map is called a neutrosophic cognitive map, which is especially useful in representing causal knowledge [10, 17]. It is formally defined in Definition 4.

Definition 4. A Neutrosophic Cognitive Map (NCM) is a directed neutrosophic graph with concepts such as policies, and events, among others, as nodes and causalities or indeterminates as edges. It represents the causal relationship between concepts. The measures described below are used in the proposed model, they are based on the absolute values of the adjacency matrix [16]:

✓   Out degree (□□) is the sum of the row elements in the neutrosophic adjacency matrix. It reflects the strength of the outgoing relations (□□□) of the variable:

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$$od(v_i) = \sum c_{ij} \tag{2}$$

✓ In degree (id_i) is the sum of the elements of the column. It reflects the strength of the relationships
(□□□) outgoing of the variable.

$$id(v_i) = \sum_{i=1}^{n} c_{ii} \tag{3}$$

✓ Total centrality (total degree(□□)), is the sum of the out-degree and the in-degree of the variable.

$$td(v_i) = od(v_i) + id(v_i) \tag{4}$$

The variables are classified according to the following criteria, see [18]:

a) The transmitting variables are those with $od(vi) > 0$ and $id(vi) = 0$.
b) The receiving variables are those with $od(vi) = 0$ and $id(vi) > 0$.
c) Ordinary variables satisfy both $od(vi) \neq 0$ and $id(vi) \neq 0$

Static analysis is applied using the adjacency matrix, considering the absolute value of the weights [15]. Static analysis in neutrosophic cognitive maps (NCM), see [17], initially contains the neutrosophic number of the form (a + bI), where I = indeterminacy [19]. Requires a deneutrosophication process as proposed in [16], where ∈ [0, 1] and is replaced by its maximum and minimum values.

Finally, the average of the extreme values is used, which is calculated with Equation 5, to obtain a single value as referred to in [20]. This value contributes to the identification of the characteristics to be addressed, according to the factors obtained, for our case study.

$$\lambda([a_1, a_2]) = \tag{5}$$

After,

$$A \succ B \Leftrightarrow \frac{a_1 + a_2}{2} > \frac{b_1 + b_2}{2} \tag{6}$$

3 Results

3.1 Background and bibliometric analysis

An analysis of the bibliography of the last decade in Elsevier [21-50-54-54-56] Using as keywords: "Assessment", and "Personality Traits" and filtering by the last decade, yielded a result of 29 studies. Figure 1 shows a map made with the co-citations of the keywords.

Figure 1. Bibliometric map analyzed using VOSviewer software version 16.19. Source: own elaboration
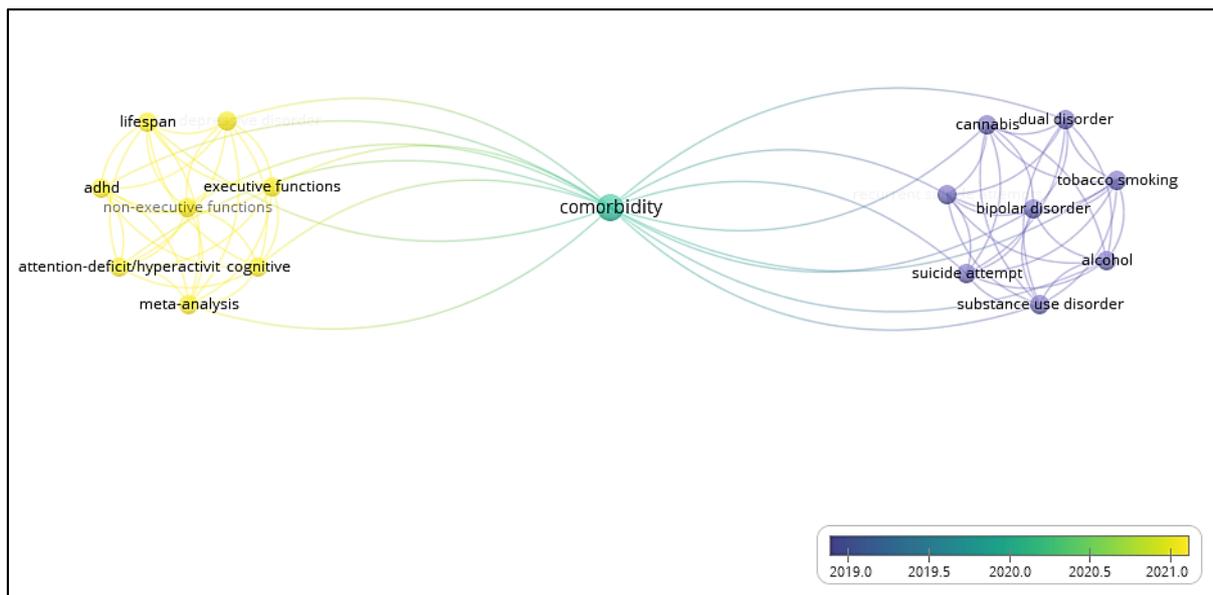

