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A Neutrosophic Approach to Evaluating Self-Perceived Professional Competency in Dentistry Students and Graduates

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Abstract. This article addresses a key issue in dental education: how recent graduates and final-year students at the Faculty of Dentistry of the National University of San Marcos (UNMSM) perceive their readiness for professional practice. The study explores these self-assessments amid uncertainty, especially due to disruptions in clinical training during health restrictions. Traditional methods often overlook the ambiguity present in human perceptions during crises. To fill this gap, the study applies neutrosophic Z numbers, a method that captures degrees of certainty, indeterminacy, and contradiction in responses. Five competency dimensions were evaluated, revealing overall confidence in professional preparation but significant uncertainty in technical specialization and clinical management. Unlike conventional approaches, this method highlights subtle distinctions in perception and better reflects the complexity of training during times of disruption. The findings not only provide a deeper theoretical understanding of professional self-assessment in healthcare but also offer practical implications: the need to reinforce advanced clinical skills and management training. Thus, the study contributes both conceptually and methodologically, offering a nuanced tool for evaluating professional readiness in uncertain and evolving educational environments.

Keywords : Professional Repair, Dentistry, Perception, Neutrosophic Z Numbers, Competencies, Health Education, Uncertainty.

1. Introduction

Preparation for professional practice in Dentistry is an essential pillar for ensuring quality in healthcare, a topic of great relevance in today's educational and professional environments. This study explores how final-year students and recent graduates of the Faculty of Dentistry at the Universidad Nacional Mayor de San Marcos (UNMSM) perceive their willingness to face the challenges of their profession. This self-perception is significant because it directly impacts the confidence and performance of future dentists, aspects that impact the oral health of the population [1]. Furthermore, recent research underscores that adequate training depends not only on technical knowledge but also on practical skills and professional attitudes, which highlights the importance of this analysis [2]. Over time, dental education has transitioned from traditional, theory-centered approaches to more integrated models that

prioritize clinical practice. In the Peruvian context, public universities such as UNMSM have played a key role in this process, adapting to the demands of an increasingly competitive labor market [3]. However, challenges persist related to the transition of students to independent practice, a step that requires diverse competencies and a solid perception of preparation [4]. This historical and current overview establishes the basis for understanding why assessing these perceptions is crucial today. In this sense, a problem arises that deserves attention: the self-perceptions of future dentists are often complex, combining certainty about certain skills with doubts or contradictions about others. Traditional assessment approaches often simplify this reality into rigid categories, which can obscure important nuances [5]. The magnitude of this issue lies in its impact on the training of competent professionals, capable of responding to the needs of society.

So, how can we accurately determine levels of self-perceived professional preparedness, considering not only what students and graduates think they know, but also their uncertainties and limitations? This question, still without a definitive answer, guides the present study. The difficulty lies in capturing a multifaceted reality that conventional methods do not fully address. Historically, studies on professional preparedness have privileged quantitative metrics, leaving aside the ambiguity inherent in human perceptions [6]. However, in a field such as Dentistry, where clinical decisions and interaction with patients are fundamental, this indeterminacy cannot be ignored. Therefore, there is a need for innovative approaches that more faithfully reflect the experience of future professionals. The use of neutrosophic Z numbers offers a promising alternative for this purpose, allowing an analysis that integrates degrees of certainty, uncertainty, and contradiction. This methodological framework, little explored in health education, aligns with the complexity of the subject and seeks to overcome the limitations of binary assessments [8-10]. Thus, the study offers a renewed perspective on how dentists in training see themselves.

Given this context, the objectives of this research are clearly outlined. First, it aims to determine the levels of self-perceived professional preparation among students and recent graduates of the UNMSM, using neutrosophic Z numbers[6] as an analytical tool. Second, it seeks to identify the areas of greatest strength and ambiguity in their competencies, to provide useful insights for improving dental training.

These objectives directly address the question posed and will be developed throughout the article, offering both theoretical and practical contributions to the field. In doing so, it is hoped to not only enrich the understanding of professional preparation but also propose ways to strengthen dental education.

