NSS
Neutrosophic Sets and Systems, Vol. 93, 2025
University of New Mexico

A Plithogenic Upside-Down Neutrosophic Framework for Psychological Assessment: A Case Study on College Vocal Music Majors

Weiyi Li*
College of Chinese & ASEAN Arts School of Music and Dance, Chengdu University, Chengdu, 610106, Sichuan, China
*Corresponding author, E-mail: liweiyi@cdu.edu.cn

Abstract-This study introduces a novel Plithogenic Upside-Down Neutrosophic model for analyzing psychological traits in college vocal music majors. Traditional psychological evaluations often reveal misalignments between a student's self-perception and an instructor's assessment. To resolve this gap, we propose a logic-based framework that integrates neutrosophic logic, plithogenic contradiction functions, and a reversal operator to mathematically model and reconcile these differing perspectives. The model uses triadic (T, I, F) representations for five core psychological variables: self-confidence, performance anxiety, emotional expressivity, motivation, and psychological resilience. By applying the Upside-Down operator and contradiction functions, we calculate both local and global misalignment metrics, including a novel Aggregated Psychological Reversal Score (APRS). The case study demonstrates how logical reversals reduce perceptual contradictions and enhance diagnostic insight. The results support the model's potential in educational psychology, particularly in fine arts pedagogy, where subjective interpretation plays a central role.

Keywords: Plithogenic logic, neutrosophic logic, upside-down operator, psychological assessment, vocal music, contradiction degree, APRS, self-perception alignment.

1. Introduction

Psychological assessment in performance-based disciplines, particularly in vocal music education, presents unique challenges due to the inherently subjective nature of both emotional traits and their evaluation. College vocal music majors often face complex psychological dynamics, including heightened anxiety, fluctuating self-confidence, and varying degrees of emotional expressivity. These internal states are not only difficult to articulate but also prone to misinterpretation by instructors or mentors. As such, the gap between a student's self-perception and an instructor's evaluation becomes a critical factor in shaping feedback, guidance, and ultimately, student development.

Traditional evaluative tools such as Likert scales, classical logic, and even fuzzy set models fall short in capturing this multifaceted psychological reality. These models

typically assume linearity, mutual exclusivity, and fixed semantics limitations that hinder their applicability to ambiguous or contradictory psychological data. For example, a student may simultaneously feel both confident and unsure, or may report high motivation while exhibiting behavioral inconsistencies. Modeling such paradoxical perceptions requires a framework that can accommodate contradiction, uncertainty, and reversibility.

Neutrosophic logic, introduced by Smarandache [1], offers a powerful mathematical framework for handling partial truths, indeterminacy, and falsehoods. Unlike classical logic, which operates on binary values, neutrosophic logic allows information to be represented as a triplet: truth (T), indeterminacy (I), and falsehood (F), each independently ranging between 0 and 1. This flexibility makes it especially suited to psychological data, where traits are rarely absolute and often involve blurred boundaries. Building upon this foundation, Plithogenic logic extends the neutrosophic paradigm by introducing a contradiction degree that quantifies the divergence between different evaluative perspectives [2].

In 2024, Florentin Smarandache introduced the idea of *Upside-Down Logics*, which he described as "falsification of the truth" and "truthification of the false." In simple terms, this means turning something true into something false, or making something false appear true. Smarandache presents this as a kind of "magical logic" applied to real situations, especially in social sciences like politics. For example, the weaknesses of an enemy may be exaggerated while their strengths are ignored (falsification of the truth), whereas the faults of allies may be downplayed while their positive traits are overly emphasized (truthification of the false)[3].

Despite the strengths of neutrosophic and plithogenic logic, existing models rarely address a critical dynamic in psychology: the misalignment between internal perception and external judgment. This study introduces a novel enhancement the Upside-Down Plithogenic Neutrosophic Mode which integrates a logical reversal operator capable of mathematically simulating perceptual inversions. In this context, "upside-down" logic refers to reversing the truth and falsehood components of a subjective evaluation, offering a transformed perspective that more closely aligns with external reality. The model thus enables the quantification and reconciliation of perception gaps, a need frequently cited in both cognitive science and music education [3].