Figure 1 shows a graphic representation that highlights the transcendental importance of basing the analysis on the concept of comorbidity, also known as associated morbidity, a term of great relevance in the field of health and medicine. Comorbidity refers to the simultaneous or sequential presence of two or more disorders or diseases in the same person. This concept is essential to understanding the complexity of health conditions and their interaction in the clinical context. To carry out a comprehensive and robust analysis, the approach of the logic of neutrosophic thinking was adopted in the construction of the cognitive map and its inherent adjacency matrix. This methodological choice makes it possible to address the uncertainty and imprecision inherent in comorbidity.

Additionally, in this bibliometric review process, a specific filter including the keyword "teachers" was applied. This search strategy revealed a considerable set of studies, where 35% of these [21-29-52-53], focused on teachers in general. Importantly, these studies mostly focused on specific geographic regions, with a particular emphasis on Saudi Arabia. Figure 2 provides a graphical representation that clearly illustrates this geographic distribution of research.

Figure 2. Specific bibliometric map for teachers using VOSviewer software version 16.19. Source: own elaboration
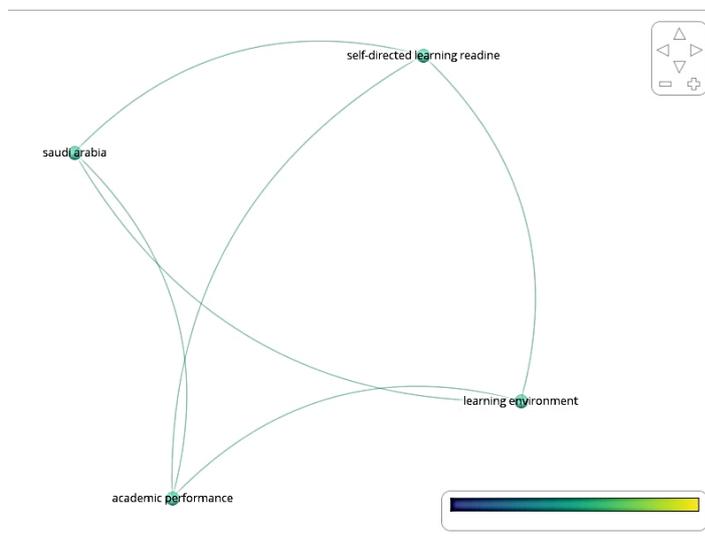
Studies focused on teachers carefully explored the learning environment and its impact on academic performance. These findings highlight the importance of understanding the interaction between the educational environment and educators' performance, which can have significant implications for improving the quality of teaching and learning in specific educational contexts. This approach reinforces the idea that the comorbidity of factors in the educational field can be just as relevant and complex as in the health field.

3.2 Application of the NCM

University professionals, like any individual, should aspire to develop personality traits that promote a healthy professional environment and effective performance in their respective careers. Below are the common traits found in the bibliography consulted, referring to the personality of teachers:
1. Empathy: the ability to understand, and empathize with, the needs of your students.
2. Openness to experience: Provide helpful feedback and encourage growth and improvement in your students.
3. Introversion: the preference for reflection, tranquility, and concentration on the internal world. This trait makes interaction difficult; generally, the person is shy and quiet, preferring to isolate themselves. Generating an inability to communicate effectively can cause difficulties in the classroom. By not knowing how to transmit knowledge adequately.
4. Emotional stability: the ability to maintain calm and serenity in the face of adversity.
5. Kindness and respect: Treat students appropriately, being compassionate, cooperative, and friendly. And foster an environment of mutual respect in the classroom.
6. Flexibility: The adaptability to address different learning styles and individual needs.
7. Excessive authoritarianism: a teacher who is too authoritarian.
8. Neuroticism: tendency to experience frequent negative emotions such as anxiety, sadness, or worry.
9. Egocentrism: Prioritizing ego over teamwork and shared goals can be detrimental to the group.

