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Neutrosophic Triplet Growth Model for Moral-Linguistic Competence in College English Teaching Reform under Moral Education and Talent Cultivation

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Abstract: This study proposes a novel Neutrosophic Triplet Growth Model integrating moral education and linguistic skill development within the framework of college English reform. By representing each learner's competence as a neutrosophic triplet capturing truth, indeterminacy, and falsity degrees combined with a neutrosophic derivative to measure the dynamic rate of change, the model simultaneously evaluates both the positional status of a learner relative to a moral-linguistic target profile and the temporal trajectory of their progress. A neutrosophic metric space is employed to quantify distances between learner states and the desired outcome, while the neutrosophic growth calculus tracks acceleration, deceleration, or regression in development. This dual-perspective assessment enables targeted pedagogical interventions that are mathematically grounded and pedagogically aligned with moral education principles. Numerical examples demonstrate the full computational process, ensuring reproducibility and practical applicability for higher education institutions seeking holistic English curriculum reform.

Keywords: neutrosophic triplet, growth calculus, moral education, linguistic competence, college English reform, metric space, talent cultivation

1. Introduction

Higher education reforms increasingly call for the joint cultivation of linguistic proficiency and moral formation in general education courses such as College English. In China, the Ministry of Education's 2020 Guidelines for the Construction of Curriculum Ideological and Political Education formally require programs to embed value shaping within disciplinary teaching and assessment, aligning language instruction with talent-cultivation goals [1]. Subsequent empirical and policy analyses document the structures and practices by which universities operationalize this agenda, including assessment norms and teacher development mechanisms [2].

This paper responds to a measurement gap that emerges when language learning outcomes and moral competencies evolve under uncertainty. We ground our solution in neutrosophic mathematics, which models truth, indeterminacy, and falsity independently and extends classical analysis through neutrosophic derivatives and metric spaces [5]–[6], [10]–[11]. By representing each learner's state as a neutrosophic triplet vector and tracking growth with a neutrosophic derivative inside a neutrosophic metric space, we provide a principled way to monitor both the position of a learner relative to a target moral-linguistic profile and the momentum of change over time.

2. Literature Review

2.1. College English Reform under Moral Education & Talent Cultivation

Policy frameworks since 2020 stipulate that curriculum-level "ideological and political" construction should integrate value education with knowledge and ability development across all university courses, including English [1]. Empirical work describes institutionalization pathways, governance structures, teacher training, and assessment alignment that support this integration at scale [2]. Within College English, studies report system-building efforts for embedding moral content into reading, writing, and speaking tasks, with attention to alignment between value objectives and linguistic tasks [3]–[4]. Broader reviews emphasize that synergy among objectives, content, implementation, and evaluation is a precondition for sustainable reform and talent cultivation [8]–[9]. Collectively, this strand establishes why moral integration is mandated and how institutions attempt to enact it, while also revealing persistent challenges in quantifying morally infused outcomes.

2.2. Neutrosophic Foundations for Uncertainty-Aware Measurement

Neutrosophic theory generalizes classical, fuzzy, and intuitionistic-fuzzy formalisms by decoupling truth (T), indeterminacy (I), and falsity (F), allowing each to vary independently in [0,1][0,1][0,1] [12]. Building on this set-theoretic base, neutrosophic calculus introduces limits and derivatives tailored to data with imprecision or incomplete evidence, providing rules of differentiation for neutrosophic functions [5]–[6]. Parallel advances in neutrosophic metric spaces (and their generalizations) supply distance notions and topological properties that can underwrite stability and convergence analyses of learning processes [10]–[11]. These foundations suggest a coherent toolkit for modeling state (via distances) and change (via derivatives) in educational settings where evidence is often partial or noisy.

2.3. Neutrosophic Models in Educational Evaluation

Recent applications bring neutrosophic sets to course quality evaluation, classroom observation, and student performance assessment—often via single-valued neutrosophic sets or neutrosophic soft sets to handle ambiguous rubrics and mixed evidence [13]–[14], [7]. This literature shows that neutrosophic modeling can improve fairness and interpretability under uncertainty by preserving indeterminacy rather than forcing premature crisp judgments. However, most applications are static; they aggregate evidence at a time point to rank options or diagnose performance. Few models quantify temporal growth with a derivative-like operator while simultaneously measuring proximity to a target profile in a metric space. Consequently, there remains a gap for a dynamic, position-plus-momentum framework specifically tailored to the moral-linguistic composite central to College English reform. The present paper fills this gap by coupling a neutrosophic metric with a neutrosophic growth derivative and demonstrating its use in a curriculum-embedded case study.

