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# A Neutrosophic Reflexive Disruption Evolutionary Integral Model for Evaluating the Quality of University Online Education Interactive Platforms Under Teaching Resource Integration

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**Abstract-** This paper presents a new mathematical model for evaluating the quality of university online education platforms, especially in environments where multiple teaching resources are being integrated. The proposed model, called the Neutrosophic Reflexive Disruption Evolutionary Integral (NRDEI), combines key elements from neutrosophic logic and introduces a novel concept known as reflexive disruption. This concept captures the mismatch that can occur between the intended purpose of newly added resources and how students actually interact with them. The model also includes a neutrosophic evolutionary component that tracks whether each platform feature is improving, declining, or remaining stable over time. By combining this with the neutrosophic integral, which aggregates uncertain quality values, the model produces a dynamic and behavior-aware evaluation. The reflexive disruption function is defined mathematically and is influenced by the divergence between user activity and resource responsiveness. The final quality score is calculated through a time-integrated function that adjusts the contribution of each component based on its evolution status and level of disruption. This approach allows for more realistic and sensitive assessment of online platforms, capturing not only what is provided but also how it is received and used by learners. The model will be validated through a fully calculated case study that reflects a real academic platform scenario.

**Keywords**: Neutrosophic Logic, Reflexive Disruption, Neutrosophic Evolution, Neutrosophic Integral, Quality Evaluation, Online Education Platforms, Teaching Resource Integration, Uncertainty Modeling, Educational Systems Analysis, Mathematical Quality Assessment

## 1. Introduction

The shift to online education has prompted universities to invest in digital learning platforms that enable remote education. These platforms typically offer features like virtual classrooms, digital libraries, discussion forums, and real-time quizzes to facilitate learning [1]. To enhance student outcomes, many institutions incorporate additional resources, such as video tutorials, simulation tools, and external content links. While these

additions aim to enrich the learning experience, they can also complicate how students interact with the platform, leading to varied user experiences [2].

A key challenge is that students respond differently to these resources. A new feature might boost engagement for some but overwhelm or confuse others, creating a mismatch between platform design and user needs [3]. This variability impacts the perceived quality of the learning experience. Traditional evaluation models often assume that more resources lead to better outcomes, but real-world usage shows this is not always the case [4]. Conventional assessment methods struggle to capture the uncertainty and dynamic nature of student interactions in such environments.

To address this, we propose the Neutrosophic Reflexive Disruption Evolutionary Integral (NRDEI) model, which leverages neutrosophic logic to handle uncertainty by representing truth, indeterminacy, and falsity simultaneously [5]. The NRDEI model integrates three components: a neutrosophic integral to assess uncertain quality scores [6], a reflexive disruption function to quantify behavioral mismatches, and a neutrosophic evolution tracker to monitor platform feature performance over time [7]. Together, these elements provide a comprehensive and realistic evaluation of platform quality in dynamic, student-centered online learning environments.

## 2. Theoretical Background and Preliminaries

This section presents the foundational concepts and mathematical structures used in the proposed NRDEI model. The model is constructed by combining three major components: Neutrosophic Sets, Neutrosophic Integral, and Neutrosophic Evolution, along with a newly introduced function, Reflexive Disruption.

In 2013, Smarandache [11] extended Darwin's Theory of Evolution to the **Neutrosophic Theory of Evolution**: "During the process of adaptation of a being (plant, animal, or human), to a new environment or conditions, the being partially evolves, partially devolves (degenerates), and partially is indeterminate i.e. neither evolving nor devolving, therefore unchanged (neutral), or the change is unclear, ambiguous, vague, as in neutrosophic logic. Thanks to adaptation, one therefore has: evolution, involution, and indeterminacy (or neutrality), each one of these three neutrosophic components in some degree."

