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Professional Identity Formation in Traditional Chinese Medicine Students: An Educational Perspective using Triple-Valued Neutrosophic Set

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Abstract: Professional identity formation (PIF) is a critical aspect of medical education, shaping how students internalize the values, knowledge, and behaviors of their chosen field. In the context of Traditional Chinese Medicine (TCM), where healing is deeply intertwined with philosophy, culture, and ethical practice, PIF takes on a unique and multifaceted character. This paper explores the educational structures, pedagogical strategies, and experiential components that influence the professional identity development of TCM students. It highlights the importance of cultural immersion, reflective practice, mentorship, and integrated clinical exposure in nurturing a cohesive sense of professional self within the context of TCM's historical and philosophical underpinnings. This study uses the Triple-Valued Neutrosophic Set (TVNS) to deal with uncertainty and vague information. TVNS has five membership functions such as truth, indeterminacy for truth, indeterminacy neither truth nor falsity, indeterminacy for falsity, and falsity. We show case study with five criteria and ten alternatives.

Keywords: Triple-Valued Neutrosophic Set; Uncertainty; Traditional Chinese Medicine; Educational Perspective.

1. Introduction

The concept of professional identity in medical education refers to the process through which students come to see themselves as competent and ethical practitioners within their discipline. In Traditional Chinese Medicine (TCM), this identity is not only about clinical skill but also involves a deep connection to centuries-old philosophies such as Confucianism, Daoism, and holistic health paradigms[1]. Unlike biomedical training, where identity often centers on empirical precision and scientific evidence, TCM demands a harmonious balance of knowledge, intuition, and cultural understanding. Therefore, professional identity formation (PIF) in TCM requires a pedagogical model that aligns medical competency with spiritual and ethical maturity[2].

Educational institutions that offer TCM programs face the dual challenge of preserving traditional values while preparing students for a contemporary, often integrative, healthcare environment[3]. This necessitates an approach that blends classical teaching such as pulse diagnosis, herbal formulation, and Qi theory—with modern clinical standards and patient communication skills. In this hybrid space, students must navigate both ancient texts and current medical expectations, making identity formation a dynamic, and sometimes conflicting, process[4]. Cultivating a strong professional identity helps students reconcile these worlds, ultimately fostering confident and culturally competent practitioners.

Key to this formation is the design of learning experiences that go beyond technical training. Reflective journaling, case-based learning, and mentorship with experienced practitioners can provide students with role models and ethical frameworks grounded in practice[5]. Additionally, early clinical exposure and patient interaction allow students to experience the humanistic side of medicine and develop interpersonal competencies essential to the TCM tradition[6]. These experiential and reflective components help solidify students' understanding of their roles and responsibilities, aligning their personal growth with professional standards.

Another critical factor is the emphasis on cultural alignment and philosophical orientation. Since TCM is as much a worldview as it is a medical system, fostering identity formation involves immersion into its ethical codes, dialectical reasoning, and cosmological views[7]. When students internalize these principles, they are more likely to advocate for TCM within interdisciplinary settings and practice with authenticity. This alignment not only strengthens their individual identities but also contributes to the broader legitimacy and resilience of TCM as a global healthcare modality.

Florentin Smarandache [8] suggested the Neutrosophic Set (NS), a new area of philosophy that examines the nature, breadth, and genesis of neutralities as well as how they interact with other ideational spectra. According to neutrosophy theory, each occurrence has a degree of truth as well as a degree of untruth and indeterminacy that must be considered separately. The neutrality {Neut-A} and its opposite {Anti-A} are therefore taken into consideration while discussing a theory, event, concept, or entity {A}. Both {A} and {Anti-A} are not {Neut-A}. {Non-A} is the term used for the {Neut-A} and {Anti-A}. This theory states that {Anti-A} and {Non-A} balance and counteract any concept {A. An effective tool for handling indeterminacy is offered by NS[9], [10].