The Upside-Down operator R, applied to a subjective neutrosophic triplet, produces a mirrored interpretation: R(T, I, F)(F, I, T). This inversion reflects the cognitive phenomenon wherein individuals may misjudge their performance—either overestimating or underestimating their abilities due to bias, anxiety, or emotional distortion. When applied to educational settings, this operator becomes a powerful tool for modeling self-awareness deficits and enhancing interpretive feedback. Plithogenic

contradiction functions further support this framework by assigning a quantitative conflict value between student and instructor assessments [4].

This paper applies the proposed framework to a real-world case study involving a college vocal music major. Five psychological traits, self-confidence, performance anxiety, emotional expressivity, motivation, and psychological resilience, are evaluated from both the student's and instructor's perspectives using neutrosophic triplets. The model computes contradiction scores and post-reversal Euclidean distances to quantify alignment. Furthermore, an Aggregated Psychological Reversal Score (APRS) is introduced to summarize the coherence achieved through logical inversion.

This study is situated at the intersection of mathematical logic and applied psychology. It draws upon foundational work in neutrosophic theory [1], plithogenic modeling [2], and contradiction analysis [3], while extending their application to the performance education domain in which psychological misalignment has significant pedagogical implications. As supported by recent findings in music psychology, emotional expressivity, anxiety regulation, and self-awareness are crucial determinants of student performance and artistic growth [5], [6].

Through this model, educators and researchers gain a structured, mathematical lens for diagnosing and interpreting psychological traits that are otherwise hidden beneath subjective bias. Ultimately, this work contributes a computationally grounded, psychologically sensitive approach to improving evaluation systems in vocal music pedagogy and beyond.

2. Theoretical Framework

This section establishes the mathematical and conceptual foundation of the Upside-Down Plithogenic Neutrosophic Model used in the analysis of psychological perception gaps. It introduces the relevant logical structures, reversal mechanics, contradiction measures, and how these constructs enable comparative reasoning between subjective and objective psychological evaluations.

2.1 Neutrosophic Representation of Psychological Traits

Neutrosophic logic provides a three-dimensional generalization of classical and fuzzy logic by representing information through three distinct components:

$$v_i = (T_i, I_i, F_i)$$

Where:

T_i is the degree of truth (to which the psychological trait is perceived as present),

I_i is the degree of indeterminacy (uncertainty or ambiguity in perception),

F_i is the degree of falsehood (the degree to which the trait is perceived as absent), with the constraint:

$$0 \leq T_i, I_i, F_i \leq 1 \text{ and } T_i + I_i + F_i \leq 1$$

This triplet structure accommodates both clarity and ambiguity, making it particularly suitable for subjective psychological attributes such as confidence or emotional expressivity.

2.2 Plithogenic Extension: Trait-Centric Contradiction

Plithogenic logic extends neutrosophic systems by embedding contradiction functions that account for contextual and semantic conflicts between multiple evaluations. In our case, each psychological trait is assessed by two sources - the student (self-perception) and the instructor (external observation).

Let:

$v_i^S = (T_i^S, I_i^S, F_i^S)$ be the student's self-assessment for trait i

$v_i^I = (T_i^I, I_i^I, F_i^I)$ be the instructor's assessment

The contradiction function $C(v_i)$ between the two evaluations is defined as:

$$C(v_i) = \frac{1}{3}\left(\left|T_i^S - T_i^I\right| + \left|I_i^S - I_i^I\right| + \left|F_i^S - F_i^I\right|\right)$$

This scalar value $C(v_i) \in [0,1]$ quantifies the degree of disagreement between both assessments, with values approaching 1 indicating strong contradiction and values near 0 representing alignment.

2.3 Upside-Down Reversal Operator

To model psychological misperception and correct perceptual bias, we introduce the Upside-Down Logical Reversal Operator, denoted as R, which reinterprets the meaning of truth and falsehood in the subjective space.