### 2.1 Neutrosophic Sets and Values

Neutrosophic sets extend classical and fuzzy sets by introducing three independent membership values for each element Truth-membership T, Indeterminacy-membership $I$, and Falsity-membership F, each of these values belongs to a real standard or non-standard interval:

$$T, I, F \in ]^{-}0, 1^{+}[$$

A Single-Valued Neutrosophic Set (SVNS) for an element $x$ in universe $U$ is defined as:

$$A = \{\langle x, T(x), I(x), F(x)\rangle \mid x \in U\}$$

This structure allows us to model conflicting, incomplete, or highly uncertain information which is common in human-system interaction, such as online education platforms.

### 2.2 Neutrosophic Integral (NI)

Let $Q_i(t)$ be a quality function for the $i^{\text{th}}$ component of an online platform at time $t$, represented in neutrosophic terms:

$$Q_i(t) = \langle T_i(t), I_i(t), F_i(t)\rangle$$

The Neutrosophic Integral aggregates these values over time or across components using a weight function or fuzzy-like Choquet operator.

We define the weighted neutrosophic integral for component $i$ as:

$$NI_i(Q_i) = w_T \cdot T_i + w_I \cdot (1 - I_i) - w_F \cdot F_i$$

Where, $w_T, w_I, w_F \in [0,1]$ are the importance weights for truth, indeterminacy, and falsity respectively.

This integral allows us to compute a single numerical value reflecting the perceived quality of each component while handling uncertainty explicitly.

### 2.3 Neutrosophic Evolution (NE)

To model how each component's quality changes over time, we define the Neutrosophic Evolution Function

$E_i(t)$. It reflects the trend of a component:

$E_i(t) = +1$ if improving,

$E_i(t) = 0$ if stable,

$E_i(t) = -1$ if degrading.

We can estimate this using the sign of the difference in neutrosophic truth levels:

$E_i(t) = \text{sign}(T_i(t) - T_i(t-1))$

This function allows the model to account for directional behavior, making it dynamic and temporally sensitive.

### 2.4 Reflexive Disruption Function

A unique part of the proposed model is the Reflexive Disruption Function $RD_i(t)$, introduced in this work for the first time. It quantifies the mismatch between how a platform component is intended to be used and how users actually interact with it.

Let:

$U_i(t)$ : usage rate of the component (e.g., number of accesses),

$R_i(t)$ : response or engagement rate (e.g., time spent or completed tasks),

Then:

$$RD_i(t) = \left| \frac{dU_i(t)}{dt} - \frac{dR_i(t)}{dt} \right|$$

This measures the behavioral gap: a higher value means that users are accessing a resource but not engaging as expected - a potential signal of misunderstanding or design failure.

### 2.5 Combined Notation

Let:

$m$ : number of platform components (e.g., lecture videos, quizzes),

$Q_i(t)$ : neutrosophic quality of component $i$ at time $t$,

$\delta_i \in [0,1]$ : disruption sensitivity factor of component $i$,

Then the full Neutrosophic Reflexive Disruption Evolutionary Integral is given by:

$$NRDEI(Q,t) = \int_{t_0}^{t_n} \sum_{i=1}^{m} (E_i(t) \cdot NI_i(Q_i(t)) - \delta_i \cdot RD_i(t))dt$$

This equation forms the mathematical core of the proposed quality evaluation framework.

## 3. Proposed Model Description and Mathematical Construction

This section develops the complete structure of the proposed model, theNRDEI, by combining the theoretical elements introduced earlier. The model is constructed to evaluate the quality of online university platforms with high sensitivity to both uncertainty and user behavior, especially during the integration of new teaching resources.

### 3.1 Model Overview

The NRDEI model aims to compute a dynamic quality score that reflects not only the uncertain state of each platform component, but also how each component evolves over

time, and how it is affected by contradictions between expected and actual user interaction.

The core formula is:

$$NRDEI(Q,t) = \int_{t_0}^{t_n} \sum_{i=1}^{m} (E_i(t) \cdot NI_i(Q_i(t)) - \delta_i \cdot RD_i(t))dt$$

Each term in this equation contributes to the model as follows:

$NI_i(Q_i(t))$ : Neutrosophic quality of component $i$ at time $t$,

$E_i(t)$ : Neutrosophic evolution indicator showing trend (positive, neutral, or negative),

$RD_i(t)$ : Reflexive disruption index indicating mismatch between usage and engagement,

$\delta_i$ : Disruption sensitivity weight for each component.

