



How Students Learn Problem Solving - A Model of Instructors' Beliefs*

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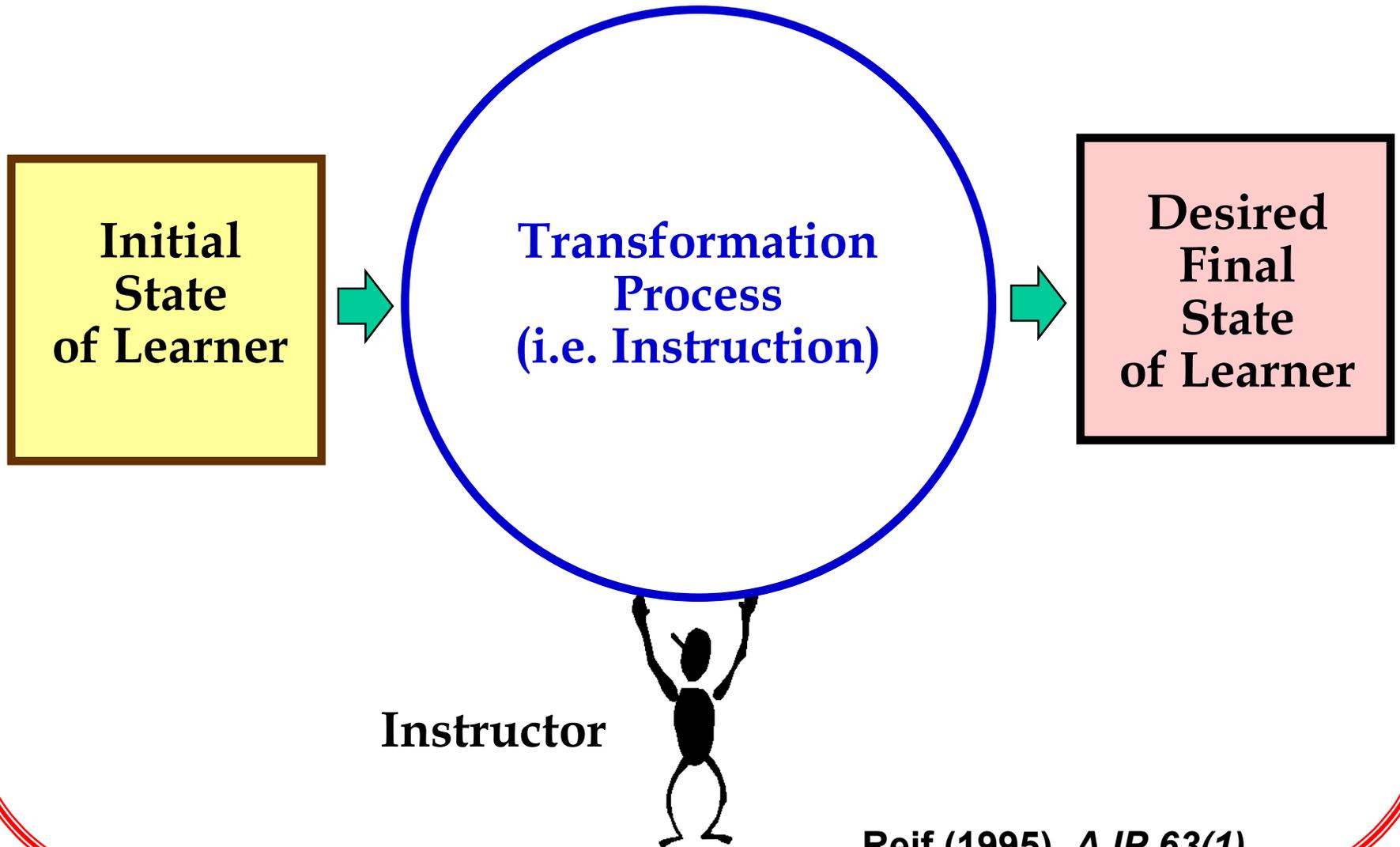


Overview

1. Why study faculty conceptions?
2. Research Methods
3. What conceptions do faculty have about **student learning activities** that help them learn how to solve physics problems?
 - What types of conceptions?
 - How explicit are these conceptions?

