Improving Conceptual Understanding of Forces through Peer Instruction

A Two-Cycle Action Research Based on FCI Diagnostics

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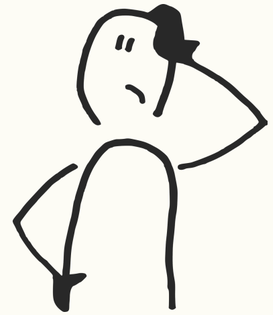
Trouble in Mechanics



Trouble

01 Persistent Misconception

02 Overemphasis on Formula-Based Learning

03 Limited Student Engagement and Interaction

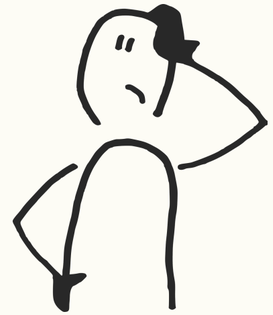
Impact

01 poor performance in reasoning-based physics problems

02 Learning becomes rote and fragile, shallow conceptual learning

03 Low Self Efficacy

Trouble in Mechanics



Proposed Solution?

Peer Instruction
(Mazur's Method)

Target Group

8 KMSW STUDENTS BASED ON EARLY DIAGNOSTIC DATA

🎯 *ACTION OBJECTIVES*

To improve students' conceptual understanding of force and motion through the implementation of Peer Instruction (Mazur's method) in classroom lessons.

(Goal: 80%)

🎯 *RESEARCH OBJECTIVES*

QUANTITATIVE:

- **To measure the conceptual gain between Diagnostic Test and Post Cycle 2 Test after each action research cycle.**

Qualitative:

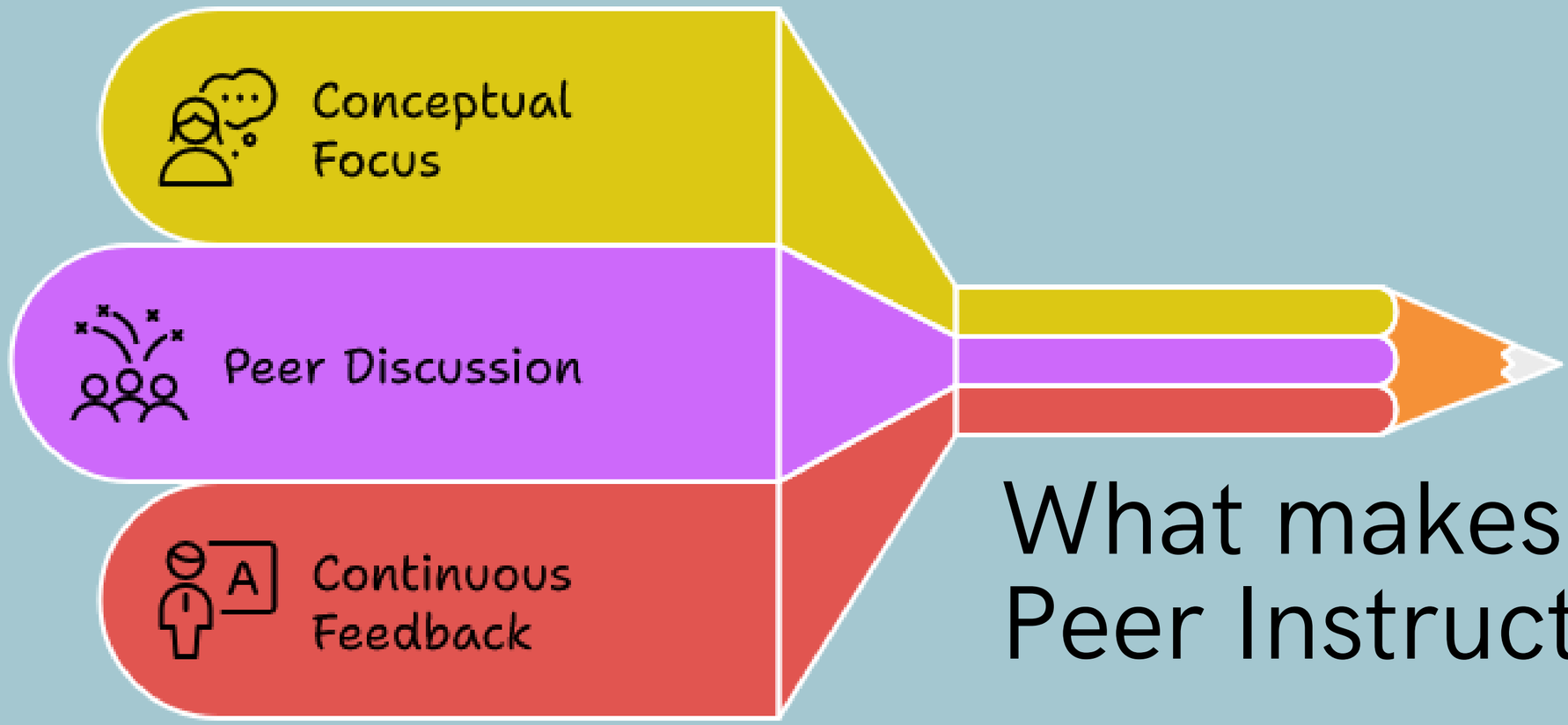
- **To explore students' experiences, perceptions, and self-efficacy in learning force concepts through Peer Instruction discussions.**