2. Literature Review

Progression through several conceptually separate developmental phases is part of Professional Identity Formation (PIF). Kegan's PIF theory is broken down into six steps, or phases 0–5. During medical school, students are thought to move through phases two through four (institutional, interpersonal, and imperial). The PIF of medical interns is now the subject of much research. There isn’t much research on Chinese interns, though. It is vital to investigate the processes of interns' PIF in Chinese socio-cultural contexts, as social-ecological theory (STC) posits that an individual's behavior and development are influenced by their multilayered interactions with the

environment. Jia et al. [11] examined the relationships between the many contributing elements that underlie the PIF process and evaluates the PIF status of Chinese medical interns. According to Kegan's model, they shown that Chinese medical interns were at stage 4. Furthermore, PIF may be facilitated by the mutual connections of behavioral, environmental, and personal factors.

Traditional Chinese Medicine (TCM) is being used by nurses more and more to treat personal health concerns. This qualitative case study aims to investigate the ways in which nurses' professional identities and behaviors are influenced by their encounters with TCM. The research framework of Sharon W. Bertrand et al. [12] that is employed is symbolic interaction. Data analysis is facilitated by mixed coding techniques. The results are explained by sociological theory. Twenty semi structured interviews with ten academic members and ten working nurses in the Twin Cities region of Minnesota were included in the study. Several new findings are based on the data. The impact of TCM experience on nurses' professional identities and nursing practices is determined by nursing subspecialty practice standards. TCM can be incorporated into a nurse's "toolbox" through flexible nursing jobs.

The purpose of study of Lai et al. [13] was to investigate the present state of medical students' professional identities in China following COVID-19 and the elements that affect them. Participants were from one medical university in Jiangxi Province, a central Chinese province, and the questionnaire was self-designed and collated by Fujian Medical University. The findings indicated that medical students had an upper-middle level professional identity and a generally good professional attitude. In terms of values, there was a significant sex difference, with males scoring better than girls. In contrast, girls scored higher than boys in areas like professional cognition and professional surroundings.

3. Triple-Valued Neutrosophic Set

Neutrosophic set is used to overcome uncertainty and vague information. Let X be a non-empty set. The neutrosophic set has three membership functions such as truth, indeterminacy, and falsity. The neutrosophic set can be defined as:

$T_A: X \to [0,1]$

$I_A: X \to [0,1]$

$F_A: X \to [0,1]$

The three functions must meet the following conditions such as:

$0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$

Example 1: Disease Diagnosis

Let X = {Influenza, COVID-19, Allergy}

For each diagnosis $x \in X$ a doctor assigns:

- $T_A(x)$: Degree of belief based on symptoms and tests
- $I_A(x)$: Degree of uncertainty due to inconclusive results
- $F_A(x)$: Degree of disbelief based on negative indicators

Example values:

- TA(Influenza) = 0.6, IA(Influenza) = 0.3, FA(Influenza) = 0.1
- TA(COVID-19) = 0.3, IA(COVID-19) = 0.5, FA(COVID-19) = 0.2
- TA(Allergy) = 0.7, IA(Allergy) = 0.1, FA(Allergy) = 0.2

Example 2: Investment Decision

Let X = {Buy, Hold, Sell}

An investor evaluates each option using market data and intuition:

- $T_A(x)$: Confidence in the decision being beneficial
- $I_A(x)$: Market unpredictability or missing data
- $F_A(x)$: Belief that the decision will fail

Example values:

- TA(Buy) = 0.5, IA(Buy) = 0.3, FA(Buy) = 0.2
- TA(Hold) = 0.6, IA(Hold) = 0.2, FA(Hold) = 0.2
- TA(Sell) = 0.4, IA(Sell) = 0.4, FA(Sell) = 0.2

Example 3: Student Performance Prediction

Let X = {Pass, Borderline, Fail}

A teacher estimates each outcome based on class performance:

- $T_A(x)$: Belief that outcome will occur
- $I_A(x)$: Ambiguity from attendance, effort, or participation
- $F_A(x)$: Belief that outcome will not occur

Example values:

- TA(Pass) = 0.8, IA(Pass) = 0.1, FA(Pass) = 0.1
- TA(Borderline) = 0.4, IA(Borderline) = 0.4, FA(Borderline) = 0.2
- TA(Fail) = 0.2, IA(Fail) = 0.3, FA(Fail) = 0.5