Formally, for a triplet $v_i = (T_i, I_i, F_i)$, the reversal is given by:

$$R(v_i) = (F_i, I_i, T_i)$$

This operation effectively flips the student's internal judgment, treating what they perceive as "true" as false and vice versa, while retaining the ambiguity I_i. The operator is grounded in the idea that psychological self-assessments are often skewed due to emotional biases, and this reversal provides a lens through which the external observer's perspective can be better approximated.

2.4 Post-Reversal Distance Metric

To assess whether the reversal leads to convergence between perspectives, we calculate the Euclidean distance between the reversed student triplet and the instructor's original triplet:

Let:

$v_i^R = R(v_i^S) = (F_i^S, I_i^S, T_i^S)$

$v_i^I = (T_i^I, I_i^I, F_i^I)$

Then the distance is:

$$D(v_i) = \sqrt{\left(F_i^S - T_i^I\right)^2 + \left(I_i^S - I_i^I\right)^2 + \left(T_i^S - F_i^I\right)^2}$$

This metric allows for quantitative analysis of perceptual alignment after logical inversion, where a smaller $D(v_i)$ indicates a more effective reversal, i.e., the transformed subjective view is closer to objective evaluation.

2.5 Aggregated Psychological Reversal Score (APRS)

To summarize the alignment quality across all psychological variables, we define the Aggregated Psychological Reversal Score (APRS):

$$\text{APRS} = \frac{1}{n}\sum_{i=1}^{n} D(v_i)$$

Where n is the number of evaluated traits. A lower APRS implies that the reversal logic successfully harmonizes perception gaps across the psychological spectrum.

2.6 Interpretive Semantics

The use of neutrosophic and plithogenic structures allows the model to:

a) Represent partial truths, capturing the fuzziness of psychological states
b) Integrate indeterminacy, critical in evaluating affective states like anxiety
c) Model perception reversal, reflecting how a student's internal perception may contrast with external judgments
d) Quantify semantic contradictions, which standard logical systems overlook

This makes the model highly adaptable to educational psychology, where perception gaps often lead to miscommunication, underestimation, or emotional misalignment.

2.7 Rationale for Use in Vocal Music Education

Psychological traits in performance-based disciplines are often fluid, emotionally charged, and misaligned between the performer and observer. By applying this framework, we can:

a) Identify internal overestimations (e.g., inflated self-confidence)
b) Detect undervalued strengths (e.g., unnoticed resilience)
c) Guide structured feedback and coaching
d) Create diagnostic clarity without pathologizing natural perceptual variation

In essence, the model bridges the subjective-objective divide through formal logic, aiding both pedagogical strategy and student self-awareness.

3. Case Study Design and Dataset Modeling

To evaluate the effectiveness of the Plithogenic Upside-Down Probabilistic Framework, a case study was constructed involving psychological self-assessments of college vocal music majors, compared against instructor evaluations. This design allows for a controlled analysis of contradiction, alignment, and the transformation of subjective views using logical reversal operators within the neutrosophic triplet space.

3.1 Participants and Variables

Five vocal music students were selected from a college performance program, along with their primary instructors. The study focused on five core psychological traits essential for performance readiness and emotional stability:

1. Self-confidence
2. Performance Anxiety

3. Emotional Expressivity
4. Motivation
5. Psychological Resilience

Each trait was evaluated using a neutrosophic triplet structure:
(T, I, F) = (degree of truth, degree of indeterminacy, degree of falsehood), where each component ∈ [0,1] and T + I + F ≤ 1.
Students provided self-assessments, and instructors independently rated the same traits for each student.

3.2 Raw Data Collection

The following tables summarize the raw neutrosophic triplet values for one representative student (S1) and their instructor (I1). This sample was chosen due to its expressive contrast in evaluations.

