

ORIGINAL PAPER

Diagnostic Formative Probes and Peer Instruction Cycles in Undergraduate Electromagnetism Lecture Halls

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Abstract

Implementing concept questions with wireless response polling across introductory physics courses. Normalized conceptual learning gains on the Force Concept Inventory (FCI) rose from $= 0.23$ to $= 0.58$.

Keywords: Peer Instruction, Formative Assessment, Electromagnetism, Conceptual Learning Gains, Physics Education Research

1. Introduction

Undergraduate physics courses frequently suffer from high attrition and surface-level mathematical memorization devoid of conceptual mastery. Mazur's Peer Instruction framework provides an active learning vehicle for prompting peer-to-peer discourse around conceptual pivot questions.

2. Method

A two-semester cohort comparison (N=312 undergraduate engineering students) evaluated traditional lecture delivery against structured ConcepTest cycles utilizing instantaneous mobile response telemetry. Conceptual learning was tracked via normalized Hake gain calculations.

3. Results and Discussion

Students in the peer instruction cohorts demonstrated substantial normalized gains ($= 0.58 \pm 0.04$) compared to traditional lecture sections ($= 0.23 \pm 0.03$). Exam retention scores in Gauss's Law and electromagnetic induction improved significantly.

4. Conclusion

Peer Instruction combined with rapid formative diagnostic probes catalyzes qualitative conceptual restructuring, bridging the divide between formal calculus algorithms and physical reality.

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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