The concept of Triple-Valued Neutrosophic Set (TVNS) can be defined as[14], [15]:

$A = \{(x, T_A(x), I_T(x), I_N(x), I_F(x), F_A(x)) : x \in X\}$ where

$T_A(x) \in [0,1]$ is a truth value,

$I_T(x) \in [0,1]$ is a leaning indeterminacy value toward truth

$I_N(x) \in [0,1]$ is a neutral indeterminacy: It is neither indeterminacy toward truth nor falsity, it is fully indeterminacy.

$I_F(x) \in [0,1]$ is an indeterminacy learning toward falsity.

$F_A(x) \in [0,1]$ is a falsity value

$0 \leq T_A(x) + I_T(x) + I_N(x) + I_F(x) + F_A(x) \leq 5$

Example 4: Cardiovascular Disease Screening

Patient A, diagnostic results:

- $T_A(x)$ (A) = 0.7 → moderate-to-high likelihood of heart condition
- $I_T(x)$ = 0.1 → slight uncertainty toward presence
- $I_N(x)$ = 0.05 → uncertain due to insufficient data
- $I_F(x)$ = 0.1 → moderate uncertainty against condition
- $F_A(x)$ = 0.05 → low likelihood of being healthy

Example 5: Early Diabetes Detection

Patient B, diagnostic results:

- $T_A(x)$ = 0.4 → low-moderate chance of diabetes
- $I_T(x)$ = 0.2 → lab indicators somewhat support the diagnosis
- $I_N(x)$ = 0.25 → uncertainty due to borderline symptoms
- $I_F(x)$ = 0.1 → some factors suggest a false positive
- $F_A(x)$ = 0.05 → relatively low belief in being healthy

Example 6: Lung Infection Diagnosis

Patient C, diagnostic results:

- $T_A(x)$ = 0.55 → moderate positive indication
- $I_T(x)$ = 0.15 → symptoms lean toward confirming presence

- $I_N(x) = 0.1 \rightarrow$ ambiguous signs from imaging
- $I_F(x) = 0.1 \rightarrow$ negative indicators from bloodwork
- $F_A(x) = 0.1 \rightarrow$ fair probability of no infection

It is obvious that the Triple-Valued Neutrosophic Set is a particular case of the n-Refined Neutrosophic Set (when n =3)[16]. In 2013 Smarandache refined / split the Neutrosophic Components (T, I, F) into Neutrosophic SubComponents (T1, T2, ..., Tp; I1, I2, ..., Ir; F1, F2, ..., Fs), where p, r, s are integers >= 0, with p + r + s = n and at least one of p, r, s be >= 2 in order to ensure refinement.

4. Case Study

This section shows the case study for Professional Identity Formation in Traditional Chinese Medicine Students: An Educational Perspective. Figure 1 shows five criteria and ten alternatives. This study uses the Triple-Valued Neutrosophic Set (TVNS) to compute the criteria weights and ranking the alternatives.

Three experts evaluate criteria and alternatives using Triple-Valued Neutrosophic Number. They use five values of Triple-Valued Neutrosophic Number as shown in Table 1.