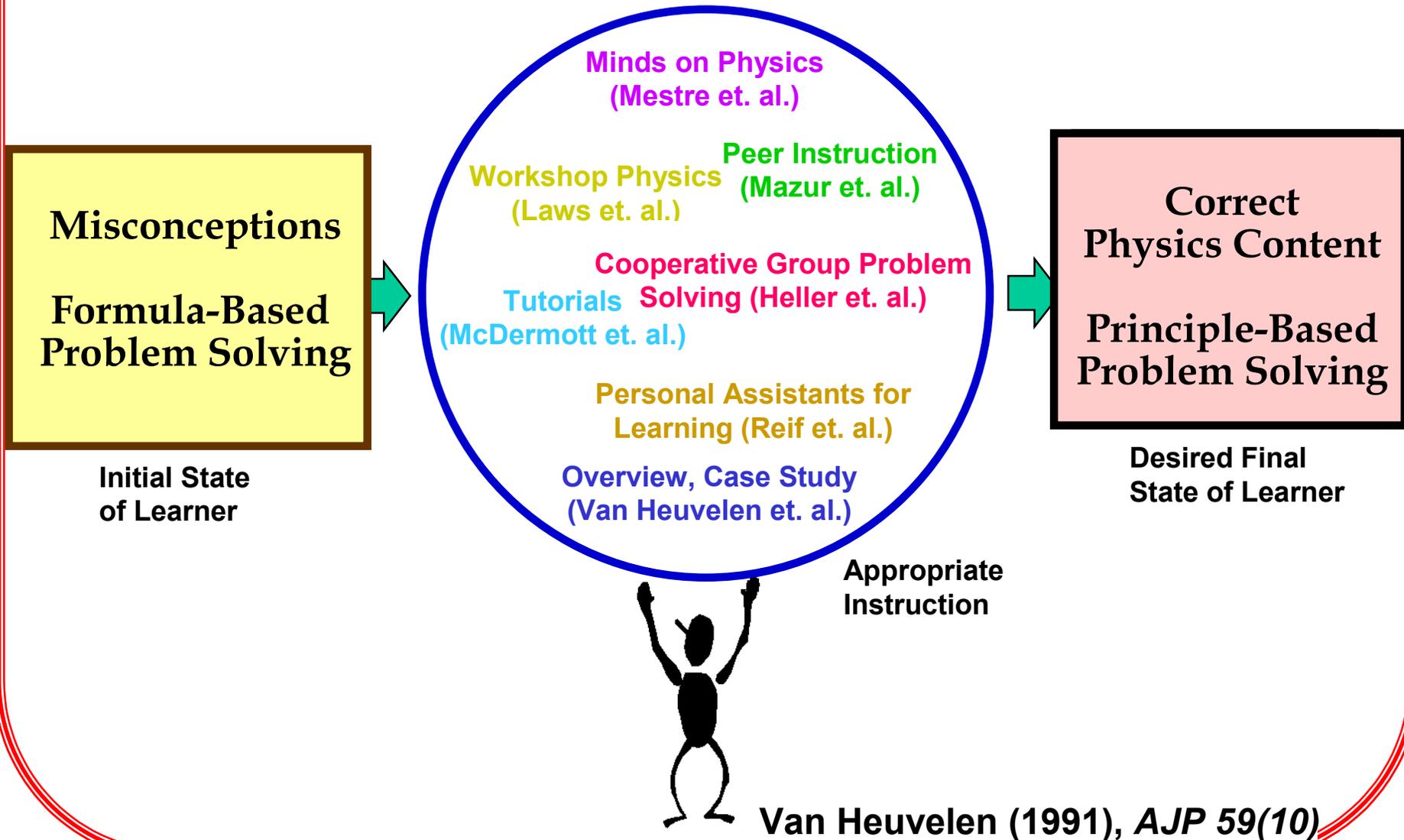
Next Talk: What conceptions do faculty have about **teaching activities that can help students learn how to solve physics problems?**

The Instructional Problem





What do we know from Physics Education Research?



What is the difficulty with these research-based curricular materials? Why aren't they widely used?

- The available curricular materials do not fit well with faculty conceptions (i.e. beliefs, values, knowledge, etc.) of teaching and learning



- For curricula to be used, we need to understand faculty conceptions:

1. Change the curricular materials

(curricular materials built on faculty conceptions are more likely to be used and more likely to be used appropriately)



2. Change the faculty conceptions

We know from students:

- Changing conceptions is hard.
- In order to change conceptions it is first necessary to determine what the current conceptions are.





The Interview Tool

To investigate faculty conceptions, we developed a 1½ - 2 hour interview based on instructional “artifacts”:

- 1st) 3 Instructor solutions: varied in the details of their **explanation, physics approach, and presentation structure**
- 2nd) 5 Student solutions: based on actual final examination solutions at the University of Minnesota to represent **features of student practice**
- 3rd) 4 Problem types: represent a range of the **types of problems used** in introductory physics courses

All artifacts were based on **one problem** -- instructors were given the problem and asked to solve it on their own before the interview.

The Interview Asked Instructors to Describe Their Conceptions of How Students Learn

7 of the 26 interview questions asked specifically about how students learn:

- “How would you like your students to use the example problem solutions you give them?”
- “What would you like your students to do with their graded problem solutions when you return them?”
- “For students who had trouble with _____ at the beginning of the course, what do you think they could do to overcome their trouble?”