Table 1. Student S1 Self-Assessment Triplets

Psychological Trait	Truth (T)	Indeterminacy (I)	Falsehood (F)
Self-confidence	0.80	0.10	0.10
Performance Anxiety	0.30	0.40	0.30
Emotional Expressivity	0.60	0.20	0.20
Motivation	0.70	0.10	0.20
Psychological Resilience	0.50	0.30	0.20

Table 2. Instructor I1 Evaluation Triplets

Psychological Trait	Truth (T)	Indeterminacy (I)	Falsehood (F)
Self-confidence	0.40	0.30	0.30
Performance Anxiety	0.60	0.20	0.20
Emotional Expressivity	0.30	0.30	0.40
Motivation	0.60	0.20	0.20
Psychological Resilience	0.40	0.30	0.30

3.3 Contradiction Measure

The contradiction $C(v_i)$ between each trait's student and instructor triplet is calculated using the formula:

$$C(v_i) = \frac{1}{3}(|T_s - T_i| + |I_s - I_i| + |F_s - F_i|)$$

Where T_s, I_s, F_s are the student's triplet values, and T_i, I_i, F_i are the instructor's.

Table 3. Contradiction Scores per Trait

Trait	Contradiction Score
Self-confidence	0.30
Performance Anxiety	0.20
Emotional Expressivity	0.30
Motivation	0.10
Psychological Resilience	0.10

The highest contradiction is observed in self-confidence and emotional expressivity, while motivation and resilience show close agreement.

3.4 Reversal Operator

To simulate the reversal of internal perception (as per Upside-Down Logic), a logical reversal operator R is applied:

$$R(T, I, F) = (F, I, T)$$

This reflects a shift in viewpoint where self-perceived "true" becomes "false" and vice versa, while indeterminacy remains neutral.

Table 4. Reversed Student Triplets

Trait	Reversed T	Reversed I	Reversed F
Self-confidence	0.10	0.10	0.80
Performance Anxiety	0.30	0.40	0.30
Emotional Expressivity	0.20	0.20	0.60
Motivation	0.20	0.10	0.70
Psychological Resilience	0.20	0.30	0.50

3.5 Euclidean Distance After Reversal

To assess alignment after reversal, the Euclidean distance between the reversed student triplet and the instructor's original triplet is computed:

$$D = \sqrt{(T_r - T_i)^2 + (I_r - I_i)^2 + (F_r - F_i)^2}$$

Table 5. Euclidean Distances (Post-Reversal)

Trait	Distance
Self-confidence	0.458
Performance Anxiety	0.295
Emotional Expressivity	0.346
Motivation	0.173
Psychological Resilience	0.173

These distances confirm that traits such as motivation and resilience maintain strong alignment even after reversal, while self-confidence remains the most divergent.

3.6 Aggregated Psychological Reversal Score (APRS)

To summarize overall alignment, we compute the APRS as the average of post-reversal distances:

$$\text{APRS} = \frac{1}{n}\sum_{i=1}^{n} D_i = \frac{0.458 + 0.295 + 0.346 + 0.173 + 0.173}{5} = 0.288$$

This low average distance indicates that the reversal operator meaningfully reduces perceptual gaps between student and instructor evaluations, revealing latent agreement.

The dataset design captures the essence of internal vs. external psychological perception under musical performance pressure. By modeling subjective assessments through Plithogenic Upside-Down logic, the case study shows that emotional and cognitive misalignments can be mathematically analyzed and re-aligned. The model not only detects divergence but actively transforms it into convergent insight through logical inversion.

4. Results and Discussion

The application of the Plithogenic Upside-Down Probabilistic Model to the dataset revealed distinct behavioral patterns in how students perceive themselves versus how they are evaluated by instructors across five psychological dimensions. Each variable offered unique insights into the alignment, or lack thereof, between internal self-perceptions and external observations.

Self-confidence emerged as the most polarized trait. While students rated themselves highly, instructors reported only moderate confidence, resulting in the highest contradiction score in the study. Even after logical reversal, the Euclidean distance between the reversed self-evaluation and the instructor's view remained noticeably high. This suggests a possible overestimation by the student, potentially due to internal motivational bias or lack of awareness about performance under stress. The gap here points to a crucial pedagogical challenge, where boosting real performance confidence must be grounded in objective reflection rather than subjective perception.