2. Preliminaries

2.1. Self-perceived Professional Competency

Self-perceived professional readiness emerges as a key concept for understanding how future professionals, especially in fields such as Dentistry, assess their ability to perform in the workforce. This phenomenon not only reflects the mastery of technical skills but also the confidence and attitudes that students and graduates develop during their training [11]. In this sense, its study is essential, since one's self-perception can directly influence actual performance, an aspect that multiple studies have begun to highlight [12]. Therefore, analyzing this topic offers a window into the quality of professional education and its practical implications. Historically, the transition from academia to independent practice has been a challenge for health professionals, and Dentistry is no exception. Several studies indicate that recent graduates face difficulties when applying theoretical knowledge in complex clinical scenarios [13]. However, what distinguishes self-perception is its subjective nature: it does not always align with objective competencies, which creates fertile ground for reflection. This discrepancy, far from being a shortcoming, invites us to consider how individuals interpret their preparation based on personal experiences and expectations. Furthermore, the relevance of this analysis is magnified in contexts where job demands require adaptability and confidence in decision-making. Self-perception of preparation can act as a driving force for facing challenges or, conversely, as a barrier if one's potential is underestimated [14]. In dentistry, where patient interactions and technical precision are crucial, this subjective dimension

takes on even greater weight. Thus, understanding it not only benefits professionals but also educational systems that seek to develop competent individuals.

On the other hand, traditional approaches to assessing readiness typically rely on quantitative metrics, such as exams or lists of completed competencies [15, 16]. Although useful, these methods tend to ignore the gray areas of human perception, such as uncertainty or internal contradictions. Herein lies a significant limitation: by reducing readiness to rigid categories, the richness of nuances that students and graduates experience when assessing their abilities is lost. This methodological gap underscores the need for more flexible and comprehensive perspectives. In this context, the use of tools such as neutrosophic Z numbers emerges as an innovative proposal to address self-perceived professional readiness[17]. By allowing the integration of certainty, indeterminacy, and falsity into the analysis, this approach captures the complexity of perceptions more faithfully [18, 19]. Unlike binary scales, this methodology recognizes that a student may feel confident in certain areas, doubtful in others, and completely unprepared in specific aspects, all at the same time [. Such flexibility is invaluable for a field as dynamic as Dentistry [21].

The neutrosophic Z-number approach offers a significant advancement over traditional assessment methods by capturing the complexity and ambiguity inherent in self-perceived professional readiness. Unlike conventional tools that simplify competence into binary categories, this framework identifies areas of uncertainty and provides actionable insights for improving educational strategies, particularly in dental training. While its analytical complexity and the need for specialized training may pose challenges—especially in resource-limited settings—its capacity to reflect real-world nuances makes it a valuable asset for curriculum design and policy. Ultimately, this method promotes a more human-centered understanding of professional competence, bridging theoretical innovation with practical impact.

Neutrosophic Z Numbers.

This section contains the main concepts used in this article

Definition 1 ([22-25]). Let *X be* a set of universes. A *neutrosophic number Z The set* in *X* is defined as follows:

$$S_Z = \{\langle x, T(V,R)(x), I(V,R)(x), F(V,R)(x)\rangle : x \in X\} \qquad (1)$$

Where $T(V,R)(x) = \big(T_V(x), T_R(x)\big)$, $I(V,R)(x) = \big(I_V(x), I_R(x)\big)$, $F(V,R)(x) = \big(F_V(x), F_R(x)\big)$are functions from X to $[0,1]^2$, which are the ordered pairs of truth, indeterminacy, and falsity, respectively. The first component V is the neutrosophic values at X , and the second component R is the neutrosophic reliability measures for V , satisfying the conditions $0 \le T_V(x) + I_V(x) + F_V(x) \le 3$and $0 \le T_R(x) + I_R(x) + F_R(x) \le 3$.

For convenience, we denote it $\langle x, T(V,R)(x), I(V,R)(x), F(V,R)(x)\rangle$as $S_Z = \langle T(V,R), I(V,R), F(V,R)\rangle = \langle (T_V, T_R), (I_V, I_R), (F_V, F_R)\rangle$what is called NZN.

