UNIVERSITY OF Cincinnati

Revealing Student Difficulties in Learning DC Circuits

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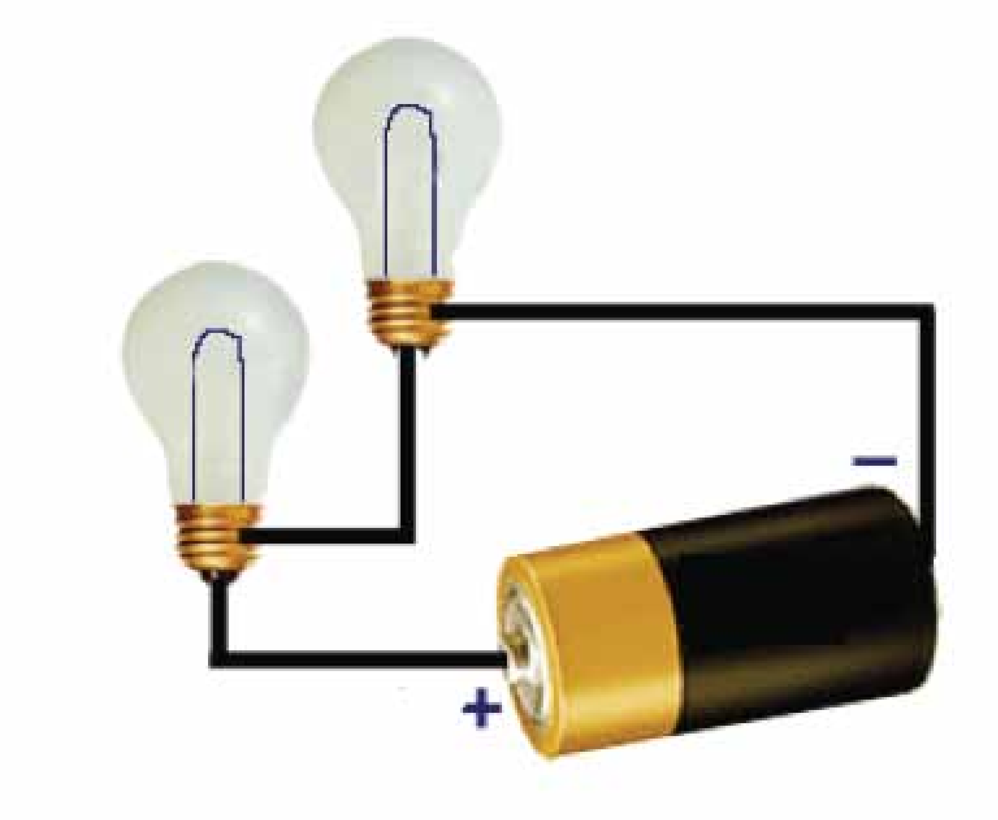

Background

- Student conceptual difficulties in learning DC circuits resistant to traditional instruction [1].
- Many PER-based interactive engagement instructional strategies developed to address student conceptual difficulties [2, 3, 4, 5].
- Limited persistent use of PER strategies by non-PER faculty [6].

Problem

- How to identify student difficulties and determine how to address them.
- How to effectively implement PER-based instructional strategies using reflective teaching to improve implementation.

References

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Methods

Context

- Open access regional campus.
- Algebra-based introductory physics course.
- 36 health science students in class.

Data Collection and Analysis

1. **Pre/Post-Test Concepts on DC Circuits**
   Calculated average normalized gain [9].
2. **Instructor Journal**
   Open coding [10] to allow themes to emerge.
3. **Student Survey**