Through the Neutrosophic Cognitive Map, these personality traits were submitted to expert consultation, where the causal relationships between the nine variables or elements that characterize the personality of the teachers with neutrosophic numbers were evaluated, an average of the evaluations of the experts. From them, an adjacency matrix and the graph that represents it were obtained, which are listed below:

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Figure 3. Neutrosophic Cognitive Map of the causal relationship between factors. Source: own elaboration.
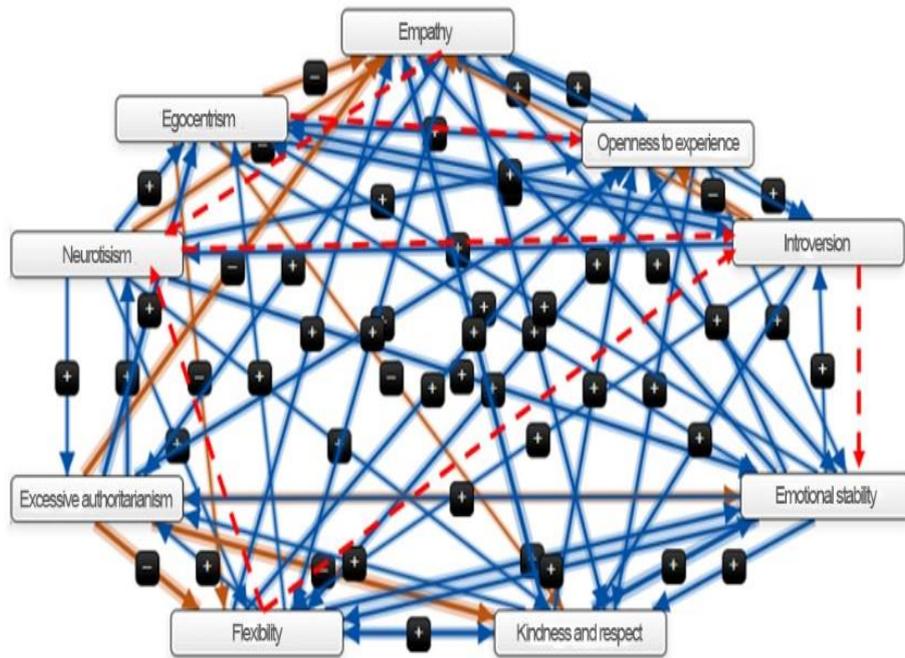
Table 1. Adjacency matrix. Source: own elaboration

	A	B	C	D	E	F	G	H	I
A	0	0.5	0.2	0.5	0.8	0.7	0.7	0	0
B	0.8	0	0.2	0.2	0.5	0.7	0	0	0.6
C	0.2	0.2	0	0.2	0.5	0.2	0	0.5	0.6
D	0.7	0.7	0.2	0	0.5	0.5	0.2	0	0.2
E	0.9	0.6	0	0.9	0	0.4	0.4	0	0
F	0.5	0.5	0.2	0.5	0.5	0	0.2	0.5	0.2
G	1	0.5	0	0.7	0.9	1	0	0.5	0.9
H	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0	0.5
I	0.5	0.5	0.5	0.2	0.2	0.2	0	0	0

Table 2. Static analysis of the adjacency matrix. Source: own elaboration

Factors	id	od	TD
Empathy	0.6375	0.425	1.0625
Openness to experience	0.5	0.375	0.875
introversion	0.225	0.3	0.525
Emotional stability	0.4625	0.375	0.8375
Kindness and respect	0.5125	0.4	0.9125
Flexibility	0.4875	0.3875	0.875
Excessive authoritarianism	0.2125	0.6875	0.9
Neuroticism	0.1875	0.3875	0.575
Egocentrism	0.375	0.2625	0.6375

Table 3. Hierarchical order and classification of variables. Source: own elaboration

Factors	Order	Classification
Empathy	1	Ordinary
Openness to experience	3	Ordinary
Introversion	5	Ordinary

Factors	Order	Classification
Emotional stability	3	Ordinary
Kindness and respect	2	Ordinary
Flexibility	2	Ordinary
Excessive authoritarianism	2	Ordinary
Neuroticism	5	Ordinary
Egocentrism	4	Ordinary

Qualitative interpretation of the MCN:

1. Classification of variables: In this context, classifying them as ordinary suggests that they are considered habitual and fundamental aspects in the analysis of personality or human behavior. These variables are common in many personality and psychology studies and are used to describe and understand the typical characteristics and traits of people in a variety of situations. Furthermore, they are both receivers and transmitters of information, which makes them codependent in the analysis of causality.