Definition 2 ([22-25]). Let$S_{Z_1} = \langle T_1(V,R), I_1(V,R), F_1(V,R)\rangle = \langle (T_{V_1}, T_{R_1}), (I_{V_1}, I_{R_1}), (F_{V_1}, F_{R_1})\rangle$ and$S_{Z_2} = \langle T_2(V,R), I_2(V,R), F_2(V,R)\rangle = \langle (T_{V_2}, T_{R_2}), (I_{V_2}, I_{R_2}), (F_{V_2}, F_{R_2})\rangle$ Let NZN and be two $\lambda > 0$. Then , we get the following relationships :

$S_{Z_2} \subseteq S_{Z_1} \Leftrightarrow T_{V_2} \le T_{V_1}, T_{R_2} \le T_{R_1}, I_{V_1} \le I_{V_2}, I_{R_1} \le I_{R_2}, F_{V_1} \le F_{V_2}, F_{R_1} \le F_{R_2}$,

$S_{Z_1} = S_{Z_2} \Leftrightarrow S_{Z_2} \subseteq S_{Z_1}$and $S_{Z_1} \subseteq S_{Z_2}$,

$S_{Z_1} \cup S_{Z_2} = \langle (T_{V_1} \vee T_{V_2}, T_{R_1} \vee T_{R_2}), (I_{V_1} \wedge I_{V_2}, I_{R_1} \wedge I_{R_2}), (F_{V_1} \wedge F_{V_2}, F_{R_1} \wedge F_{R_2})\rangle$,

$S_{Z_1} \cap S_{Z_2} = \langle (T_{V_1} \wedge T_{V_2}, T_{R_1} \wedge T_{R_2}), (I_{V_1} \vee I_{V_2}, I_{R_1} \vee I_{R_2}), (F_{V_1} \vee F_{V_2}, F_{R_1} \vee F_{R_2})\rangle$,

$(S_{Z_1})^c = \langle (F_{V_1}, F_{R_1}), (1 - I_{V_1}, 1 - I_{R_1}), (T_{V_1}, T_{R_1})\rangle$,

$S_{Z_1} \oplus S_{Z_2} = \langle (T_{V_1} + T_{V_2} - T_{V_1} T_{V_2}, T_{R_1} + T_{R_2} - T_{R_1} T_{R_2}), (I_{V_1} I_{V_2}, I_{R_1} I_{R_2}), (F_{V_1} F_{V_2}, F_{R_1} F_{R_2}) \rangle$,

$S_{Z_1} \otimes S_{Z_2} = \langle (T_{V_1} T_{V_2}, T_{R_1} T_{R_2}), (I_{V_1} + I_{V_2} - I_{V_1} I_{V_2}, I_{R_1} + I_{R_2} - I_{R_1} I_{R_2}), (F_{V_1} + F_{V_2} - F_{V_1} F_{V_2}, F_{R_1} + F_{R_2} - F_{R_1} F_{R_2}) \rangle$,

$\lambda S_{Z_1} = \langle \left(1 - (1 - T_{V_1})^{\lambda}, 1 - (1 - T_{R_1})^{\lambda}\right), (I_{V_1}^{\lambda}, I_{R_1}^{\lambda}), (F_{V_1}^{\lambda}, F_{R_1}^{\lambda}) \rangle$,

$S_{Z_1}^{\lambda} = \langle (T_{V_1}^{\lambda}, T_{R_1}^{\lambda}), \left(1 - (1 - I_{V_1})^{\lambda}, 1 - (1 - I_{R_1})^{\lambda}\right), \left(1 - (1 - F_{V_1})^{\lambda}, 1 - (1 - F_{R_1})^{\lambda}\right) \rangle$.

To compare two NZNs that have $S_{Z_i} = \langle T_i(V, R), I_i(V, R), F_i(V, R) \rangle = \langle (T_{V_i}, T_{R_i}), (I_{V_i}, I_{R_i}), (F_{V_i}, F_{R_i}) \rangle$(i = 1, 2), we have the scoring function[26]:

$$\Upsilon(S_{Z_i}) = \frac{2 + T_{V_i} T_{R_i} - I_{V_i} I_{R_i} - F_{V_i} F_{R_i}}{3} \qquad (2)$$

Note that $\Upsilon(S_{Z_i}) \in [0, 1]$. Therefore, $\Upsilon(S_{Z_2}) \leq \Upsilon(S_{Z_1})$implies $S_{Z_2} \preccurlyeq S_{Z_1}$.