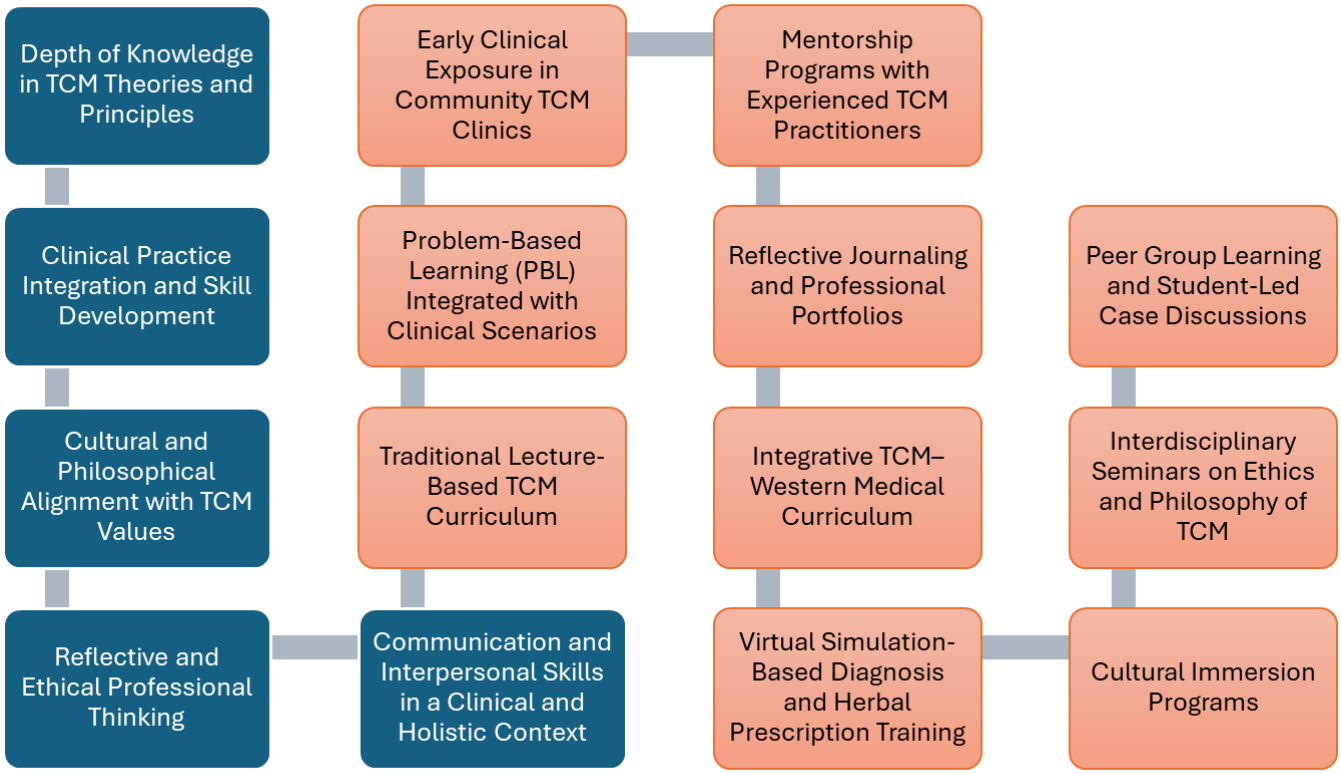

Figure 1. Criteria and alternatives.

Table 1. Triple-Valued Neutrosophic Numbers.

