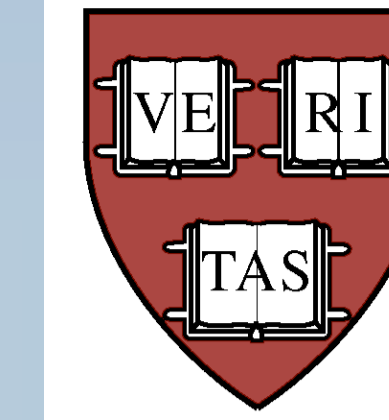


PROMOTING CONCEPTUAL UNDERSTANDING IN THE CLASSROOM: AN EXAMINATION OF INTERACTIVE ENGAGEMENT PEDAGOGIES

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BACKGROUND

Interactive Engagement Pedagogies

- Promote conceptual understanding
- Students are engaged in activities that are heads-on (always) and hands-on (usually)
- Generates immediate feedback through discussion with peers and the teacher

Motivation

- Many students leave science classrooms with misconceptions about the natural world in life, earth, and physical sciences
- The National Science Education Standards call for an improvement in conceptual understanding

PURPOSE AND STRUCTURE

Review of the Literature

- Constructivist theory of learning and conceptual understanding
- IE models in use at the university level
- Efficacy of university-level IE pedagogies
- Mediating factors between IE models and conceptual understanding gains

Survey of IE Methods in Secondary Science and Math Classes

- Questionnaire completed by high school teachers
- Designed to evaluate intensity of the three IE mediating factors in questioning sessions

Research Proposal

- Evaluate the effectiveness of PI in a high school science classroom
- Experimental design

CONSTRUCTIVIST LEARNING THEORY

Misconceptions

- Students have their own models for explaining the natural world (why the moon has phases, how life evolves)
- Oftentimes, the models are inaccurate = MISCONCEPTIONS
- Misconceptions are difficult to change

Cognitive Conflict

- When students' models fail to explain some phenomenon, cognitive conflict is created
- Conflict forces students to re-arrange thinking and try new ideas

Social Interaction

- Discussion with others facilitates the consideration of new ideas
- The ideas of other students serve as scaffolding upon which new understanding can be constructed

The social construction of knowledge is related to improved conceptual understanding

IE METHODS AT THE UNIVERSITY LEVEL

Hypothesis-Experiment-Instruction (HEI)

- Instructor poses a question to the class - three or four multiple choice answers are available
- Students "vote" for an answer - instructor tallies votes
- Students debate answers with each other
- Students "revote" for an answer
- Students test answers by performing an experiment or reading text
- Class will discuss results of experimental and textual findings
- Associated with a gain in conceptual understanding (Kobayashi, 1994)

Class-wide Discussion (CWD)

- Instructor poses a question to the class - three or four multiple choice answers are available
- Students have time to think of answers individually
- Students discuss answers in groups (groups no larger than 4)
- Individual students "vote" for an answer
- Instructor tallies votes and displays distribution of answers to the class
- Class discussion ensues, with students giving reasoning behind answers
- Instructor moderates the discussion and ensures that closure is reached
- Students indicated they enjoy CWD lectures and that CWD improves learning (Dufrense, 1996)

Peer Instruction (PI)

- Instructor poses a question to the class - three or four multiple choice answers are available
- Students have 1-2 minutes to think of and vote for an answer - instructor tallies votes
- Students debate answers for 2-3 minutes
- Students "re-vote" for an answer
- Instructor displays distribution of answers
- Instructor discusses correct answer - re-teaching if not enough correct answers
- Quantitatively related to gains in conceptual understanding, as indicated by improved scores on the Force Concept Inventory (Mazur, 1997; Crouch, 2001; Fagen, 2002))

MEDIATING FACTORS BETWEEN IE AND CONCEPTUAL UNDERSTANDING

Structured Questioning

- Each IE strategy follows a specific routine of questioning students
- More *wait-time* is generated when using these specific strategies (PI ensures a wait time of at least one minute for the first response)
- Elevated wait-time associated with learning gains in secondary science classrooms (Rowe, 1974; Tobin, 1980)

Active Student Response (ASR)

- *Every* student responds (by voting) to *every* teacher question during IE classes
- An increase in ASR is associated with achievement gains in secondary science classes (Pratton, 1986; Gardner, 1994)