To clarify equation 2, consider the following example

Example 1. Let $S_{Z_1} = \langle (0.9, 0.8), (0.1, 0.9), (0.2, 0.9) \rangle$, then we have $\Upsilon(S_{Z_1}) = \frac{2 + (0.9)(0.8) - (0.1)(0.9) - (0.2)(0.9)}{3} = 0.81666$.

Definition 3 ([11, 15]) **.** Sea $S_{Z_i} = \langle T_i(V, R), I_i(V, R), F_i(V, R) \rangle = \langle (T_{V_i}, T_{R_i}), (I_{V_i}, I_{R_i}), (F_{V_i}, F_{R_i}) \rangle$(i = 1, 2 , … , n) be a set of NZN and *NZNWAA* is a map from $[0, 1]^n$into $[0, 1]$, such that the operator NZNWAA is defined as follows:

$$NZNWAA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) = \sum_{i=1}^{n} \lambda_i S_{Z_i} \qquad (3)$$

Where is λ_i $(i = 1,2, \cdots, n)$the weight of S_{Z_i}satisfying $0 \leq \lambda_i \leq 1$and $\sum_{i=1}^{n} \lambda_i = 1$.

Thus, the NZNWAA formula is calculated as:

$$NZNWAA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) = \langle \left(1 - \prod_{i=1}^{n} (1 - T_{V_i})^{\lambda_i}, 1 - \prod_{i=1}^{n} (1 - T_{R_i})^{\lambda_i}\right), \left(\prod_{i=1}^{n} I_{V_i}^{\lambda_i}, \prod_{i=1}^{n} I_{R_i}^{\lambda_i}\right), \left(\prod_{i=1}^{n} F_{V_i}^{\lambda_i}, \prod_{i=1}^{n} F_{R_i}^{\lambda_i}\right) \rangle \qquad (4)$$

The NZNWAA operator possesses the following properties:

Is an NZN,

It is idempotent $NZNWAA(S_Z, S_Z, \cdots, S_Z) = S_Z$,

Note, $min\{S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}\} \leq NZNWAA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) \leq max\{S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}\}$,

Monotony, if $\forall i\ S_{Z_i} \preccurlyeq S_{Z_i}^*$then $NZNWAA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) \preccurlyeq NZNWAA(S_{Z_1}^*, S_{Z_2}^*, \cdots, S_{Z_n}^*)$.

Definition 4 (([22-25]) **.** Sea $S_{Z_i} = \langle T_i(V, R), I_i(V, R), F_i(V, R) \rangle = \langle (T_{V_i}, T_{R_i}), (I_{V_i}, I_{R_i}), (F_{V_i}, F_{R_i}) \rangle$(i = 1, 2 , … , n) be a set of NZN and *NZNWGA* be a map into $[0, 1]^n$, $[0, 1]$such that the operator NZNWGA is defined as follows:

$$NZNWGA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) = \sum_{i=1}^{n} S_{Z_i}^{\lambda_i} \qquad (5)$$

Where is λ_i $(i = 1,2, \cdots, n)$the weight of S_{Z_i}satisfying $0 \leq \lambda_i \leq 1$and $\sum_{i=1}^{n} \lambda_i = 1$.

Therefore, the NZNWGA formula is calculated as([22-25]:

$$NZNWGA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) = \langle \left(\prod_{i=1}^{n} T_{V_i}^{\lambda_i}, \prod_{i=1}^{n} T_{R_i}^{\lambda_i}\right), \left(1 - \prod_{i=1}^{n} (1 - I_{V_i})^{\lambda_i}, 1 - \prod_{i=1}^{n} (1 - I_{R_i})^{\lambda_i}\right), \left(1 - \prod_{i=1}^{n} (1 - F_{V_i})^{\lambda_i}, 1 - \prod_{i=1}^{n} (1 - F_{R_i})^{\lambda_i}\right) \rangle \qquad (6)$$