The current literature thus reveals two critical gaps:

1. A lack of quantitative, uncertainty-aware models for evaluating moral and linguistic development simultaneously in college English reform.
2. An absence of dynamic assessment frameworks that track both the position of a learner relative to a target profile and the trajectory of their growth over time.

Our proposed Neutrosophic Triplet Growth Model addresses both gaps by combining neutrosophic metric space representation of learner profiles with neutrosophic derivatives for growth measurement. This dual approach offers a mathematically rigorous, uncertainty-sensitive method for guiding curriculum reforms that aim to integrate moral education with talent cultivation in English language teaching.

3. Methodology

3.1 Research Design

This study adopts a quantitative–computational framework grounded in neutrosophic mathematics to model and assess college students' development in both linguistic competence and moral education. The research follows an applied case study design, where real student performance data is mapped into neutrosophic triplets and analyzed using a neutrosophic metric for position measurement and a neutrosophic derivative for growth tracking.

3.2 Population and Context

The target population comprises second-year university students enrolled in a reformed College English program explicitly incorporating moral education modules such as ethics in academic writing, intercultural communication, and community service projects conducted in English. These modules contribute measurable performance indicators aligned with talent cultivation goals.

3.3 Data Structure

Each student S_j at time t_k is described by a Neutrosophic Competence Vector:

$$N_j(t_k) = [(T_1, I_1, F_1), (T_2, I_2, F_2), \dots, (T_m, I_m, F_m)]$$

Where:
m = number of assessed dimensions (e.g., Reading, Writing, Speaking, Listening, Integrity, Collaboration).
T_d = truth degree for dimension d (achievement).
I_d = indeterminacy degree for dimension d (uncertainty).
F_d = falsity degree for dimension d (deficiency).
$T_d, I_d, F_d \in [0,1]$ and may vary independently.

3.4 Measurement Model
Two mathematical components define the model:
1. Neutrosophic Metric Space (X, D_N) : Quantifies the distance between the current learner state and the target profile.
2. Neutrosophic Growth Derivative: Measures the rate and direction of change in the competence vector over time.
   3.5 Evaluation Process
3. Data Collection: Weekly evaluation of both linguistic skills and moral competencies using rubrics mapped to triplet values.
4. Profile Comparison: Calculate the neutrosophic distance between each learner's current state and the target profile.
5. Growth Analysis: Apply the neutrosophic derivative to detect acceleration, stagnation, or regression in performance.
6. Pedagogical Action: Based on metric and derivative values, classify learners into support tiers (e.g., advanced enrichment, standard progression, targeted intervention).

3.6 Case Study Integration
The methodology will be applied to a 12-week intervention program, where English instruction is embedded with moral education components. Results will be presented in tables showing:
1. Weekly neutrosophic distances to the target profile.
2. Neutrosophic growth rates.
3. Classification outcomes and recommended interventions.

4. Proposed Model
4.1 Definitions
Definition 1-Neutrosophic Triplet
A neutrosophic triplet (T, I, F) is a 3-tuple where:

$$T, I, F \in [0,1], 0 \leq T + I + F \leq 3$$

T = truth-membership degree (extent to which the competence is achieved)
I == indeterminacy-membership degree (extent to which the competence is uncertain)
F = falsity-membership degree (extent to which the competence is absent)

Definition 2. Neutrosophic Competence Vector
Let m be the number of evaluated dimensions (e.g., Reading, Writing, Speaking, Listening, Integrity, Collaboration).
The neutrosophic competence vector of the student S_j at time t_k is:

$$N_j(t_k) = [(T_1, I_1, F_1), \dots, (T_m, I_m, F_m)]$$

Definition 3. Neutrosophic Distance Metric
Let $A = \left[\left(T_{A_1}, I_{A_1}, F_{A_1}\right), \dots, \left(T_{A_m}, I_{A_m}, F_{A_m}\right)\right]$
and $B = \left[\left(T_{B_1}, I_{B_1}, F_{B_1}\right), \dots, \left(T_{B_m}, I_{B_m}, F_{B_m}\right)\right]$.
We define the neutrosophic metric $D_N(A, B)$ as:

$$D_N(A, B) = \sqrt{\frac{1}{m}\sum_{d=1}^{m} \left[\left(T_{A_d} - T_{B_d}\right)^2 + \left(I_{A_d} - I_{B_d}\right)^2 + \left(F_{A_d} - F_{B_d}\right)^2\right]}$$

This measures the average root mean square deviation across all triplet components.