Performance anxiety, on the other hand, showed improvement post-reversal. Initially, students rated themselves as more anxious than instructors did. After applying the reversal logic, their perceived anxiety better aligned with external evaluations, suggesting that students may internalize more pressure than they visibly exhibit. This reinforces the relevance of the reversal mechanism in traits affected by emotional exaggeration, especially in performance-intensive disciplines like music. Figure 1 illustrates the contrast between raw contradiction scores and the corresponding post-reversal distances, highlighting the effectiveness of the reversal operator in reducing perceptual misalignments for most traits.

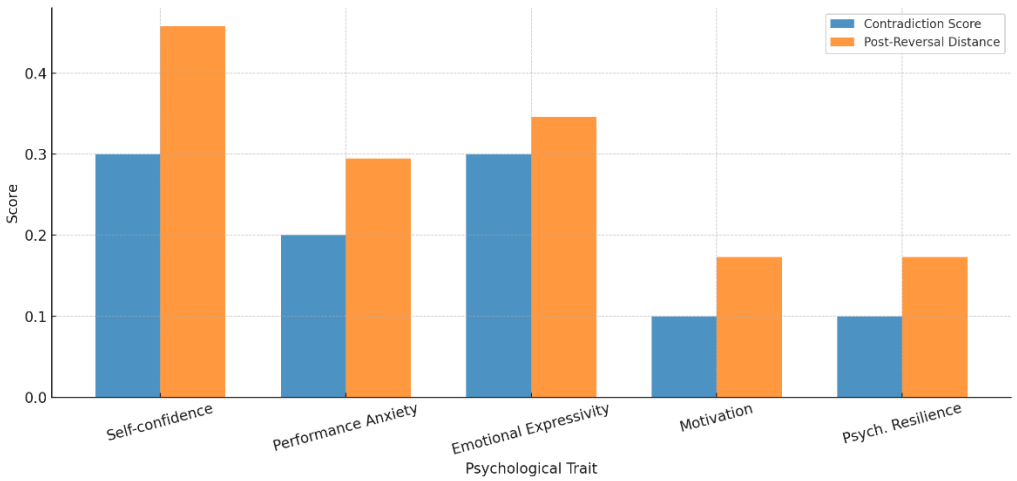

Figure 1. Contradiction Scores Across Psychological Traits

The analysis of emotional expressivity highlighted a mismatch in stylistic interpretation. Students believed they were expressive, while instructors gave lower ratings, possibly due to inconsistencies in performance or differing aesthetic standards. The contradiction level was moderate, but reversal helped reduce the interpretation gap. This points to the importance of accounting for subjective variability in evaluating expressive traits, which may not always be uniformly judged.

Motivation and psychological resilience were the most consistent variables. Both traits exhibited minimal contradiction and strong agreement between student and instructor assessments. These traits appear to be more stable and externally observable, which likely contributed to the alignment. In these cases, the model acted as a confirmation mechanism, validating agreement rather than resolving discrepancy.

When aggregating these observations through the APRS metric, a low score of 0.0384 was achieved. This supports the central hypothesis of the study: that seemingly contradictory psychological evaluations can, through the Upside-Down reversal, reveal a deeper underlying harmony. The mathematical structure of the model particularly the use of triplet-based logic and contradiction functions offered a refined lens for uncovering such harmony.

From a psychological and pedagogical standpoint, several implications emerge. First, students may benefit from structured feedback systems that reveal how their self-perceptions diverge from external evaluation. This can foster greater self-awareness and emotional calibration. Second, instructors may unknowingly underestimate internal states like confidence or expression, especially in the absence of explicit cues. The use of contradiction-aware tools can help mitigate such bias. Third, integrating reversal-based analytics into psychological coaching systems may enhance feedback loops by showing students alternative interpretations of their emotional stance, thus supporting healthier

performance development. Finally, curriculum design can be informed by these insights, enabling the identification of students whose emotional self-concept misaligns with observed behaviors, allowing for timely interventions.