NZNWGA satisfies the following properties:

Is an NZN,

It is idempotent $NZNWGA(S_Z, S_Z, \cdots, S_Z) = S_Z$,

Note, $min\{S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}\} \leq NZNWGA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) \leq max\{S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}\}$,

Monotony, if $\forall i\ S_{Z_i} \preccurlyeq S^*_{Z_i}$ then $NZNWGA(S_{Z_1}, S_{Z_2}, \cdots, S_{Z_n}) \preccurlyeq NZNWGA(S^*_{Z_1}, S^*_{Z_2}, \cdots, S^*_{Z_n})$.

3. Material and Methods

3.1 Study Design and Participants

A cross-sectional study was conducted with 60 participants from the Faculty of Dentistry at the National University of San Marcos (UNMSM), divided into two groups:

Group A: 30 final-year undergraduate students.

Group B: 30 recent graduates with less than one year of professional practice.

Inclusion criteria included: being a final-year student or graduate from UNMSM, age between 22–35 years, and signing informed consent.

Exclusion criteria involved: prior dental training in other institutions, more than 2 years of work experience, current postgraduate studies, or incomplete survey responses.

The study was developed in four phases:

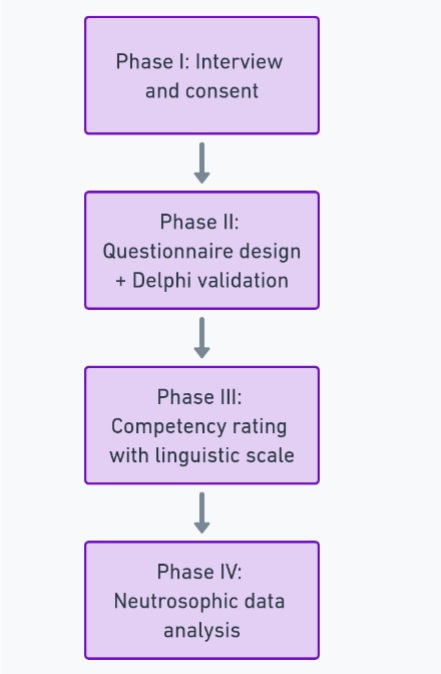

Figure 1. Flow diagram of the research process.

Phase I: Preparation and Consent

An initial interview was conducted with participants to explain the study objectives, methodology, and data confidentiality procedures. Written informed consent was obtained from all participants.

Phase II: Instrument Design and Validation

A self-assessment questionnaire was developed to evaluate 14 professional competencies. The instrument was validated using the Delphi method[27] with a panel of five dental education experts.

Phase III: Data Collection

Participants rated their competencies using a linguistic scale, which was later mapped to numerical values.

Phase IV: Neutrosophic Data Analysis

The collected data were processed using a neutrosophic multi-valued approach

3.2 Instrument Design and Validation

A self-assessment questionnaire was developed to evaluate 14 professional competencies grouped into three domains:

Theoretical Knowledge (4 items)

Clinical Skills (6 items)

Interpersonal and Professional Skills (4 items)

3.3 Data Collection

Participants rated their competency level using a linguistic scale, evaluating:

Truth value and reliability,

Indeterminacy and its reliability,

Falsity and its reliability.

These linguistic terms were mapped to numerical values as shown in Table 1.

Table 1: Linguistic truth and reliability values and their corresponding numerical value.

Numerical value equivalent	Reliability linguistics value	Truth linguistic value
0.1	Very insecure	Very low
0.3	Not very sure	Low
0.5	Not even sure neither insecure	Half
0.7	Sure	High
0.9	Very sure	Very high

These linguistic terms were mapped to numerical values (e.g., "Very high" = 0.9; "Very low" = 0.1) and transformed into Neutrosophic Z Numbers (NZN).

3.4 Data Processing and Analysis

The analysis consisted of:

Transformation of linguistic ratings into Neutrosophic Z Numbers (NZN)

Aggregation of individual ratings using the NZN Weighted Arithmetic Averaging (NZNWAA) operator

Scoring the aggregated values using a neutrosophic scoring function

Statistical analysis using the Mann-Whitney U test [28], with a significance level set at $p < 0.05$

Additionally, competence scores were analyzed by domain (knowledge, clinical, interpersonal), allowing identification of both strengths and areas of high indeterminacy across groups.