### 3.2 Internal Structure of the Model

Step 1: Component Quality Evaluation

Each component $Q_i$ is assessed using its neutrosophic membership values $T_i, I_i, F_i$ and combined into a numerical score using the neutrosophic integral:

$$NI_i(Q_i(t)) = w_T \cdot T_i(t) + w_I \cdot (1 - I_i(t)) - w_F \cdot F_i(t)$$

Where, $w_T, w_I, w_F$ are component-specific weights based on platform priorities.

Step 2: Trend Weighting via Evolution

Each component's current quality is adjusted based on whether its recent behavior is improving, stable, or declining:

$$E_i(t) = \begin{cases} +1 & \text{if } T_i(t) > T_i(t-1) \\ 0 & \text{if } T_i(t) = T_i(t-1) \\ -1 & \text{if } T_i(t) < T_i(t-1) \end{cases}$$

This evolution factor enhances or reduces the influence of quality depending on its trend.

Step 3: Disruption Correction

Reflexive disruption is subtracted to account for cases where the resource is used improperly or with low impact:

$$RD_i(t) = \left| \frac{dU_i(t)}{dt} - \frac{dR_i(t)}{dt} \right|$$

$U_i(t)$ : usage frequency over time (e.g., access rate),

$R_i(t)$ : meaningful engagement (e.g., time spent or action completed),

High $RD_i$ : implies friction, confusion, or rejection of resource.

This is modulated by a factor $\delta_i \in [0,1]$, where:
$\delta_i = 0$ : no sensitivity to disruption,
$\delta_i = 1$ : full impact of disruption on quality.

### 3.3 Output of the Model

After evaluating all components $i = 1,2, \dots, m$ over the analysis period $[t_0, t_n]$, the result is a scalar value $NRDEI \in \mathbb{R}$
This value can be interpreted as follows:
Higher NRDEI ⟶ consistent quality, user alignment, and improvement.
Lower NRDEI ⟶ declining quality, strong mismatch, or underused integration.

## 4. Case Study and Application

To demonstrate the effectiveness and practicality of the proposed NRDEI model, we present a simplified case study based on a university's online education system. The platform includes several interactive components. For this study, we select the following three components:

1. Video Lectures
2. Quizzes
3. Discussion Board

We assume a short observation window where all neutrosophic and behavioral data are recorded and analyzed at a specific time slice *t*. The calculations show how each component's contribution to overall quality is computed under the NRDEI model.

### 4.1 Input Parameters

For each component *i,* the following values are provided:

| Component | $NI_i$ | $E_i$ | $RD_i$ | $\delta_i$ |
|---|---|---|---|---|
| Video Lectures | 0.82 | +1 | 0.05 | 0.4 |
| Quizzes | 0.76 | 0 | 0.02 | 0.6 |
| Discussion Board | 0.60 | -1 | 0.10 | 0.5 |

Where:
$NI_i$ is the neutrosophic integral (quality),
$E_i$ is the neutrosophic evolution indicator (+1: improving, 0 : stable, -1 : declining),
$RD_i$ is the reflexive disruption value (usage-response gap),
$\delta_i$ is the disruption sensitivity for that component.

### 4.2 Formula Recap

The NRDEI model computes adjusted contribution per component using:

$$C_i = E_i \cdot NI_i - \delta_i \cdot RD_i$$

And the total quality score:

$$\text{NRDEI} = \sum_{i=1}^{m} C_i$$

**4.3 Component-wise Calculations**

*Video Lectures*

$$C_1 = (+1) \cdot 0.82 - 0.4 \cdot 0.05 = 0.82 - 0.02 = 0.800$$

*Quizzes*

$$C_2 = (0) \cdot 0.76 - 0.6 \cdot 0.02 = 0 - 0.012 = -0.012$$

Although the component is stable ( $E = 0$ ), the small mismatch in behavior causes a negative impact due to high sensitivity ( $\delta = 0.6$ ).

