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Towards The Next-Generation Education: The Mathematical Function Governing Ideal Factors to Achieve High-Quality Teaching in Educational Institutions

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Abstract

This study investigates the use of the mathematical idea of functions to find and represent the best elements affecting teaching in universities, colleges, and schools. Conceptualising these elements as variables inside functional connections helps us create a phenomenal mathematical approach to maximise learning results. A strict method of grasping the complicated interaction of factors like teacher competence, student involvement, resources, and institutional policies is the integration of mathematical models, hence enabling evidence-based techniques for academic excellence.

Keywords: mathematics; education; teaching quality; universities; colleges; schools

1. Introduction

Effective educational systems depend on high-quality teaching all around. Although thorough qualitative research (Mageed & Nazir, 2024; Mageed, 2024a; Mageed, 2024b; Mageed, 2024c; Mageed, 2024d; Mageed, 2025a; Mageed, 2025b; Mageed, 2025c; Mageed, 2025d) quantifies the connections among different influencing elements, it is difficult to measure them. Recent developments in educational data analytics(Mougiakou et al. , 2024) indicate that a mathematical approach, especially the employment of functions, can provide accurate models for studying and raising teaching quality (Madukala & Bai, 2025). Essential building blocks in mathematics, functions define connections between outputs (dependent variables) and inputs (independent variables). Using this model on education enables the creation of teaching quality dynamics models.

2. Mathematical Foundations of Functions in Education

A function, f, is defined as a relation that assigns exactly one output y to each input x in each domain (Demidovich & Yankovskv, 2020). Formally, $f: X \to Y$ are sets of inputs and outputs, respectively. In the context of education, inputs could include teacher qualifications, student motivation, institutional resources, and pedagogical methods, while the output could be a measure of teaching quality, student achievement, or satisfaction(Amtu et al., 2020).

2.1. Modeling Factors Influencing Teaching Quality

Let us consider a set of variables:

- T : Teacher competence
- S : Student engagement
- R : Resources available
- P : Institutional policies

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- E : Educational environment

The quality of teaching, Q , can be modelled as a function:

$$Q = f(T, S, R, P, E) \quad (1)$$

This multivariate function encapsulates the combined influence of these factors. For simplicity, initial models can assume linearity:

$$Q = a_0 + a_1 T + a_2 S + a_3 R + a_4 P + a_5 E + \varepsilon \quad (2)$$

where a_i are coefficients representing the weight of each factor, and ε accounts for error or unmodeled variability.

2.2. Optimizing Teaching Quality through Functional Analysis

Understanding the sensitivity of Q to each factor enables targeted interventions(Li, 2022; Guo et al., 2023). For instance, if the partial derivative $\frac{\partial Q}{\partial T}$ is high, then enhancing teacher competence yields significant improvements in quality. Nonlinear models, such as polynomial or exponential functions, can capture more complex relationships:

$$Q = \beta_0 e^{\beta_1 T} + \beta_2 S^2 + \beta_3 log(R + 1) + \cdots \quad (3)$$

Applying calculus and optimization techniques, educational policymakers can identify optimal levels of each factor to maximize .

It is evident that:

$$\frac{\partial Q}{\partial T} = \beta_0 \beta_1 e^{\beta_1 T} \quad (4)$$

$$\frac{\partial Q}{\partial s} = 2\beta_2 S \quad (5)$$

$$\frac{\partial Q}{\partial s} = \frac{\beta_3}{R+1} \quad (6)$$

2.3. Empirical Evidence and Model Validation

Using regression analysis, structural equation modeling, and machine learning algorithms, empirical investigations have verified the applicability of such functional models ((Yao & Lin, 2023, Yu, 2024; Johnson et al. , 2023; Liao et al., 2021; Singh et al., 2024; Poulose et al. , 2024). For visual demonstrations, see *Figs.1-5* (Yao & Lin, 2023).