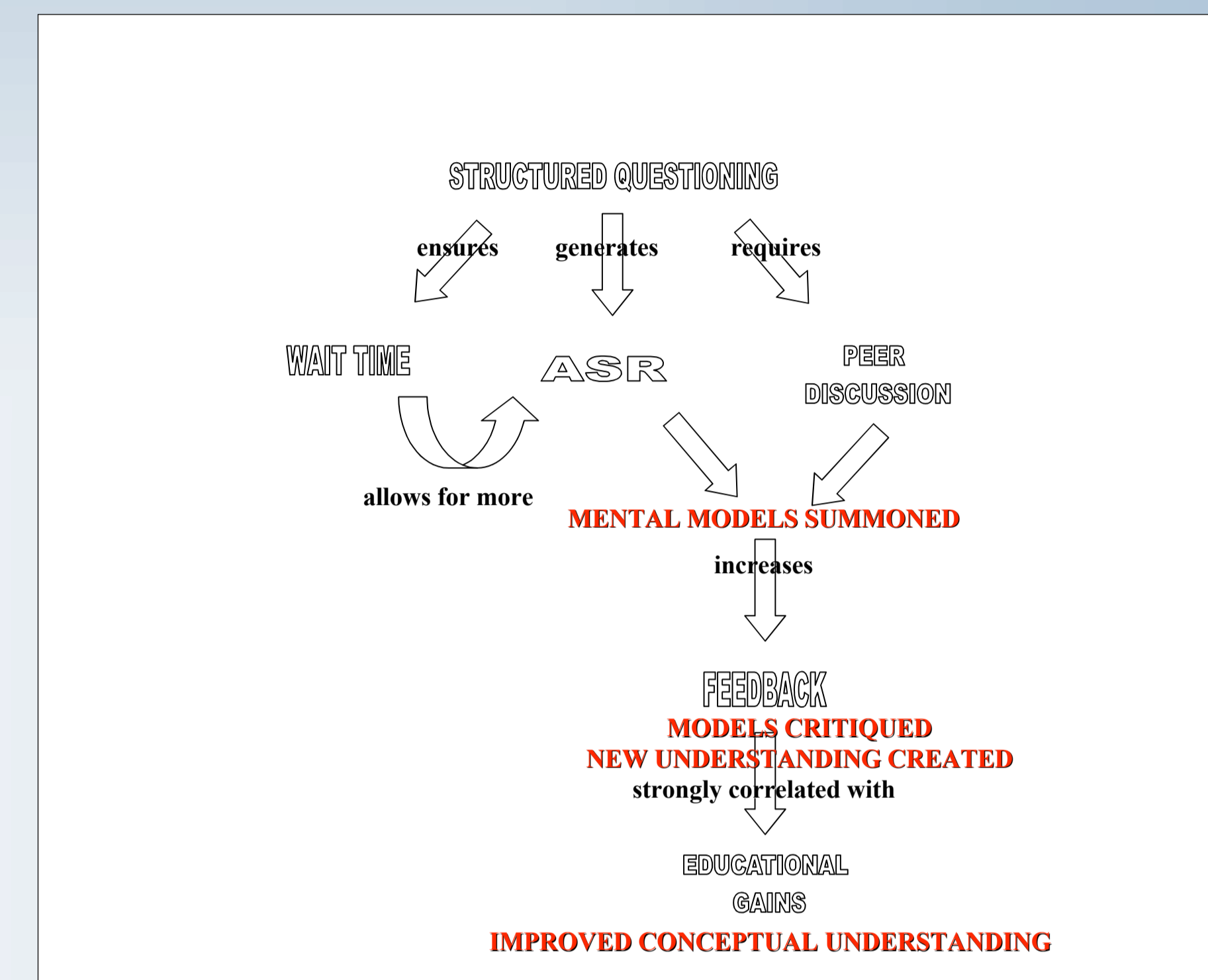
Peer Discussion

- All three IE pedagogies require students to debate their understandings with each other
- Sharing ideas with peers related to improved learning in secondary science classes (Lazarowitz, 1998; Maheady, 2002)

Improving Conceptual Understanding

- Increased wait-time allows more students to summon mental models
- Models are presented during active student response and discussion
- Ideas are critiqued
- New understandings built using the ideas of others

A MODEL OF IE PEDAGOGIES



IE FACTORS IN THE SECONDARY CLASSROOM

Five high school science teachers and one math teacher were surveyed regarding the use of IE methods in their classrooms.

Major Findings

- Used questioning 45% of class time
- Average wait-time of 23.3 seconds (literature reports an average of 1 second)
- Verbal asking and answering most common mode of communication
- Typically, 1/3 of students respond to questions
- All teachers felt questioning helped students learn
- 4 out of 6 teachers indicated that student do not enjoy questioning

Recommendations based on findings

- Improved monitoring and use of wait-time
- Change questioning techniques to enhance active student response
- Examine the effect of Peer Instruction on conceptual understanding using an experimental design

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