	$TVNC_1$	$TVNC_2$	$TVNC_3$	$TVNC_4$	$TVNC_5$
$TVNA_1$	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)
$TVNA_2$	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_3$	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.33,0.22,0.15,0.2,0.1)
$TVNA_4$	(0.25,0.35,0.20,0.1,0.1)	(0.75,0.05,0.1,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)
$TVNA_5$	(0.5,0.1,0.2,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.75,0.05,0.1,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)
$TVNA_6$	(0.5,0.1,0.2,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)
$TVNA_7$	(0.33,0.22,0.15,0.2,0.1)	(0.33,0.22,0.15,0.2,0.1)	(0.75,0.05,0.1,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)	(0.33,0.22,0.15,0.2,0.1)
$TVNA_8$	(0.33,0.22,0.15,0.2,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.75,0.05,0.1,0.05,0.05)
$TVNA_9$	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_{10}$	(0.4,0.3,0.2,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.5,0.1,0.2,0.1,0.1)	(0.33,0.22,0.15,0.2,0.1)	(0.5,0.1,0.2,0.1,0.1)
	$TVNC_1$	$TVNC_2$	$TVNC_3$	$TVNC_4$	$TVNC_5$
$TVNA_1$	(0.25,0.35,0.20,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)
$TVNA_2$	(0.75,0.05,0.1,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_3$	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_4$	(0.6,0.15,0.1,0.1,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)
$TVNA_5$	(0.4,0.3,0.2,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)
$TVNA_6$	(0.25,0.35,0.20,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)
$TVNA_7$	(0.75,0.05,0.1,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_8$	(0.33,0.22,0.15,0.2,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)
$TVNA_9$	(0.75,0.05,0.1,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)
$TVNA_{10}$	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.5,0.1,0.2,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)
	$TVNC_1$	$TVNC_2$	$TVNC_3$	$TVNC_4$	$TVNC_5$
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$TVNA_2$	(0.4,0.3,0.2,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.25,0.35,0.20,0.1,0.1)
$TVNA_3$	(0.33,0.22,0.15,0.2,0.1)	(0.6,0.15,0.1,0.1,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.5,0.1,0.2,0.1,0.1)	(0.33,0.22,0.15,0.2,0.1)
$TVNA_4$	(0.5,0.1,0.2,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.6,0.15,0.1,0.1,0.05)
$TVNA_5$	(0.25,0.35,0.20,0.1,0.1)	(0.33,0.22,0.15,0.2,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.4,0.3,0.2,0.05,0.05)
$TVNA_6$	(0.75,0.05,0.1,0.05,0.05)	(0.5,0.1,0.2,0.1,0.1)	(0.33,0.22,0.15,0.2,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.33,0.22,0.15,0.2,0.1)
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$TVNA_8$	(0.33,0.22,0.15,0.2,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.33,0.22,0.15,0.2,0.1)
$TVNA_9$	(0.75,0.05,0.1,0.05,0.05)	(0.6,0.15,0.1,0.1,0.05)	(0.25,0.35,0.20,0.1,0.1)	(0.6,0.15,0.1,0.1,0.05)	(0.5,0.1,0.2,0.1,0.1)
$TVNA_{10}$	(0.4,0.3,0.2,0.05,0.05)	(0.4,0.3,0.2,0.05,0.05)	(0.5,0.1,0.2,0.1,0.1)	(0.4,0.3,0.2,0.05,0.05)	(0.25,0.35,0.20,0.1,0.1)

The average method is used to combine the Triple-Valued Neutrosophic Numbers into a crips values as shown in Figure 2. The Triple-Valued Neutrosophic Numbers have three values such as truth, indeterminacy for truth, indeterminacy neither truth nor falsity, indeterminacy for falsity, and falsity values.

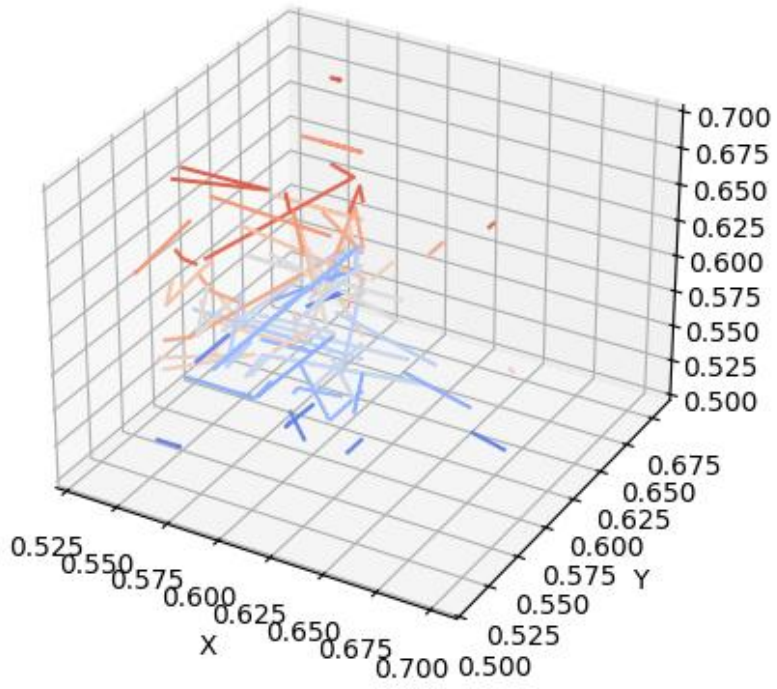

Figure 2. Crisp values of Triple-Valued Neutrosophic Numbers.