Instructional Strategies

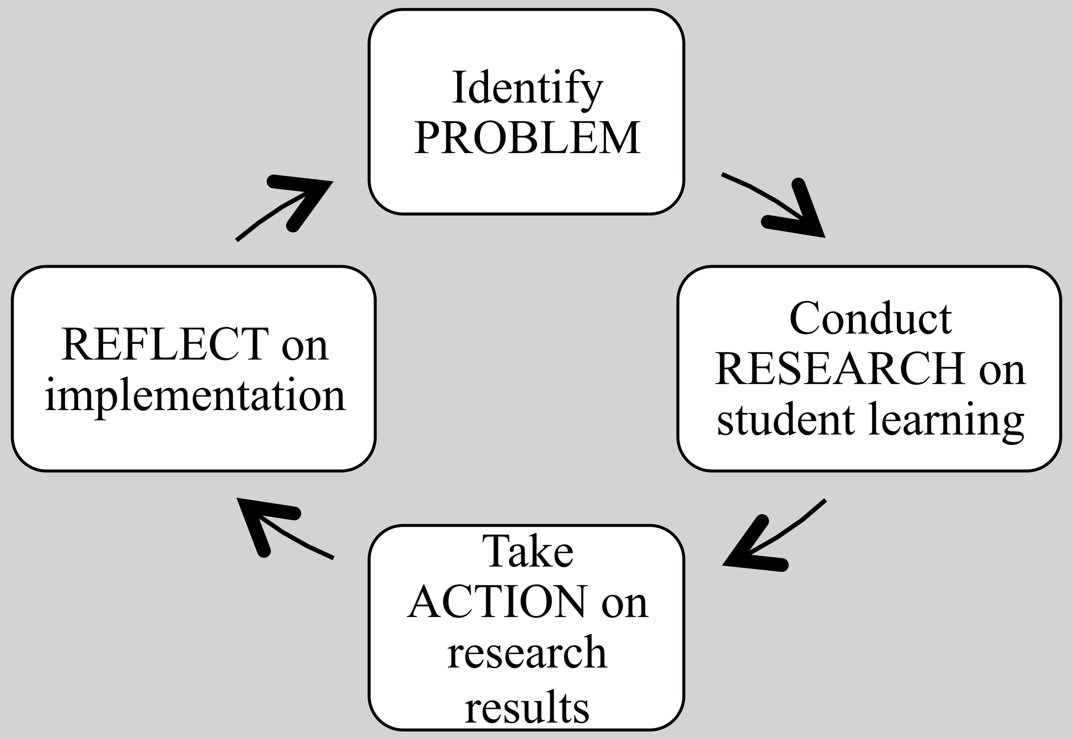
Peer Instruction *(in lecture)*

- Multiple choice concept questions presented.
- Think-Pair-Share *(1st think, then discuss with peer)*
- Students vote.
- Instructor asks for multiple student volunteers to answer and explain their reasoning.

Collaborative Problem Solving *(in recitation)*

- Small groups work together on applications.
- Instructor guides thinking by seeding [8] ideas in the small groups

Classroom Action Research for Improving Instructional Practice



Problem: Persistent difficulties with DC circuits
Conduct Research: Identify Student Difficulties

- Conceptual difficulties
- Reasoning
- Mental Engagement

Take Action: to address difficulties
Inquiry-based Circuits activity addressing current concepts.
Reflect on implementation & Repeat cycle

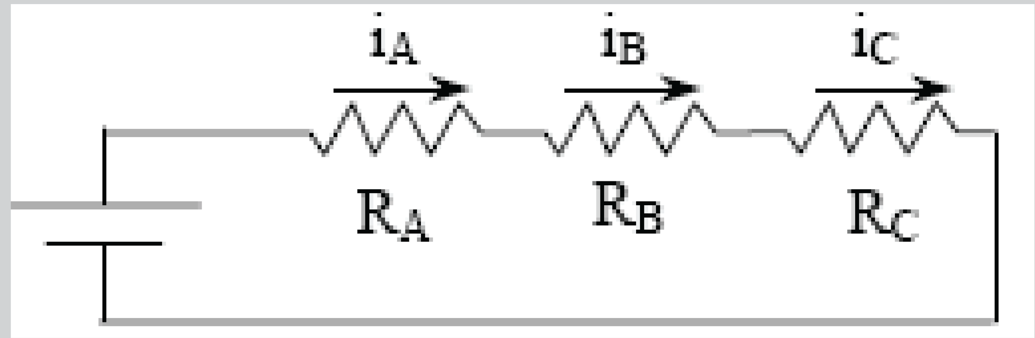


Figure 1. Series Circuit
All three resistors are identical, $R_A = R_B = R_C$.
What is the relationship between i_B and i_C?

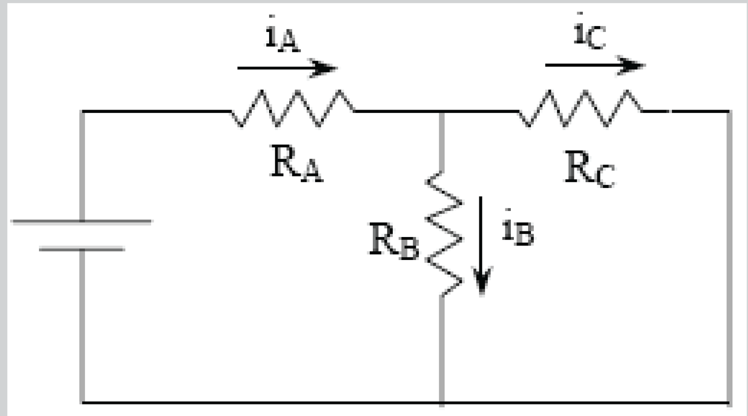


Figure 2. Parallel Circuit
R_A is identical to R_B and their resistance is half of R_C, $R_A = R_B = ½R_C$.
What is the relationship between i_B and i_C?