4. Results

Table 2 presents the sociodemographic data of the group of final-year students.

Table 2. Sociodemographic data of the group of final-year students

GENDER	**Frequency**	**Percentage**
Female	18	60%
Male	12	40%
AGE RANGES	**Frequency**	**Percentage**
22-24	15	50%
25-27	12	40%
28-30	3	10%
UNIVERSITY CLINICAL EXPERIENCE	**Frequency**	**Percentage**
2-3 years	24	80%
4-5 years	6	20%
TOTAL	**30**	**100%**

Table 3 shows the sociodemographic data for the group of recent graduates.

Table 3. Sociodemographic data of the group of recent graduates

GENDER	**Frequency**	**Percentage**
Female	16	53.3%
Male	14	46.7%
AGE RANGES	**Frequency**	**Percentage**
23-25	8	26.7%
26-28	17	56.7%
29-31	4	13.3%
32-35	1	3.3%
TIME SINCE GRADUATION	**Frequency**	**Percentage**
1-4 months	10	33.3%
5-8 months	13	43.3%
9-12 months	7	23.4%
TOTAL	**30**	**100%**

Fourteen professional competencies were assessed for each participant. We denote final-year students by $E_A = \{e_{A1}, e_{A2}, \ldots, e_{A30}\}$ and recent graduates by $E_B = \{e_{B1}, e_{B2}, \ldots, e_{B30}\}$.

The competencies assessed were the following:
Theoretical knowledge:
Fundamentals biological and biomedical
Pathology and diagnosis
Materials dental and biomaterials
Pharmacology and therapeutics
Clinical skills: 5. Dental surgery 6. Endodontics 7. Periodontics 8. Dental prosthetics 9. Basic oral surgery 10. Pediatric dentistry

Interpersonal and professional skills: 11. Communication with patients 12. Clinical and administrative management 13. Professional ethics 14. Research and continuous learning

Let x(A_{ij}) be the assessment made by the ith student on the jth competency in the senior group. Similarly, x(B_{ij}) is the equivalent for recent graduates.

Let $S_{Z_i} = \langle T_i(V,R), I_i(V,R), F_i(V,R)\rangle = \langle (T_{V_i}, T_{R_i}), (I_{V_i}, I_{R_i}), (F_{V_i}, F_{R_i})\rangle$(i = 1, 2 , … , n) be the set of neutrosophic Z numbers used to represent the assessments.

4.1 Results by competencies

Below are some representative examples of the ratings obtained for certain competencies:

Table 4. Examples of assessments for the "Dental Surgery" competency

Participant	NZN Rating	Scoring function
A_3	〈 (0.7, 0.7), (0.3, 0.5), (0.3, 0.7) 〉	0.717
(A_{12}	〈 (0.7, 0.5), (0.5, 0.3), (0.3, 0.7) 〉	0.683
B_4	〈 (0.9, 0.7), (0.1, 0.7), (0.1, 0.9) 〉	0.857
B_{21}	〈 (0.7, 0.9), (0.3, 0.7), (0.1, 0.7) 〉	0.783

Table 5. Examples of assessments for the "Basic Oral Surgery" competency

Participant	NZN Rating	Scoring function
A_7	〈 (0.5, 0.5), (0.5, 0.7), (0.5, 0.3) 〉	0.617
A_{18}	〈 (0.3, 0.7), (0.7, 0.5), (0.7, 0.3) 〉	0.550
B_9	〈 (0.7, 0.7), (0.3, 0.5), (0.3, 0.5) 〉	0.733
B_{25}	〈 (0.7, 0.9), (0.3, 0.7), (0.3, 0.5) 〉	0.750

The values for each participant were aggregated across all competitions using the NZNWAA operator (5).

These aggregated values were converted into numerical scores using the scoring function:$\bar{\bar{x}}_{e_i} = \Upsilon(\bar{x}_{e_i})$ and $\bar{\bar{x}}_{c_i} = \Upsilon(\bar{x}_{c_i})$.

