

ORIGINAL PAPER

Diagnostic Assessment Models for Action Research in Secondary Science Classrooms: Addressing Misconceptions in Thermodynamics

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Received: 12 August 2026 • Revised: 28 September 2026 • Accepted: 10 October 2026 • Published Online: 24 October 2026

Abstract

A three-cycle action research study detailing the design and classroom validation of two-tier diagnostic formative probes. Results showed persistent thermodynamic misconceptions decreased by 61% following targeted micro-interventions.

Keywords: Action Research, Diagnostic Assessment, Thermodynamics Misconceptions, Two-Tier Probes, Science Education

1. Introduction

Secondary physics students frequently conflate the concepts of heat, temperature, and thermal energy, treating heat as a substance rather than a thermodynamic process. Classroom Action Research (CAR) provides a cyclical empirical vehicle for practitioner-teachers to diagnose and dismantle these alternative conceptions.

2. Method

A collaborative Classroom Action Research model following the Kemmis and McTaggart spiral (Plan, Act, Observe, Reflect) was conducted over three instructional cycles across two 11th-grade physics classrooms (N=68 students). Data included diagnostic two-tier test items and reflective journals.

3. Results and Discussion

Cycle 1 identified that 72% of students harbored caloric theory misconceptions. Cycle 2 introduced hands-on thermal equilibrium discrepant events. By Cycle 3, correct scientific understanding rose from 28% to 89% (misconceptions reduced by 61.4%).

4. Conclusion

Integrating two-tier formative diagnostic probes within reflexive teacher action research cycles enables immediate instructional calibration and durable conceptual change in thermodynamics.

Declarations

Funding: This study was supported by institutional research development grants.

Conflicts of Interest: The authors declare that they have no competing financial or personal interests.

Data Availability: The dataset and analysis matrices associated with this study are available in the public data repository.

Author Contributions: All authors contributed equally to conceptualization, investigation, formal analysis, and manuscript preparation.

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