Selecting Faculty for Interviews

Physics faculty in Minnesota (~107 meet selection criteria):

- taught introductory calculus-based physics course in the last 5 years
- could be visited and interviewed in a single day

Sample **Randomly Selected**:

30 faculty members

(From 35 contacted, 5 declined to be interviewed)

Roughly evenly divided among:

- 1) Community College (CC) N = 7
- 2) Private College (PC) N = 9
- 3) Research University (RU) N = 6
- 4) State University (SU) N=8

Interviews were videotaped and the audio portion transcribed:

~ **30** pages of text/interview



Goal of this Study

- **Begin the process of building a model of faculty conceptions (beliefs and values) about the teaching and learning of problem solving in introductory calculus-based physics based on 6 UMN instructors.**
 - **Can (how can) faculty conceptions be measured?**
 - **Can (how can) a model be constructed to describe these conceptions?**
 - **What are the important parts of this model?**
 - **How are these parts related?**

The focus of this study is on problem solving because the Physics Education Research Group at UMN is interested in problem solving.



Next Steps

Exploratory Study –
Small Sample

Current Study

- Initial model based on 6 UMN faculty.

Next Step

- Refine and expand the initial model based on remaining 24 faculty from different institutions.

- Determine the distribution of conceptions among faculty using a larger national sample.

