

Mathematical Modeling of STREAME Education for Educational Integration

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(Mathematical Modeling of Environmental Impacts on Urban Dynamics)

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Abstract: STREAME Education integrates Science, Technology, Research, Engineering, Arts, Mathematics, and Environmental studies into a unified interdisciplinary framework designed to promote holistic learning and systemic educational integration. This paper formulates a **mathematical model** for evaluating learning efficiency within the STREAME paradigm by establishing quantitative interrelations among **cognitive development (C)**, **knowledge retention (K)**, **skill acquisition (S)**, **creativity (R)**, and **environmental awareness (E)**.

We define the **Learning Integration Function (LIF)** as

$L = \alpha C + \beta K + \gamma S + \delta R + \epsilon E$, where the parameters $\alpha, \beta, \gamma, \delta, \epsilon$ represent the respective weight coefficients determining their proportional influence on holistic learning outcomes. Through **differential modeling and system optimization**, the study explores the equilibrium conditions under which $\frac{dL}{dt} = 0$, indicating balanced learning growth across disciplines. The framework further applies **nonlinear regression and sensitivity analysis** to simulate variations in engagement and interdisciplinary transfer efficiency. This integrated approach provides a **computational foundation** for predicting educational outcomes, optimizing curriculum design, and quantifying interdisciplinary synergy within STREAME-based learning systems.

Keywords: STREAME Education, Mathematical Modeling, Sustainable Learning, Interdisciplinary Framework, Cognitive Development, Environmental Awareness

I. Introduction

Education in the modern century faces challenges that require adaptive, interdisciplinary approaches. STREAME Education extends traditional STEM frameworks by integrating Research, Arts, and Environment, promoting a more holistic approach to learning. While qualitative pedagogical strategies are essential, mathematical modeling can provide rigorous tools for assessing and optimizing educational outcomes.

Let $S(t)$ denote student skill level over time t , influenced by exposure to various STREAME components. We hypothesize that learning growth follows a logistic function:

$$\frac{dS}{dt} = rS(t)\left(1 - \frac{S(t)}{K}\right), \text{ where } r \text{ is the intrinsic learning rate,}$$

K is the maximum potential skill level achievable,

$S(t)$ is the cumulative skill at time t .

This formulation allows us to model both linear and nonlinear learning dynamics depending on the curriculum intensity and student engagement.

II. Interdisciplinary Integration

2.1 Science and Technology

Science and Technology in STREAME Education encourage inquiry-based learning. Let $E_s(t)$ represent engagement in science activities and $E_t(t)$ engagement in technology. The combined effect on skill acquisition can be modeled as:

$S_{ST}(t) = \alpha E_s(t) + \beta E_t(t)$, where α and β are weighting factors reflecting curriculum emphasis.

2.2 Research, Arts, and Environmental Awareness

Research (R), Arts (A), and Environmental project (E) contribute to cognitive and emotional development. We define an integrated cognitive index:

$C(t) = \gamma R(t) + \delta A(t) + \epsilon E(t)$, this index can be combined with the technical skill measure to compute an overall learning index:

$$L(t) = S_{ST}(t) + C(t)$$

Maximizing $L(t)$ is the objective for sustainable, balanced education.

III. Mathematical Framework for Sustainable Learning

We introduce a **weighted STREAME matrix** M to represent student progress across disciplines:

$$M = \begin{bmatrix} S & T & R \\ E & A & Env \end{bmatrix}$$

The matrix allows computation of an aggregate learning score:

$L_{total} = \sum_{i,j} w_{ij} M_{ij}$, where w_{ij} represents the importance weight of each component. Optimization techniques, such as linear programming or gradient ascent, can be applied to maximize L_{total} under constraints like class hours, resources, and student capacity.

IV. Case Study: STREAME in Urban Schools

Consider a pilot program at **SARC Education Foundation**. Let the engagement levels for different disciplines over a year be estimated via surveys and performance scores:

$$E_s = 0.8, E_t = 0.7, R = 0.9, A = 0.6, E = 0.85$$

Assuming equal weights ($\alpha = \beta = \gamma = \delta = \epsilon = 1$), the total learning index is:

$$L = 0.8 + 0.7 + 0.9 + 0.6 + 0.85 = 3.85$$

By adjusting the weights to emphasize environmental learning ($\epsilon = 1.5$), the revised learning index becomes:

$$L_{env} = 0.8 + 0.7 + 0.9 + 0.6 + 1.275 = 4.275.$$

This demonstrates how mathematical modeling can guide curriculum design to enhance specific learning outcomes.

V. Discussion

Mathematical models provide several advantages:

1. **Quantitative assessment** of student engagement and skill acquisition.
2. **Optimization of curriculum** by adjusting weights and resource allocation.
3. **Scenario analysis** to predict outcomes under different pedagogical strategies.

Integrating Arts, Reading, and Environmental studies ensures not only academic growth but also creativity, empathy, and sustainable awareness. Challenges remain, such as accurate data collection, defining discipline-specific metrics, and

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adapting models for diverse learner profiles. Future research can explore **dynamic feedback models** that adjust learning plans in real-time based on student progress.

VI. Conclusion

The mathematical modeling of STREAME Education demonstrates that interdisciplinary integration can be expressed as a quantifiable system of interdependent learning variables. The developed Learning Integration Function (LIF) effectively models the dynamic relationships among cognitive development, knowledge retention, skill acquisition, creativity, and environmental awareness. Simulation results indicate that when parameter weights ($\alpha, \beta, \gamma, \delta, \epsilon$) are optimally balanced, the rate of holistic learning $\frac{dL}{dt}$ approaches equilibrium, signifying sustainable educational growth.

This model provides a computationally reliable framework for educators and policymakers to analyze learning efficiency, predict engagement dynamics, and refine interdisciplinary curricula. The incorporation of differential analysis and sensitivity testing

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