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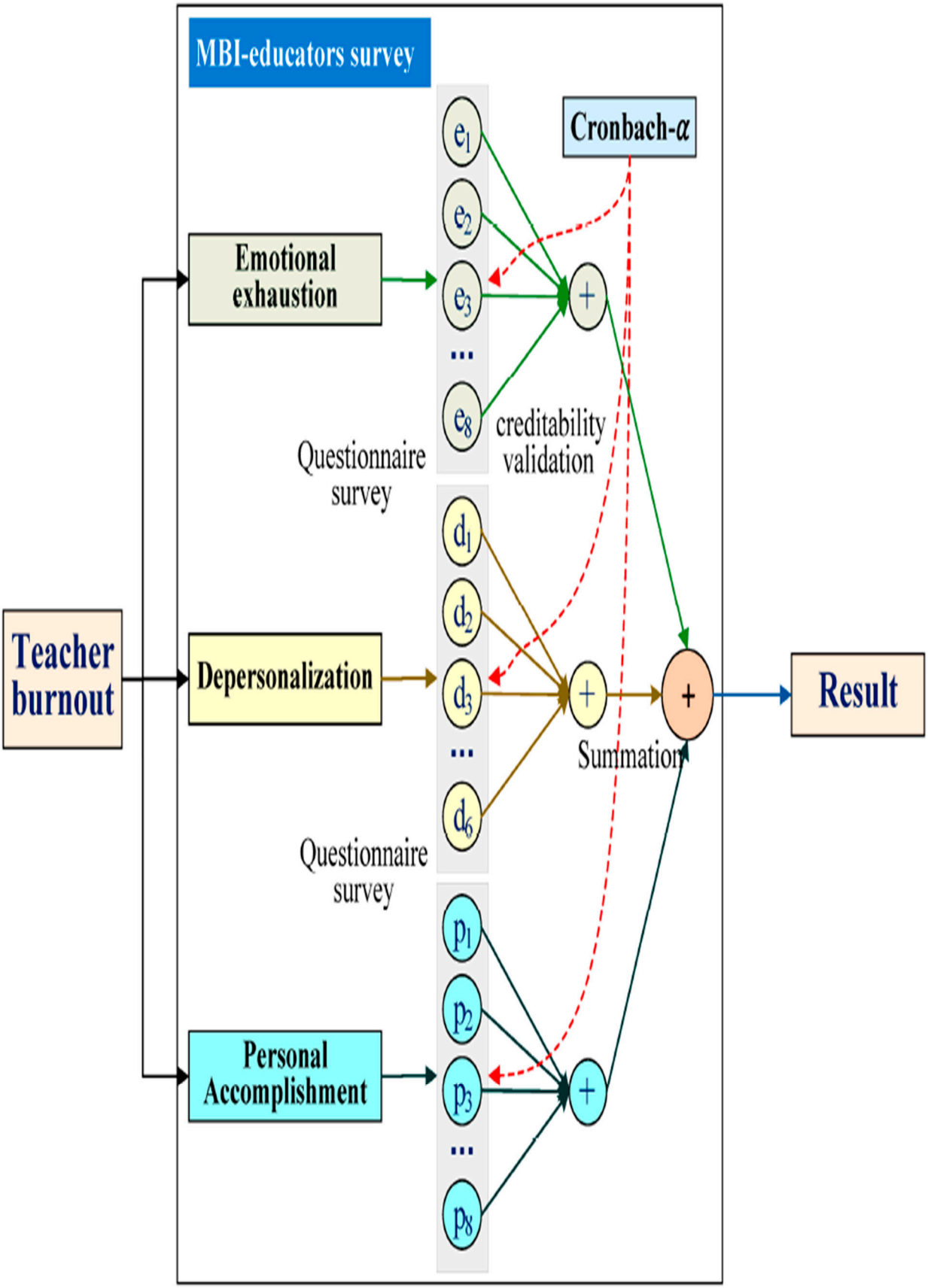

Figure 1. Creating a quantitative burnout model for educators.

