Transfer of Argumentation Skills in Conceptual Physics Problem Solving

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INTRODUCTION

- Argumentation is a key skill used to logically make decisions and solve problems [1-4].
- Bing and Redish [5] investigated warrants used to argue about physics problems using mathematics.
- No studies regarding argumentation on conceptual physics problems requiring qualitative reasoning.

RESEARCH QUESTIONS

1. To what extent can students trained to construct (evaluate) arguments transfer skills to tasks requiring them to evaluate (construct) arguments?
2. How does transfer of argumentation skills compare between the construct and evaluate groups?
3. How do students' argumentation skills on training and transfer problems change over time?

THEORETICAL BACKGROUND

- Toulmin's Argumentation Pattern (TAP) [6] elements of an argument:
  — claim,
  — data,
  — warrants,
  — backing, and
  — rebuttals.
- Vertical Transfer of Learning [7]
  — When new transfer context differs from learning context in more than one way.
  — Requires knowledge reconstruction.

METHODOLOGY

Data Collection

- N = 107 ; Physics for future elementary teachers.
- Format: 3 hr. Lecture, 2 hr. Lab, 3E Learning Cycle.
- No prior instruction on argumentation.
- Started in week 3 of semester.
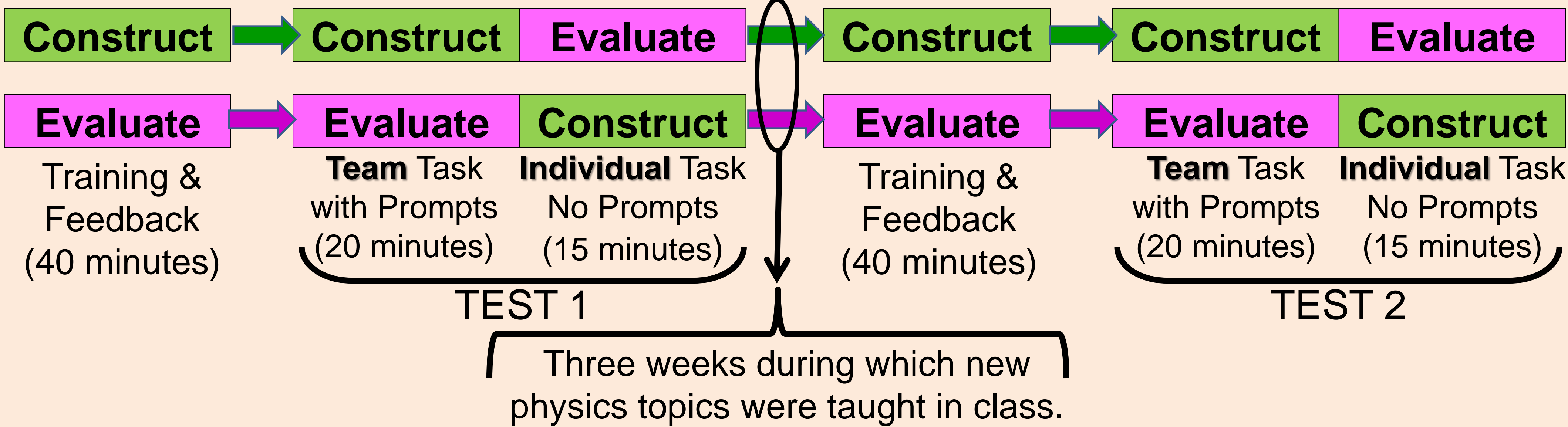- Data from TEST 1 & 2. See **RESEARCH DESIGN**

Data Analysis

- Test problems analyzed as per rubric adapted from Sadler & Fowler [8], based on TAP Toulmin's TAP [6].
- Scored for both correctness & justification.

Scientific Correctness	Grounds Provided
0: Incorrect, with no justification	1: No grounds
1: Incorrect with justification	2: Single grounds
2: Correct, with no justification	3: Multiple grounds
3: Correct, with justification	4: Single/Multiple grounds, with counter-position
	5: Single/Multiple grounds, with counter-position and rebuttal

- Max pts. = 8 points x 2 probs. per test = 16 points.

RESEARCH DESIGN

Construct	Construct	Evaluate	Construct	Construct	Evaluate
Evaluate	Evaluate	Construct	Evaluate	Evaluate	Construct
Training & Feedback (40 minutes)	**Team** Task with Prompts (20 minutes)	**Individual** Task No Prompts (15 minutes)	Training & Feedback (40 minutes)	**Team** Task with Prompts (20 minutes)	**Individual** Task No Prompts (15 minutes)

TEST 1   TEST 2

Three weeks during which new physics topics were taught in class.