Why Mazur’s Peer Instruction?

Promotes Conceptual Change through Cognitive Conflict.
(Posner et al., 1982).

Enhances Learning through Peer Discussion and Social Constructivism.
(Vygotsky, 1978)

Proven Effectiveness in Increasing Conceptual Gains
(Mazur, 1997; Crouch & Mazur, 2001; Hake, 1998)



What makes Mazur's Peer Instruction?

Action Research Cycle 1

Plan

The pre-test using HFCI A identified students' main misconceptions about force and motion.

Act

3 Peer Instruction sessions were conducted using Mazur's ConcepTests to target these misconceptions.

Observe

HFCI B was administered to measure conceptual understanding and observe learning progress.

Reflect

Results showed a moderate gain ($g = 0.49$), leading to plans for more contextual questions and stronger discussion guidance.

Kemmis and McTaggart

Cycle 1 Reflection

The results from Cycle 1 showed that while students' conceptual understanding of force improved moderately, many still relied on memorized formulas rather than reasoning through concepts. Peer discussions helped expose misconceptions, but some concept questions were too abstract. Therefore, the next cycle will include more relatable, real-life examples and clearer discussion prompts to strengthen conceptual dialogue and reasoning.

Action Research Cycle 2

Plan

The Peer Instruction strategy was refined with real-life contexts and clearer discussion scaffolds.

Act

Students engaged in another series of Peer Instruction sessions focusing on Newton's Third Law.

Observe

HFCI A was again implemented to assess conceptual change and confirm improved engagement.

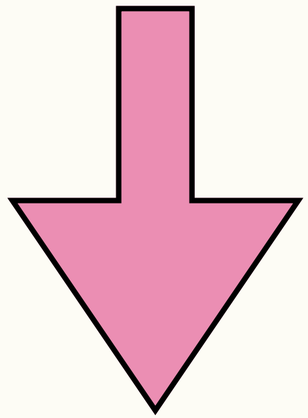
Reflect

Post-test results indicated all students achieve >80% on HFCI

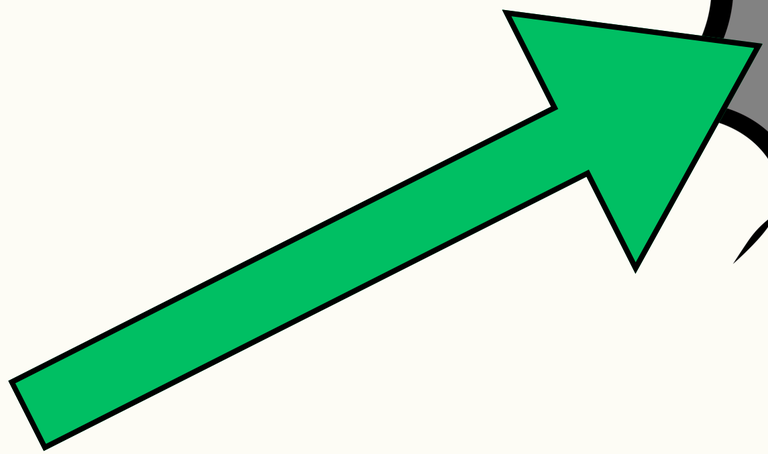
Kemmis and McTaggart

Results!