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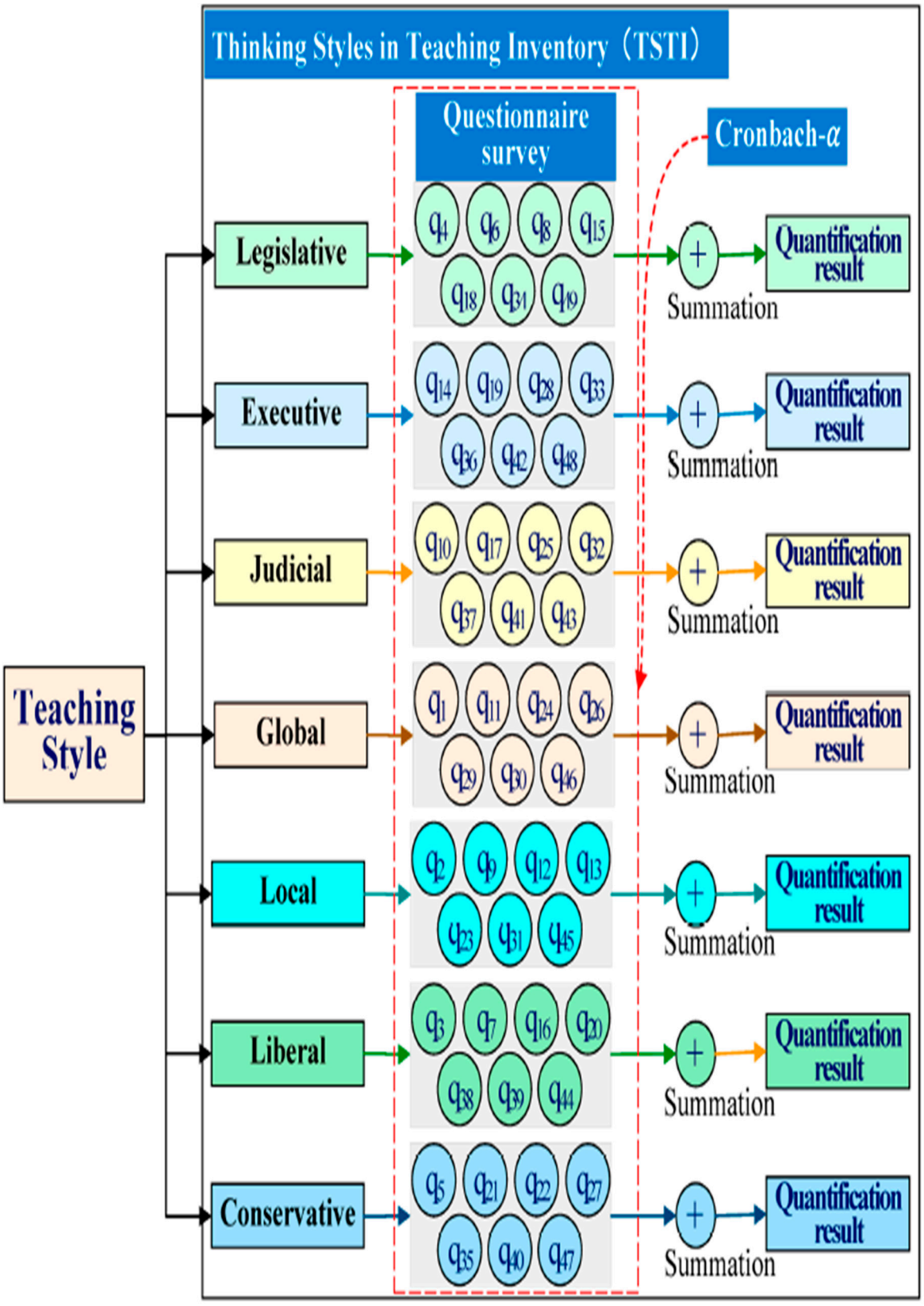

Figure 2. A quantitative approach to education.