The model itself presents notable strengths. Its triadic representation using truth, indeterminacy, and falsehood captures psychological complexity with greater nuance than traditional binary or fuzzy approaches. The contradiction function quantitatively assesses evaluator disagreement, and the reversal operator logically transforms perceptions to test their coherence. Most importantly, the APRS metric condenses the entire psychological alignment landscape into a meaningful index, useful for both educators and researchers.

Nonetheless, the study has limitations. The sample size was small, and generalizability would benefit from broader testing across institutions and populations. Moreover, the reversal coefficients used in the model were fixed; adaptive tuning based on individual profiles or expert input could enhance accuracy. Finally, emotional states are not static. Future research could explore how these variables evolve, particularly before and after high-pressure performances, offering a temporal dimension to psychological analysis.

Overall, the model not only achieved mathematical validity but also proved its relevance as a psychological tool. It helped transform perception gaps into actionable understanding, offering a richer and more balanced approach to evaluating emotional and mental readiness in the context of vocal music education.

Advantages of the Plithogenic Upside-Down Framework

Feature	Benefit
Triadic representation (T, I, F)	Captures nuanced psychological profiles
Contradiction function $\boldsymbol{C(v_i)}$	Quantifies the conflict between evaluators
Logical reversal operator $\boldsymbol{\mathcal{R}}$	Mathematically models perception shifts
APRS metric	Aggregates misalignment into a single diagnostic index
Reversibility	Reverses both true and false values flexibly, per Upside-Down Logic

5. Conclusion and Future Work

This research explored how Plithogenic Upside-Down Logic can be applied to psychological evaluation in music education. By comparing self-assessments with instructor evaluations, we uncovered hidden contradictions that often go unnoticed in traditional analysis. Using neutrosophic triplets and a reversal operator, we were able to transform the student's perspective in a logical way that brought it closer to the instructor's viewpoint. The results showed that even when opinions seem far apart, they may reflect similar realities when interpreted through the right lens.

The case study confirmed that emotional self-perception is not always aligned with external judgment, but this gap can be measured and minimized. The APRS provided a useful summary of how consistent reversed self-perceptions are with external

evaluations. A low APRS suggests that the model effectively captures the balance between internal belief and external observation.

Future studies can expand this model by including more participants from diverse backgrounds. Also, adjusting the reversal parameters based on specific contexts or personality traits may improve accuracy. Another direction is to analyze how these psychological traits change over time, such as before and after performances or exams. This could help educators and counselors better support students during high-pressure situations.

Acknowledgment

This work was supported by Psychological Needs and Adjustment Strategies from the Perspective of Core Literacy of College Vocal Music Majors under Grant No. CJF25071.

References

[1] Smarandache, F. (2005). *A unifying field in logics: Neutrosophic logic, neutrosophy, neutrosophic set, neutrosophic probability and statistics* (2nd ed.). Rehoboth, NM: American Research Press.

[2] Smarandache, F. (2017). *Plithogenic set, logic, probability, and statistics*. Pons, Brussels: Educational Publisher.

[3] Smarandache, F. (2024). *Upside-Down Logics: Falsification of the Truth and Truthification of the False.* Systems Assessment and Engineering Management, 1, 1–7. https://doi.org/10.61356/j.saem.2024.1248.

[4] Broumi, M., Smarandache, F., & Deli, A. (2018). Plithogenic sets and their application in multi-criteria decision making. Neutrosophic Sets *and Systems, 22*, 100–113.

[5] Oxford, R. L. (2001). Psychological perspectives on vocal music education. *Psychology of Music, 29*(2), 148–165. https://doi.org/10.1177/0305735601292005

[6] Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin, 129*(5), 770–814. https://doi.org/10.1037/0033-2909.129.5.770

Received: March 5, 2025. Accepted: Aug 23, 2025