Diagnostic:
26.8%

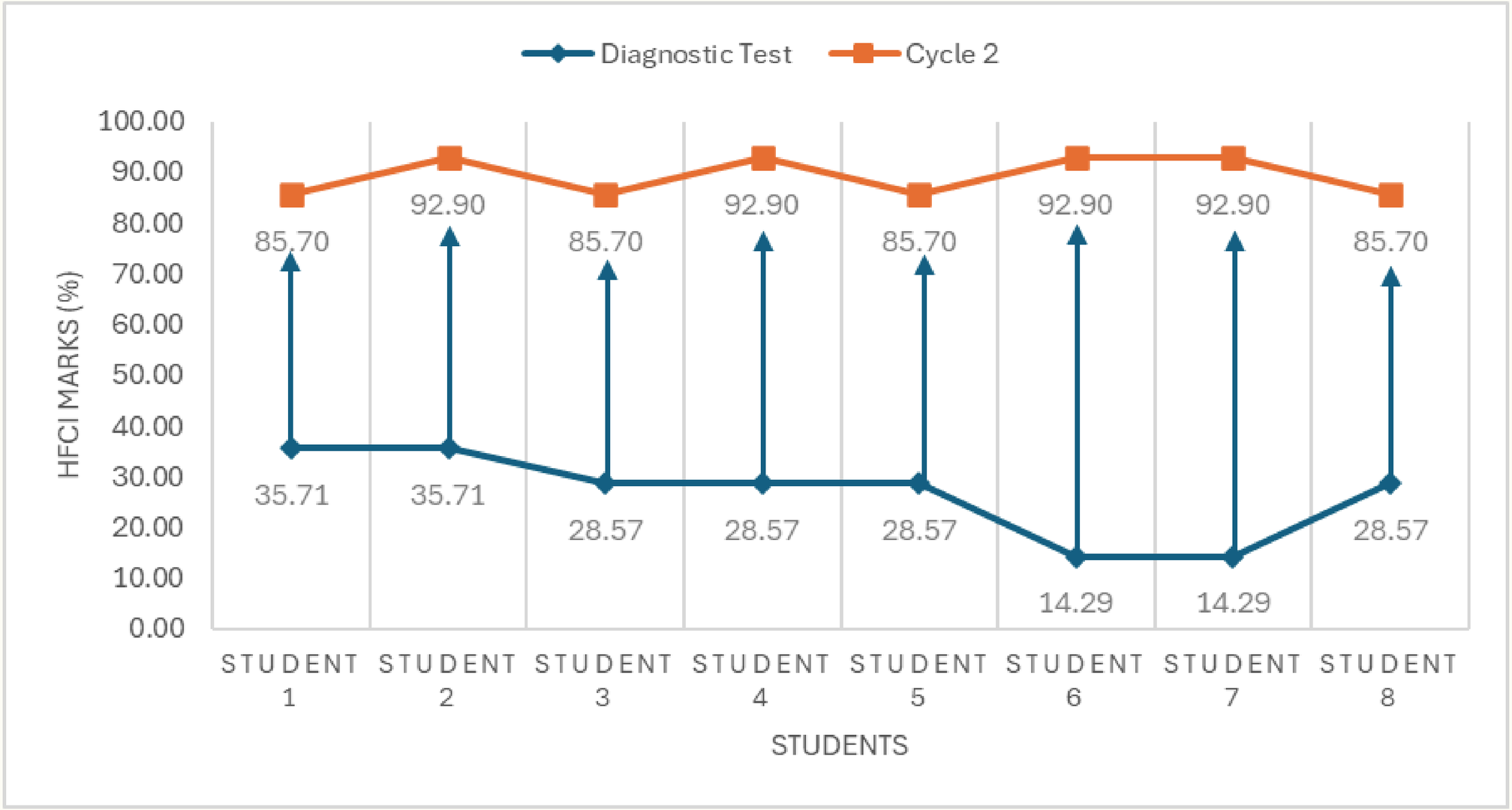


Cycle 1:
56.3%

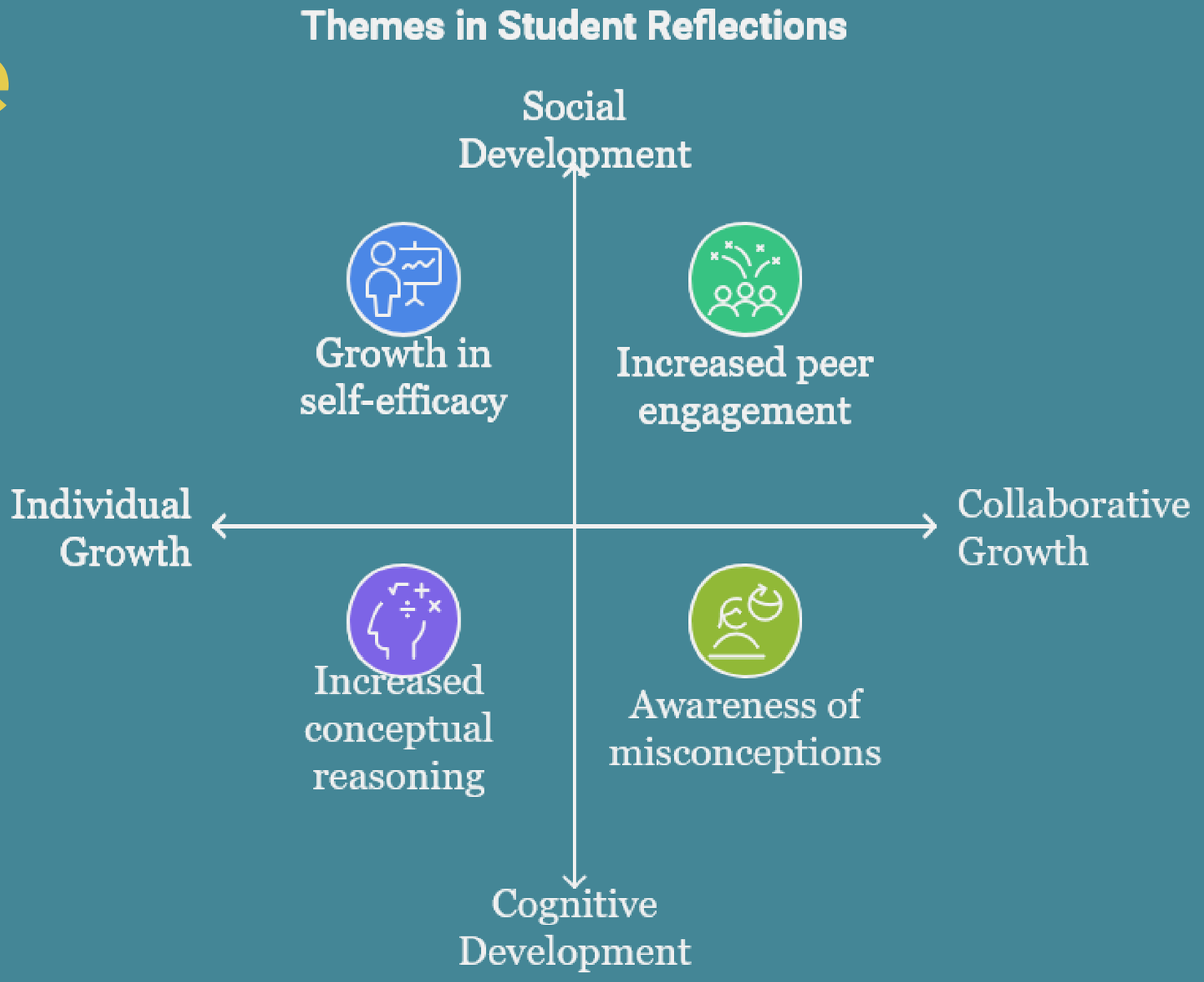


Cycle 2:
89.3%

Results!


Diagnostic Test
Cycle 2
HFCI MARKS (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
85.70
92.90
85.70
92.90
85.70
92.90
92.90
85.70
35.71
35.71
28.57
28.57
28.57
14.29
14.29
28.57
STUDENT 1
STUDENT 2
STUDENT 3
STUDENT 4
STUDENT 5
STUDENT 6
STUDENT 7
STUDENT 8
STUDENTS

Qualitative Results!



Reflections

- **Peer Instruction effectively enhanced students' conceptual understanding and confidence in learning force concepts.**
- **Clear evidence of conceptual gains, with all students achieving above 80% by the end of Cycle 2**
- **Increased self-efficacy and enjoyment in collaborative learning**

Pedagogical Recommendations

Adopt Active Learning Strategies

Incorporate Peer Instruction regularly in physics lessons to shift from teacher-centered to learner-centered approaches that promote active reasoning and conceptual understanding.

Encourage Collaborative Dialogue

Foster structured peer discussion where students explain, defend, and revise their ideas, supporting learning through social interaction as proposed by Vygotsky (1978).

Integrate Formative Assessment

Use short conceptual quizzes, clicker responses, or mini HFCI items to provide ongoing feedback and identify misconceptions during lessons.

Develop Students' Metacognition

Embed reflection activities after each Peer Instruction session so students can monitor their reasoning processes and recognize conceptual shifts.

Key References

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