CONSTRUCT PROBLEM EXAMPLE

Two kids that you are babysitting are playing with spring loaded toy cars that can bounce off each other. Ryan picks up a truck and Sam picks up a car that is lighter than the truck. They push them against each other in the center of the living room on the wooden floor ready to let go. Before they do that, you ask: "Which one will get to the reach the wall on their side faster?"
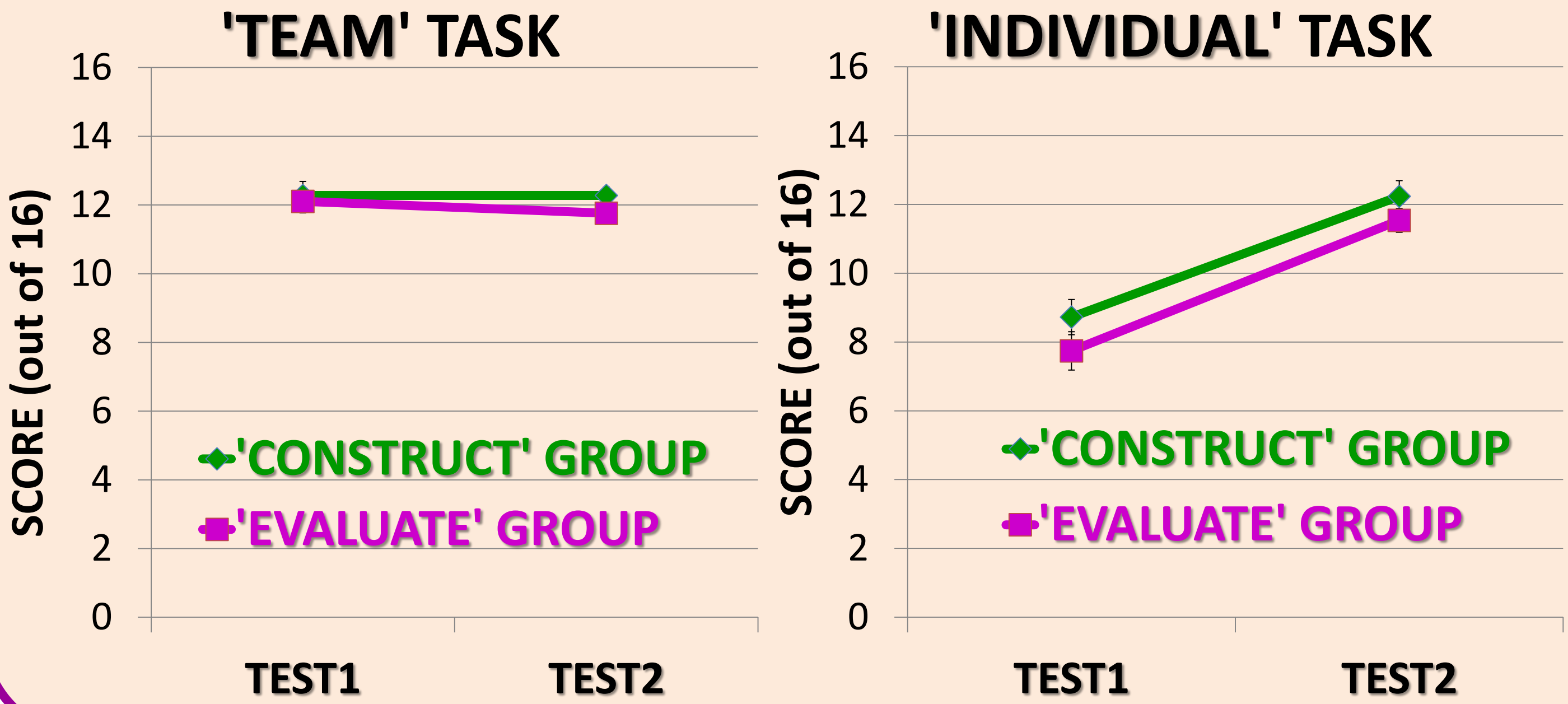
PROMPTS

CONSTRUCT	EVALUATE
What is your answer? Construct an argument to justify your answer. Remember to consider: • What evidence supports your answer? • One of your classmates may disagree with you. What might their alternative be? • What reasons would your classmate provide to support their conclusion? • What would you reply to classmate to explain your position is right?	Which statement do you agree with? Or do you have another argument? Explain your answer. Remember to consider: • What evidence supports your selection? • Explain your reasons for not choosing the alternative. • How might a classmate supporting the other solution disagree with your preferred solution? • What would you reply to your classmate to explain your position is right?

EVALUATE PROBLEM EXAMPLE

Kids you are babysitting play with spring loaded toy cars that bounce off each other. Ryan picks up a truck and Sam a car that is lighter than the truck. They push them against each other in the center of the living room ready to let go. Just then, you ask: "Which one will get to the reach the wall on their side faster?"
Ryan: "They get there at same time, we are start from the middle of the room, the walls are equally far, so it takes the same time to get to walls."
Sam: "Your heavier truck is slower than my lighter car, so my car gets to wall sooner than your truck."

RESULTS

'TEAM' TASK — SCORE (out of 16) vs TEST1, TEST2; 'CONSTRUCT' GROUP, 'EVALUATE' GROUP

'INDIVIDUAL' TASK — SCORE (out of 16) vs TEST1, TEST2; 'CONSTRUCT' GROUP, 'EVALUATE' GROUP

- **Repeated Measures** ANOVA:
  —No significant change from TEST 1 to TEST 2 on **TEAM** Task.
  —Significant improvement from TEST 1 to TEST 2 on **INDIVIDUAL** Task.
- **Within Subject** Analysis:
  — TEST 1: Significant decline for both groups from Team to Individual task.
  — TEST 2: No significant change for either group from Team to Individual.
- **Between Subject** Analysis:
  —NO Significant difference between Construct & Evaluate groups.

CONCLUSIONS & IMPLICATIONS

To address each Research Question:

1. Transfer of argumentation skills from team (training) to individual (transfer) task on Test 2 is better than on Test 1.
2. Students trained to construct arguments are as effective at transferring skills to evaluating arguments as vice versa.
3. Students do not improve on team task from Test 1 to Test 2, but improve at transferring experiences from team to individual tasks.

Implications: (a) Training in any argumentation form can transfer to other forms. (b) Improvement over time in transfer from team to individual task must be explored from socio-cultural perspective.

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