Mental Engagement

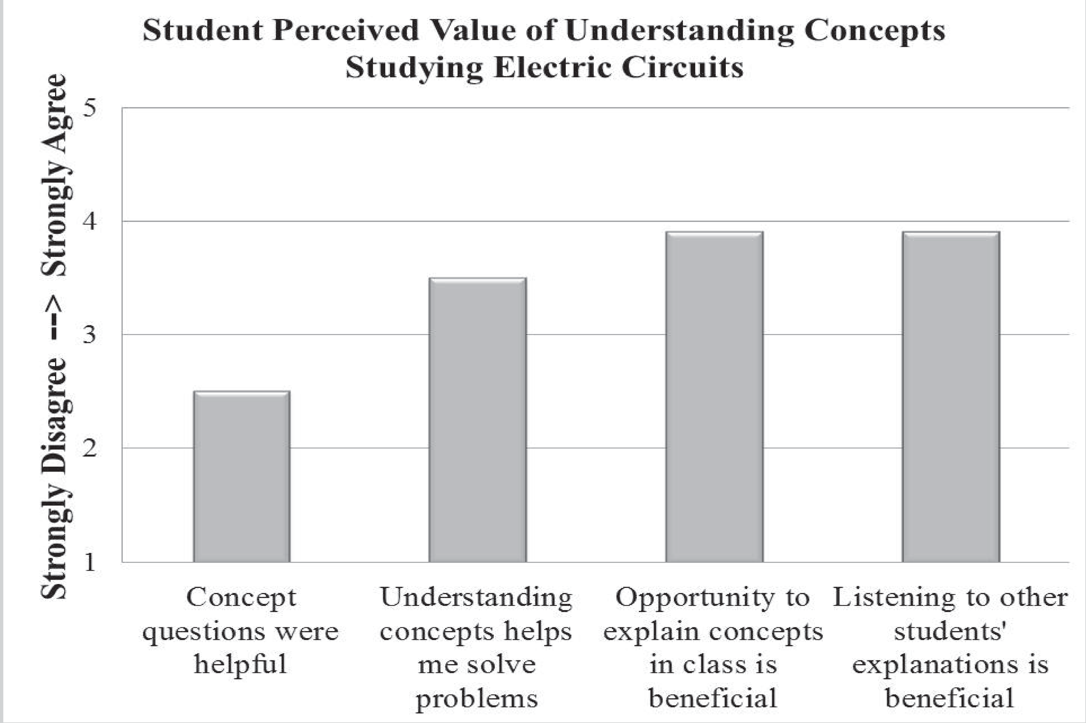


Figure 3. Student Perceived Value of Understanding Concepts studying electric circuits.

Discussion of Findings

Conceptual Difficulty

a) Difficulties with concepts related to electric current [1]. [See FIGURE 1]

- Order of resistors matters.

"A resistor resists the current passing through it, therefore i_B should be > i_C …since R_B is the 2nd resistor…i_B = $2i_C$."

- Current is "used up" in a circuit.

"More current will flow to R_B, but after it passes over it there will only be ½ of what went in to move to R_C."

b) Failure to recognize that circuit diagrams represent elements, not physical or spatial relationships [1]. [See FIGURE 2]

"Because R_C is farther away and goes through a longer line the current would only travel through R_B."

c) Lack of a conceptual model for explaining the behavior of a DC circuit [1]. [See FIGURE 1]

"All three resistors are identical and R_A=R_B=R_C. For all three to be identical I_A=I_B=I_C."

Reasoning

- Initially students used conceptual reasoning to explain their thinking, often incorrectly [See FIGURE 2].

"R_C has twice the resistance of R_B and they're both getting the same amt. of current from i_A, so i_C would only have ½ the current i_B has."

- Used both algebraic and conceptual reasoning, as they developed greater understanding. [See FIGURE 2].

"Ohm's Law: $V=IR \rightarrow I=V/R$. Since R_B and R_C are in parallel, they have the same voltage and we know the relationship of their resistors, so plug those into Ohm's Law:
$i_B=V/R_B$ $i_C=V/R_C$
$i_B = 2V/R_C$ vs. $i_C = V/R_C$
$i_B = 2i_C$."