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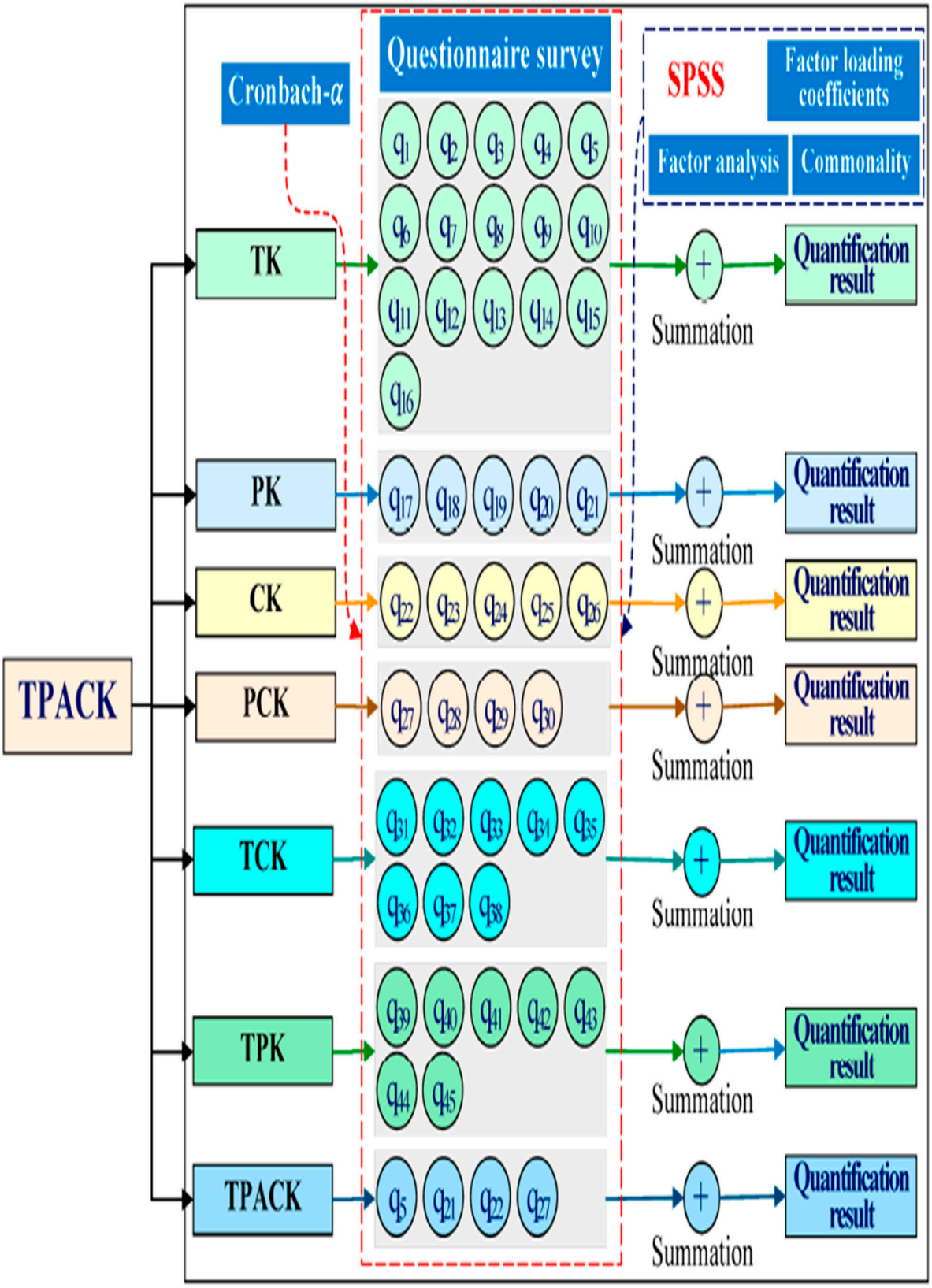

Figure 3. The quantitative model of TPACK.