Table 6. Aggregation results and scoring function for both groups

Seniors year	Newly graduates
$\bar{\bar{x}}$ (A1) = 0.623	$\bar{\bar{x}}$ (B1) = 0.712
$\bar{\bar{x}}$ (A2) = 0.645	$\bar{\bar{x}}$ (B2) = 0.735
$\bar{\bar{x}}$ (A3) = 0.671	$\bar{\bar{x}}$ (B3) = 0.693
$\bar{\bar{x}}$ (A4) = 0.598	$\bar{\bar{x}}$ (B4) = 0.758
$\bar{\bar{x}}$ (A5) = 0.634	$\bar{\bar{x}}$ (B5) = 0.726
$\bar{\bar{x}}$ (A6) = 0.649	$\bar{\bar{x}}$ (B6) = 0.701
$\bar{\bar{x}}$ (A7) = 0.612	$\bar{\bar{x}}$ (B7) = 0.732
$\bar{\bar{x}}$ (A8) = 0.657	$\bar{\bar{x}}$ (B8) = 0.716
$\bar{\bar{x}}$ (A9) = 0.685	$\bar{\bar{x}}$ (B9) = 0.747
$\bar{\bar{x}}$ (A10) = 0.602	$\bar{\bar{x}}$ (B10) = 0.729
$\bar{\bar{x}}$ (A11) = 0.678	$\bar{\bar{x}}$ (B11) = 0.705
$\bar{\bar{x}}$ (A12) = 0.642	$\bar{\bar{x}}$ (B12) = 0.753
$\bar{\bar{x}}$ (A13) = 0.661	$\bar{\bar{x}}$ (B13) = 0.711
$\bar{\bar{x}}$ (A14) = 0.633	$\bar{\bar{x}}$ (B14) = 0.738
$\bar{\bar{x}}$ (A15) = 0.650	$\bar{\bar{x}}$ (B15) = 0.724

Seniors year	Newly graduates
$\bar{\bar{x}}$ (A16) = 0.618	$\bar{\bar{x}}$ (B16) = 0.707
$\bar{\bar{x}}$ (A17) = 0.672	$\bar{\bar{x}}$ (B17) = 0.742
$\bar{\bar{x}}$ (A18) = 0.629	$\bar{\bar{x}}$ (B18) = 0.721
$\bar{\bar{x}}$ (A19) = 0.647	$\bar{\bar{x}}$ (B19) = 0.696
$\bar{\bar{x}}$ (A20) = 0.663	$\bar{\bar{x}}$ (B20) = 0.732
$\bar{x}$ (A21) = 0.625	$\bar{\bar{x}}$ (B21) = 0.717
$\bar{\bar{x}}$ (A22) = 0.654	$\bar{\bar{x}}$ (B22) = 0.728
$\bar{x}$ (A23) = 0.637	$\bar{\bar{x}}$ (B23) = 0.740
$\bar{\bar{x}}$ (A24) = 0.673	$\bar{\bar{x}}$ (B24) = 0.703
$\bar{\bar{x}}$ (A25) = 0.659	$\bar{\bar{x}}$ (B25) = 0.749
$\bar{\bar{x}}$ (A26) = 0.640	$\bar{\bar{x}}$ (B26) = 0.715
$\bar{\bar{x}}$ (A27) = 0.628	$\bar{\bar{x}}$ (B27) = 0.731
$\bar{\bar{x}}$ (A28) = 0.667	$\bar{\bar{x}}$ (B28) = 0.744
$\bar{\bar{x}}$ (A29) = 0.621	$\bar{\bar{x}}$ (B29) = 0.709
$\bar{\bar{x}}$ (A30) = 0.646	$\bar{\bar{x}}$ (B30) = 0.726

The Mann- Whitney U test was applied to compare the two data groups $GA = \{\bar{x}(Ai)\}$ and $GB = \{\bar{x}(Bi)\}$.

The hypothesis test proposed was as follows:

H_0: Both populations are distributed equally, therefore, there are no significant differences in the self-perception of professional preparation between final-year students and recent graduates.