The weights of criteria are computed using the average method as shown in Figure 3. We show the criterion 3 is the best and criterion 5 is the worst.

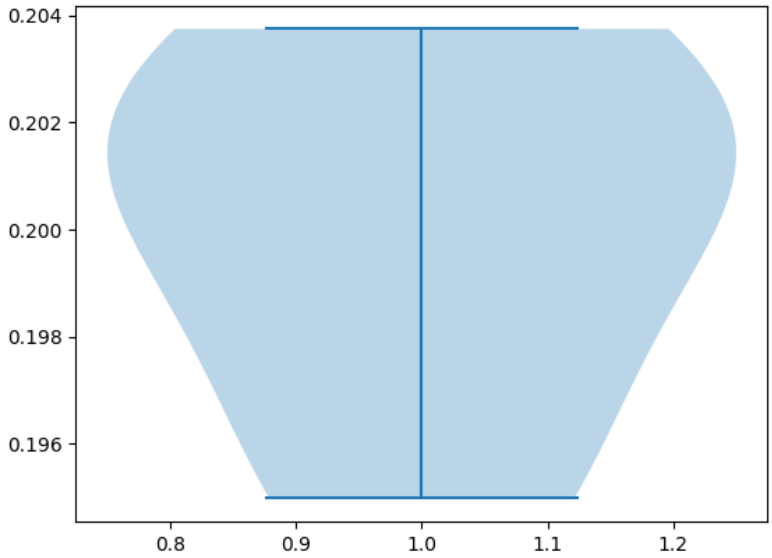

Figure 3. Criteria weights.

This paper ranks the alternatives using the weighted normalized matrix. We rank the alternatives as shown in Figure 4. The rank of alternatives is computed from largest to lowest. The results show alternative 4 is the best and alternative 2 is the worst.

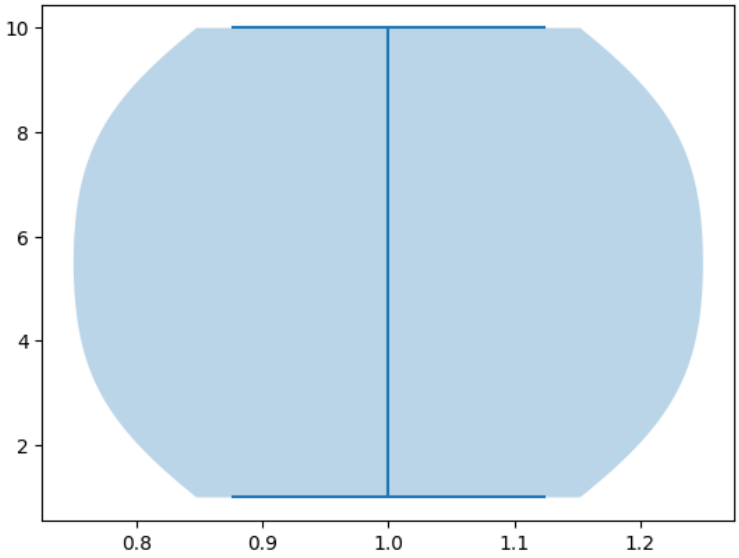

Figure 4. Ranks of alternatives.

5. Conclusions

Professional identity formation in TCM education is a nuanced, culturally embedded process that demands more than clinical proficiency. By integrating traditional philosophy, reflective practice, and modern pedagogical methods, educators can cultivate practitioners who are not only skilled but also grounded in the values that define TCM. This study used the Triple-Valued Neutrosophic Set (TVNS) is used to overcome uncertainty information. It has five membership functions. We show a case study with five criteria and ten alternatives. The results showed that criterion 3 is the best and criterion 5 is the worst. Alternative 4 is the best and alternative 2 is the worst.

Future research and curriculum innovation should continue to explore how best to balance heritage with adaptability, ensuring that students develop a professional identity that is both meaningful and resilient in a rapidly changing medical landscape.

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