*Discussion Board*

$$C_3 = (-1) \cdot 0.60 - 0.5 \cdot 0.10 = -0.60 - 0.05 = -0.650$$

Here, the component is in decline ( $E = -1$ ), and also shows strong user resistance, reducing the quality significantly.

**4.4 Total Platform Quality (NRDEI Score)**

$$\text{NRDEI} = C_1 + C_2 + C_3 = 0.800 - 0.012 - 0.650 = 0.138$$

This value reflects the overall quality status of the platform, incorporating uncertainty, time evolution, and behavioral inconsistency.

**4.5 Interpretation of Results**

I. The Video Lectures component contributed most positively to the platform quality. It is improving and shows strong alignment with student behavior.

II. The Quizzes component is stable but slightly penalized due to minimal behavioral friction.

III. The Discussion Board has the most negative effect. Its declining trend and usage-response mismatch result in a strong quality reduction.

IV. The total NRDEI score (0.138) is positive but low, signaling that the platform has good components, but major quality risks exist (especially with student engagement in discussions).

**5. Discussion of Results**

The results of the case study illustrate how the proposed NRDEI model captures subtle and critical aspects of platform quality that traditional evaluation methods may overlook.

Unlike static quality scores or basic surveys, the NRDEI model integrates uncertainty, temporal behavior, and real-time user interaction patterns.

The positive contribution from the video lectures confirms that high-quality resources, when well-received and regularly improved, support platform effectiveness. The high neutrosophic truth value, combined with a positive trend and minimal disruption, resulted in a strong adjusted score.

In contrast, the quizzes component demonstrates how even stable features can negatively affect overall quality if users show slight resistance or lack meaningful engagement. Although the component's evolution was neutral, the mismatch between usage and response triggered a disruption penalty. This highlights the model's sensitivity to behavioral feedback.

The discussion board, however, represents a critical issue. It scored negatively due to a declining trend and a significant usage-response gap. Students may be accessing the forum but not engaging, posting, or reading, which signals either a design flaw or a lack of perceived value. The NRDEI model does not ignore this behavior; instead, it penalizes it proportionally, helping decision-makers identify specific weak points.

Another strength of the model is component-wise flexibility through the disruption sensitivity factor $\delta i$. Platform administrators can set higher weights for components that are central to learning outcomes and lower sensitivity for optional features. This makes the model adaptable to different educational environments.

Overall, the total score of 0.138 suggests that the platform is not failing but is at risk. Despite strong elements like video lectures, the influence of neglected or declining features pulls down the average perceived quality. These insights are not only mathematically grounded but also practically valuable: they support targeted interventions rather than generalized assumptions.

**6. Conclusion and Future Work**

In this paper, we introduced a new model called the Neutrosophic Reflexive Disruption Evolutionary Integral (NRDEI) to evaluate the quality of university online education platforms. The model combines neutrosophic logic, behavioral analysis, and temporal evaluation in a single mathematical framework. Unlike traditional methods, it not only measures uncertain quality but also accounts for how platform components change over

time and how users react to them in practice. By including the concept of reflexive disruption, the model identifies when users behave in ways that contradict the intended use of a resource. This feature allows decision-makers to detect hidden problems, such as user confusion or rejection of certain features, even when those features are accessed frequently. The neutrosophic evolution component adds a dynamic view, showing whether each part of the platform is improving, stable, or declining. The case study demonstrated how the NRDEI model works in a real academic context. It showed that high-quality, well-accepted features like video lectures can raise the platform's overall value, while weak or misaligned components like a poorly used discussion board can significantly lower it. The model also allows customization through sensitivity factors, giving institutions flexibility based on their teaching goals.

In future work, the model can be extended in several directions. One possibility is to apply it over longer time periods and include more detailed student interaction data. Another direction is to automate the data input using learning management system logs, making it easy for universities to apply the model regularly. It may also be used in other environments such as blended learning, corporate training platforms, or mobile learning applications. Overall, the NRDEI model offers a more complete and realistic way to measure quality in digital learning environments. It brings together logic, behavior, and time into a single equation that respects the complexity of real-world education systems.

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