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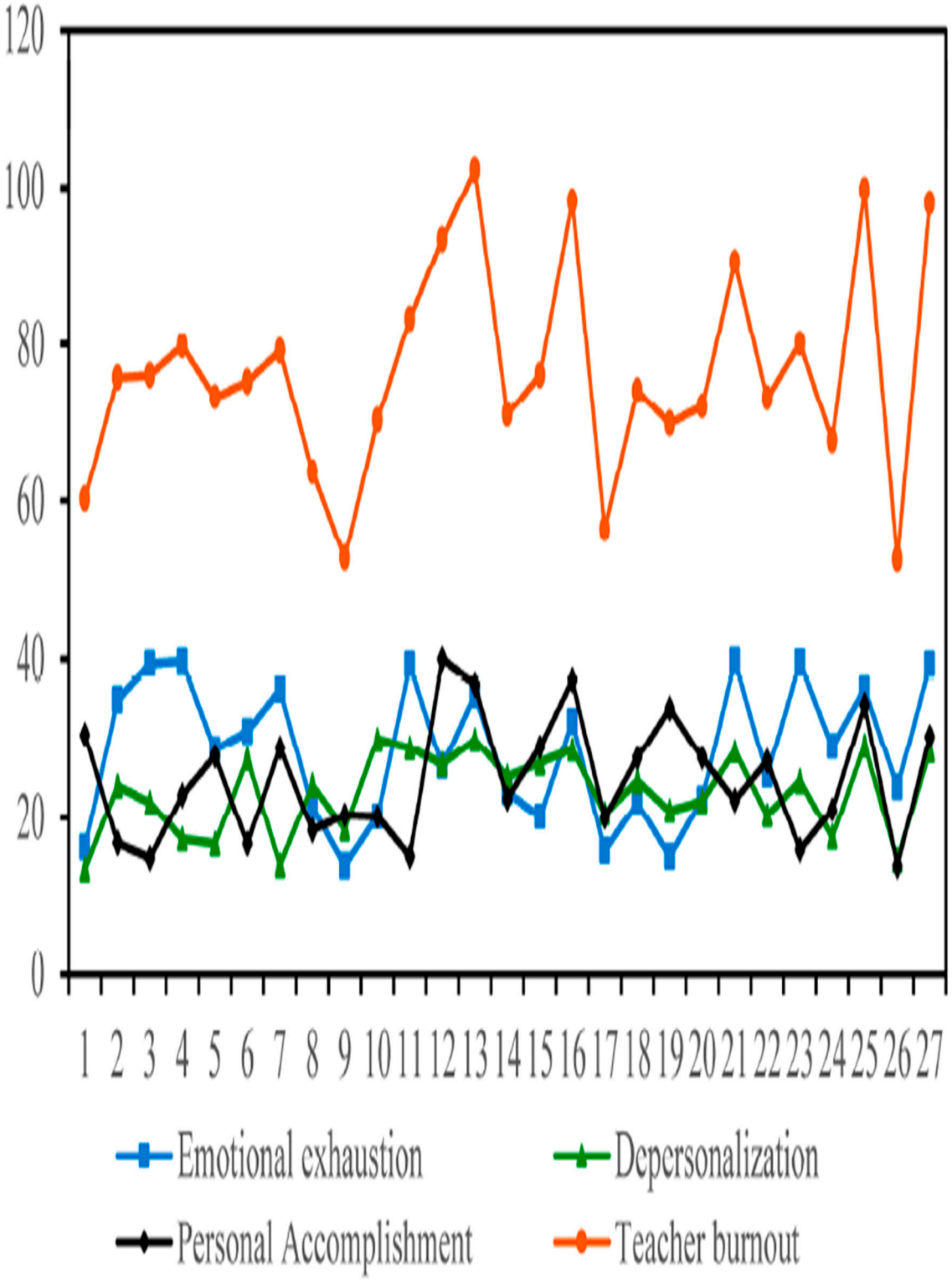

Figure 4. University Lecturers' varied burnout circumstances, underscoring the necessity for more thorough and in-depth studies on their working conditions and mental health.