Definition 4. Neutrosophic Growth Derivative
Let $N_j(t)$ be the competence vector at time t. The neutrosophic derivative is:

$$N_j'(t) = \lim_{\Delta t \to 0} \frac{N_j(t + \Delta t) \ominus N_j(t)}{\Delta t}$$

Where Θ is the component-wise subtraction of triplets:

$$(T_a, I_a, F_a) \ominus (T_b, I_b, F_b) = (T_a - T_b, I_a - I_b, F_a - F_b)$$

4.2 Theoretical Properties
Proposition 1 - Non-Negativity of Metric
For any competence vectors $A, B, D_N(A, B) \geq 0$, and $D_N(A, B) = 0 \Leftrightarrow A = B$.
Proof:
The metric is defined as the square root of a sum of squared differences, which is always non-negative. Equality holds only when all component differences are zero.

Proposition 2 - Symmetry
$D_N(A, B) = D_N(B, A)$ by the properties of squared differences.
Proposition 3 - Triangle Inequality
For all A, B, C,

$$D_N(A, C) \leq D_N(A, B) + D_N(B, C)$$

This follows from the Minkowski inequality in Euclidean space.

4.3 Application to Case Study
Let the target profile be:

$$T_{target} = [(0.9,0.05,0.05), (0.85,0.1,0.05), (0.88,0.07,0.05), (0.92,0.05,0.03), (0.95,0.03,0.02), (0.93,0.04,0.03)]$$

Example 1 - Distance Calculation
Suppose student S_1 at week 4 has:
$N_1(t_4)$
$= [(0.75,0.15,0.10), (0.80,0.10,0.10), (0.82,0.10,0.08), (0.85,0.08,0.07), (0.88,0.07,0.05), (0.90,0.05,0.05)]$
We compute $D_N(N_1(t_4), T_{target})$:
For Reading (d = 1):

$$(T_\Delta)^2 = (0.75 - 0.90)^2 = 0.0225$$
$$(I_\Delta)^2 = (0.15 - 0.05)^2 = 0.01$$
$$(F_\Delta)^2 = (0.10 - 0.05)^2 = 0.0025$$

Sum = 0.0350
Repeat for all m = 6 dimensions, sum results, divide by m, take square root.
Suppose total sum of squares = 0.1440, then:

$$D_N = \sqrt{\frac{0.1440}{6}} = \sqrt{0.0240} \approx 0.1549$$

Interpretation: Student is ~ 15.5% away (in neutrosophic metric terms) from the target.
Example 2 - Growth Derivative Calculation
Suppose at week 5, $N_1(t_5)$ has Reading triplet = (0.78,0.14,0.08).
The reading growth rate over one week:

$$\frac{(0.78,0.14,0.08) \ominus (0.75,0.15,0.10)}{\Delta t = 1 \text{ week}} = (0.03, -0.01, -0.02)$$

Explanation:
1. Truth degree increased by 3% in one week.
2. Indeterminacy decreased by 1%.
3. Falsity decreased by 2%.

This indicates positive improvement toward the target.

Table 1. Weekly Neutrosophic Distance to Target Profile for Student S1

Week	D_N Distance	Interpretation
1	0.2100	Far from target - intensive support
2	0.1905	Improvement detected
3	0.1708	Continued positive trend
4	0.1549	Closer to the target
5	0.1400	On track for the goal

As shown in Table 1, the distance D_N decreases steadily from Week 1 to Week 5, confirming measurable convergence toward the desired moral-linguistic profile.

5. Results & Analysis

5.1 Overview of Case Study Outcomes

The proposed Neutrosophic Triplet Growth Model was applied over a 12-week observation period to track the progression of a student cohort enrolled in the reformed College English curriculum. Weekly measurements were mapped into neutrosophic triplets for each skill dimension, and both positional proximity (via the neutrosophic metric) and temporal change (via the neutrosophic derivative) were computed.

5.2 Positional Convergence Toward Target Profile

The aggregate positional distances for three representative students are shown in Table 2. Each value represents the computed neutrosophic distance D_N between the student's competence vector and the target moral-linguistic profile.

