ENHANCING HEAT TRANSFER TEACHING THROUGH THE THEORY OF DIDACTIC SITUATIONS AND FINITE DIFFERENCE METHOD: A CASE STUDY

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ABSTRACT

The Theory of Didactic Situations (TDS) was applied to teach heat transfer using the Finite Difference Method (FDM), with the aim of fostering active, meaningful learning and developing mathematical, physical, and computational skills among undergraduate students. This quasi-experimental case study, conducted with 19 pre-service Physics and Mathematics teachers at the Higher Pedagogical School of Bié (Angola) during the 2024/2025 academic year, investigated how TDS-guided teacher mediation enhances students' understanding of FDM in modeling steady-state and transient heat conduction.

TDS structures learning through four phases: action (problem exploration and strategy formulation), formulation (development of explanations, models, and representations), validation (testing ideas, identifying errors, and refining procedures), and institutionalization (formalizing knowledge and linking it to scientific principles). In the context of heat transfer, these phases were adapted to FDM, enabling students to understand the physics of conduction while also grasping the numerical logic behind the method. As an iterative approach, FDM requires students to discretize space and time, implement algorithms, and interpret physical results, thereby fostering computational thinking (abstraction, decomposition, pattern recognition, and algorithmic reasoning).

Data were collected through questionnaires and pre- and post-tests, and analyzed using content analysis and Hake's normalized gain equation. The results revealed an average improvement of over 70% in academic performance, with significant gains in conceptual understanding of thermal conduction, procedural skills in applying FDM, active participation in the TDS phases, long-term retention through the integration of theory and practice, and the development of computational thinking as a cross-disciplinary skill. Teacher mediation ensured the meaningful use of FDM, promoting skills in modeling, critical and creative thinking, computational thinking, and interdisciplinary integration.

This study demonstrates that integrating TDS and FDM constitutes an effective didactic strategy for transforming heat transfer education. By bridging theoretical and practical knowledge, this approach strengthens the training of future Physics and Mathematics teachers, promoting deeper, more engaged, and longer-lasting learning.

Keywords Theory of Didactic Situations. Finite Difference Method. Teaching Heat Transfer. Teacher Mediation.

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