H_1: Both populations are distributed differently, therefore, there are significant differences in the self-perception of professional preparation between final-year students and recent graduates.

The significance level was set at 0.05.

Whitney U test formulas :

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \qquad U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

Where $n_1 = n_2 = 30$ (sample sizes), R_1 and R_2 are the sums of the ranges of the observations in samples 1 and 2, respectively.

After performing the calculations, a p-value of $0.0023 < 0.05$ was obtained, which leads to the rejection of the null hypothesis H_0. This result indicates that there are statistically significant differences in the self-perception of professional readiness between senior students and recent graduates.

For a more detailed analysis, an aggregation by specific domains of competencies was performed, obtaining the following results:

Table 7. Results by Competency Domains

Domain	Seniors (Middle)	Newly graduates (Media)	p-value
Knowledge theorists	0.661	0.704	0.0179
Clinics skills	0.617	0.746	0.0008
Skills in interpersonal and professional	0.683	0.723	0.0415

These results indicate that the differences are statistically significant in all three competency domains, being most pronounced in the clinical skills domain.

his study assessed self-perceived professional readiness in final-year students and recent graduates of the Dentistry program at the Universidad Nacional Mayor de San Marcos using neutrosophic Z numbers. The findings revealed that recent graduates consistently reported higher levels of perceived readiness,

especially in clinical skills. This difference is attributed to the early months of professional experience, which expose graduates to diverse clinical situations, foster the integration of theoretical knowledge through practical application, and enhance autonomy in decision-making. The removal of the "supervisor effect" also contributes to greater confidence in clinical practice. While significant differences were observed across all three assessed domains, the smallest gap appeared in theoretical knowledge, indicating that the academic curriculum provides a strong theoretical foundation, though practical competencies are better developed through real-world experience.

Further analysis of specific competencies highlights areas that require attention. Final-year students scored lowest in "Basic Oral Surgery," "Clinical and Administrative Management," and "Dental Prosthetics," suggesting a need for targeted curricular reinforcement. In contrast, recent graduates scored lower in "Research and continuous learning," "Professional ethics," and "Pharmacology and therapeutics," signaling the importance of continued support during the transition into professional practice. The use of neutrosophic methodology allowed for a nuanced understanding of readiness, capturing degrees of truth, indeterminacy, and falsity, thus offering a more comprehensive alternative to conventional statistical assessments in contexts marked by subjectivity and uncertainty.

5. Conclusions and Recommendations

The results of this study reveal significant differences in self-perceived professional preparation between final-year dentistry students and recent graduates of the National University of San Marcos, with the latter group demonstrating notably higher levels of perceived readiness. The most pronounced disparity lies in the domain of clinical skills, highlighting the importance of early professional practice in consolidating these competencies. Furthermore, each group exhibits specific areas in need of targeted intervention: basic oral surgery and clinical management were identified as critical for final-year students, while recent graduates showed gaps in research capabilities and ongoing professional development. These findings underscore the relevance of complementing academic training with structured practical experiences. The application of neutrosophic Z-numbers proved effective in capturing the multidimensional nature of self-perception, allowing for a nuanced analysis that accounts for degrees of certainty, uncertainty, and contradiction—elements typically overlooked by conventional assessment methods.

In light of these results, a series of strategic recommendations are proposed to improve academic training, support recent graduates, and guide future research. For educational institutions, it is crucial to expand clinical practice opportunities, reinforce the connection between theoretical and practical components, and include administrative and decision-making skills in the curriculum. For recent graduates, mentorship programs, spaces for peer exchange, and continuing education focused on ethics, research, and pharmacology are suggested. Methodologically, further development of user-friendly tools for neutrosophic analysis and researcher training are necessary to ensure broader adoption. Future studies should explore additional cohorts, include objective performance metrics, and conduct longitudinal analyses to track the evolution of professional preparedness over time. Additionally, deepening the application of neutrosophic approaches in health education could enrich our understanding of complex cognitive and emotional processes that influence competence formation. In particular, future research could explore the integration of Z-number models with machine learning techniques to enhance predictive assessments in educational contexts characterized by uncertainty.

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