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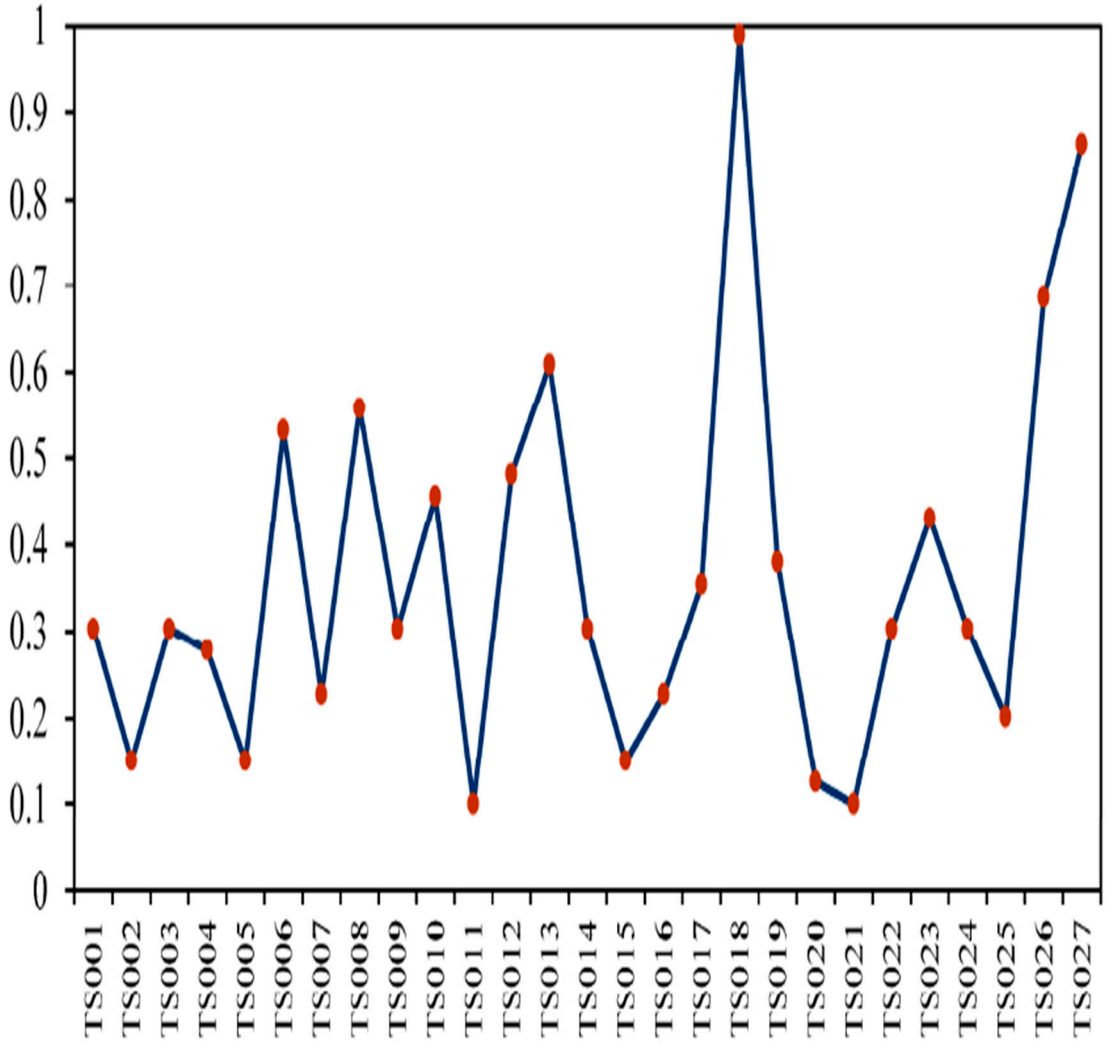

Figure 5. Outcomes of 27 teachers' academic performance.

Data from standardized tests, instructor assessments, and student questionnaires are used to estimate the parameters of these functions, therefore offering practical insights.

2.4. Discussion

There are several benefits of mathematically framing variables affecting instruction quality:-

- Predictive Power: Based on variable changes, models can project results (Almalawi et al., 2024).
- Strategically planning locating main leverage points for resource distribution (Jafari et al., 2024).
- Ongoing improvement: Tracking developments over time to improve approaches (Yorkofsky et al., 2020). Data quality, the complexity of human variables, and contextual variation across educational environments, nevertheless, present issues (Lee et al., 2024).

3. Open Problems

- Looking at Eqs (1)-(6), it is needed to explore further investigations to find the exact expressions of Q in terms of Institutional policies (P) and Educational environment (E).
- Having done that, exploratory research needs to be undertaken to closely analyse and examine the equational relations between Q and $T, S, R, R, P,$ and E.

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- The third phase ahead is to examine other undisclosed factors, shown as ε , referring for error or unmodeled variability, and how to mathematically configure such an ε.
- The fourth phase is to redefine Eqs (1) - (6) and solve the whole system of the newly generated (1)-(6).

Conclusion

Applying the concept of functions to represent the variables controlling great teaching offers a strict, quantitative framework for educational change. Future research should concentrate on creating complex, nonlinear models and using real-time data analytics to dynamically enhance teaching methods. This framework shows how the mathematical idea of functions can methodically simulate and improve the elements affecting excellent teaching across many degrees of education. Future research should build upon these models with real-time data and sophisticated nonlinear methods to more precisely define educational approaches.

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