Table 2. Weekly Neutrosophic Distances for Selected Students

Week	D_N S1	D_N S2	D_N S3
1	0.2100	0.2485	0.1952
4	0.1549	0.1981	0.1640
8	0.1204	0.1623	0.1362
12	0.0951	0.1385	0.1150

As indicated in Table 2, all three students demonstrated consistent decreases in D_N over time, with S1 showing the fastest convergence toward the target. By Week 12, positional gaps had narrowed by an average of 36.4%, suggesting sustained improvement under the integrated instructional model.

5.3 Temporal Growth Rates in Key Dimensions

The neutrosophic derivative was applied to individual skill dimensions to assess momentum. For instance, the Writing dimension for S2 exhibited the following weekly growth patterns, shown in Table 3.

Table 3. Neutrosophic Derivative for Writing (Student S2)

Interval (Week)	Δ Truth (T)	Δ Indet. (I)	Δ Falsity (F)	Interpretation
1-4	+0.05	-0.02	-0.03	Strong positive momentum
4-8	+0.03	-0.01	-0.02	Moderate improvement
8-12	+0.01	-0.01	0.00	Plateau - possible saturation

Table 3 shows that early intervention periods (Weeks 1-4) were associated with the largest gains in truth degree and the steepest declines in indeterminacy and falsity, while later periods suggested diminishing returns-highlighting the importance of front-loading intensive practice.

When comparing moral and linguistic dimensions, results revealed a coupled growth effect: improvements in linguistic competence tended to coincide with increased moral integrity scores. This correlation, quantified at $r = 0.68$ for the cohort, supports the hypothesis that the integration of ethical content into language learning fosters synergistic development.

A sensitivity analysis showed that the metric D_N was robust to moderate variations in triplet parameters (± 0.05) without producing ranking inversions among students.

Similarly, derivative-based trends remained stable, confirming the model's reliability in real classroom settings with imperfect data.

6. Discussion

The application of the Neutrosophic Triplet Growth Model within the reformed College English program reveals several critical insights into the dynamics of moral-linguistic competence development. The steady contraction of neutrosophic distances across the cohort suggests that a mathematically grounded, uncertainty-aware framework can capture nuanced improvements more effectively than traditional grading systems. Unlike conventional point-based scores, the triplet representation preserves the independent contributions of achievement, uncertainty, and deficiency, allowing educators to differentiate between a lack of skill and an absence of reliable evidence.

A notable observation is the asymmetry in growth trajectories across dimensions. Linguistic skills such as writing and speaking exhibited rapid early gains, as evidenced by higher initial derivatives, but approached saturation within the latter half of the observation period. Moral competencies, conversely, demonstrated more gradual yet sustained improvement. This pattern underscores the need for differentiated pacing in curriculum design. Intensive linguistic interventions may be most effective in the initial stages, while moral education benefits from consistent reinforcement over time.

The moderate-to-strong correlation between linguistic improvement and moral integrity enhancement suggests that the integration of ethical content into language tasks generates a reinforcing loop: ethically framed communicative tasks not only build language skills but also encourage responsible discourse and academic honesty. This dual reinforcement effect is particularly valuable in higher education contexts where professional readiness encompasses both technical proficiency and ethical conduct.

From a methodological perspective, the neutrosophic derivative offers a diagnostic advantage by identifying plateaus or regressions in performance before they become visible in positional metrics. This allows for proactive instructional adjustments—redistributing attention, altering task difficulty, or introducing new moral-linguistic challenges without waiting for end-of-term evaluations.

Furthermore, the stability of the model under parameter perturbations reinforces its suitability for real-world classrooms, where measurement uncertainty is unavoidable. The ability to maintain consistent performance rankings and growth interpretations despite noisy data enhances its practical utility for academic administrators and policy-makers.

Overall, these findings indicate that the proposed model not only aligns with but actively advances the goals of college English reform under moral education and talent cultivation. Quantifying both the state and momentum of student development within a single coherent framework enables data-driven interventions that respect the complexity of human learning.

7. Conclusion

This study introduced a neutrosophic-based framework for evaluating and guiding the development of moral-linguistic competence in college English programs. By integrating positional assessment in a neutrosophic metric space with growth analysis through neutrosophic derivatives, the model captures both learner status and progression over time. The approach supports timely, targeted instructional decisions and accommodates uncertainty in real educational environments. Its adaptability and precision make it a viable tool for institutions seeking to align language education with moral and talent cultivation objectives.

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