2. Causality analysis based on the hierarchical order between nodes:

   - There is an important relationship between the Empathy factor and the other factors, this having a higher level of causality, as this factor increases the others increase positively, except in the case of Egocentrism. That is to say, Empathy is the central factor.
   - Kindness and respect as positive drivers: Kindness and respect have a positive effect when activated, positively influencing the other nodes. However, this influence does not apply to excessive authoritarianism and egocentrism.
   - Excessive authoritarianism as a negative influence: Excessive authoritarianism, associated with people with strong and dominant ego characteristics, exerts a negative influence on the other personality nodes. As this node increases, empathy, emotional stability, kindness, and flexibility decrease. Therefore, it is considered to be an important aspect to consider, and on which objectives must be focused to eradicate it. Because its negative influence can interfere with teacher quality and training. This suggests that reducing excessive authoritarianism could be an important goal for improving teacher quality and training.
   - Indeterminate relationships: There are indeterminate causal relationships between several pairs of personality nodes, such as empathy and neuroticism, introversion and emotional stability, flexibility and introversion, flexibility and neuroticism, neuroticism and introversion, and egocentrism and openness to experience. This suggests that the influence of these factors on others may be more complex or less clear.
   - Diversity of personality traits: The analysis highlights the diversity of personality traits and how a person is built upon a combination of positive and negative factors. The importance of enhancing the traits that favor the development of students and that contribute positively to their personality is emphasized.

4 Discussion

Personality traits like empathy and patience create a more welcoming and safe learning environment for students. This facilitates participation, the exchange of ideas, and the expression of doubts. Teachers who practice constructive feedback and respect contribute to the personal and academic growth of their students, promoting self-esteem and self-confidence. Organization and effective communication can help students better understand concepts and be better prepared for academic success.

Teachers who recognize and work on improving their negative personality traits can experience significant professional growth. This may include honing communication, classroom management, and interpersonal skills, which in turn improves your ability to teach effectively. Modifying negative personality traits in teachers not only benefits students in the short term but also has a long-term impact on their development. Students can learn valuable lessons about self-evaluation, personal growth, and overcoming challenges by watching their teachers address and improve their negative traits.

In summary, teachers' ability to identify and modify negative personality traits is essential for creating a healthier educational environment and for their professional development. Additionally, this improvement process can have a lasting impact on students' lives.

The study of [51] on "*Traits of personality that affect the performance of the professors of the PUCE matrix*

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in the functions of teaching and research", concludes that it does not find significant relationships between personality traits and the performance of teachers in teaching functions; This is not the case with regard to the relationship between personality traits and performance in functions as a researcher, where it has been found that teachers with more creative, less affable and less self-controlled personalities have better performance. These results differ from those found in the present investigation. It was concluded that traits such as excessive Authoritarianism and Egocentrism in teachers can constitute a barrier to communication with their students.

Conclusions

From the text provided, several significant conclusions can be drawn:
1. Importance of Comorbidity: Comorbidity, which refers to the coexistence of multiple disorders or diseases in the same person, is an essential concept in the field of health and medicine. Its understanding is essential to address the complexity of health conditions and their interaction in a clinical context.
2. Application of the Logic of Neutrosophic Thinking: The choice to apply the logic of neutrosophic thinking in the construction of the cognitive map demonstrates the importance of addressing the uncertainty and imprecision inherent in comorbidity. This methodology is valuable for clinical decision-making and health research.
3. Focus on Teacher Studies: The bibliometric review focusing on the keyword "teachers" reveals a particular focus on teacher research, especially in Saudi Arabia. The studies explored the relationship between the learning environment and academic performance, highlighting the influence of educators' personality traits on the quality of teaching.
4. Impact of Personality Traits on Teaching: Personality traits, such as empathy, patience, organization, and effective communication, create a more positive and productive learning environment for students. Modifying negative personality traits, such as excessive authoritarianism and egocentrism, can have a significant impact on teachers' professional development and the quality of training.
5. Divergent Results with Previous Studies: A previous study mentioned that did not find significant relationships between personality traits and the performance of teachers in teaching functions but did find significant relationships in research functions. This contrasts with the findings of the current research, which highlights the importance of traits such as excessive authoritarianism and egocentrism in communication with students and the quality of training.
6. Results of the Neutrosophic Cognitive Map: The analysis through the Neutrosophic Cognitive Map revealed causal relationships between the personality traits analyzed. Positive traits, such as empathy, kindness, and flexibility, positively influence other traits. On the other hand, excessive authoritarianism shows an inversely proportional relationship with positive traits, suggesting that modifying these negative traits can lead to a more favorable learning environment.

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