Focused Study –
Large Sample

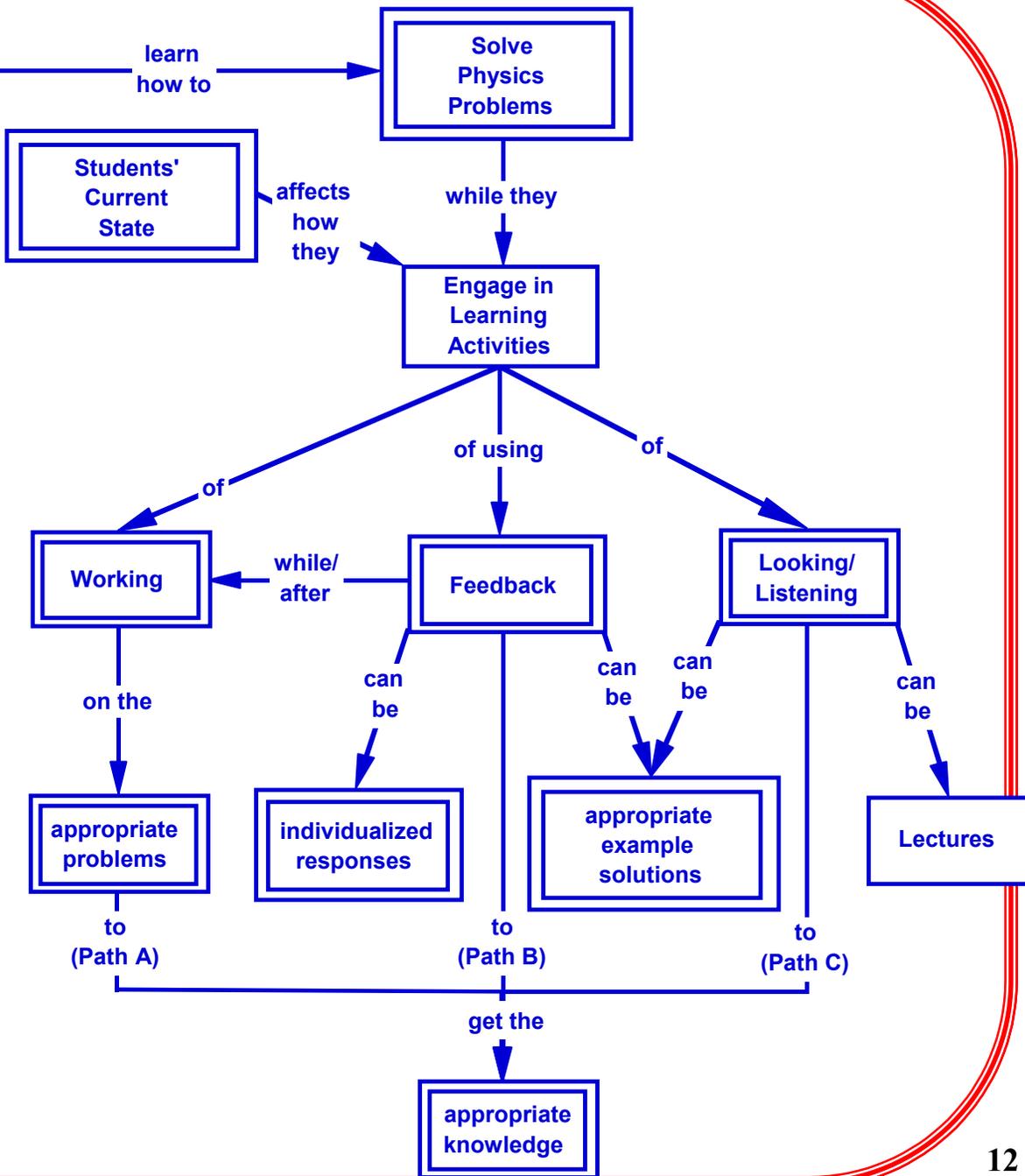


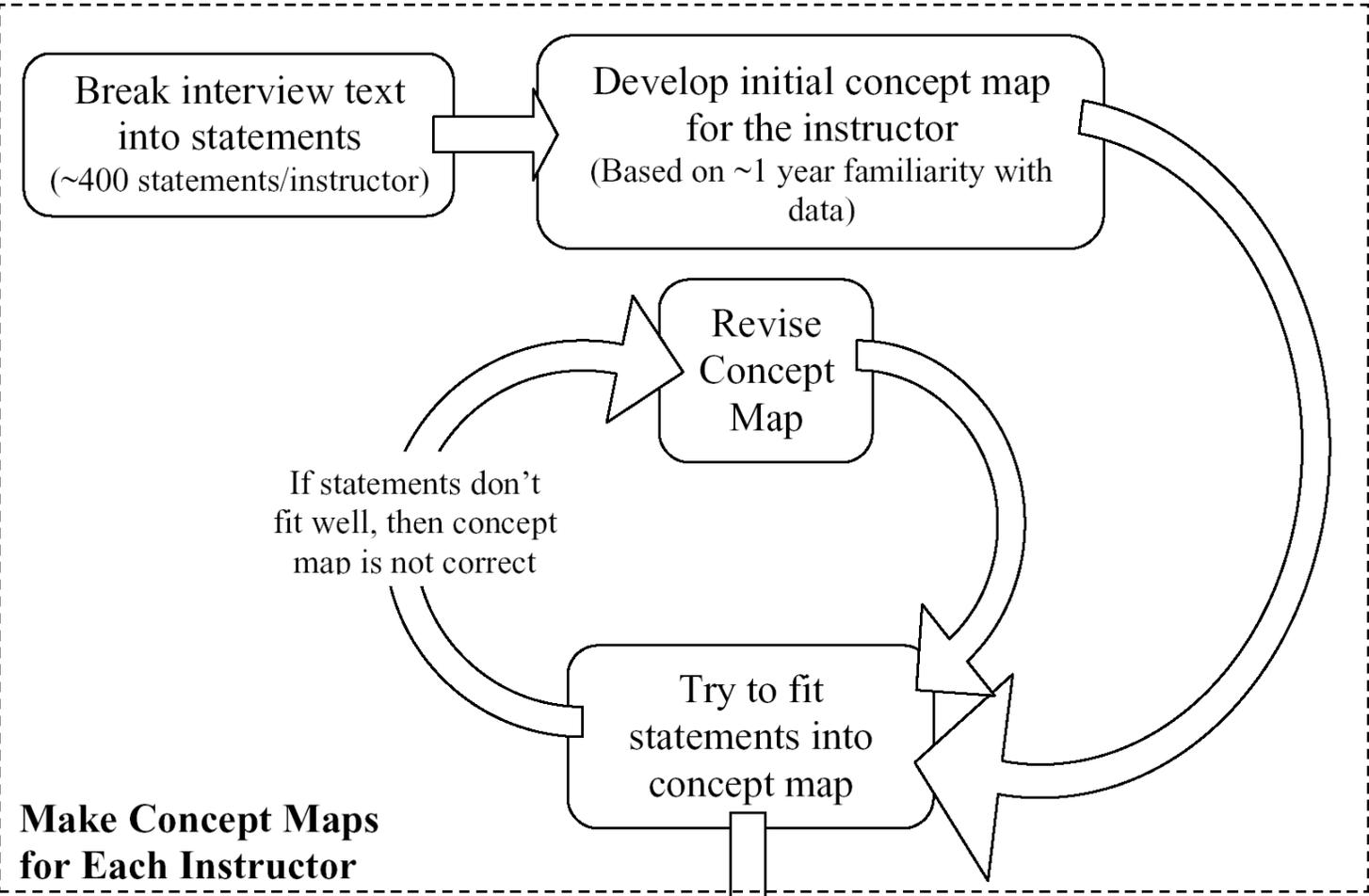
Final Product (of Current Study)

Final product is a concept map that describes an initial, testable model of how faculty think about the teaching and learning of problem solving.



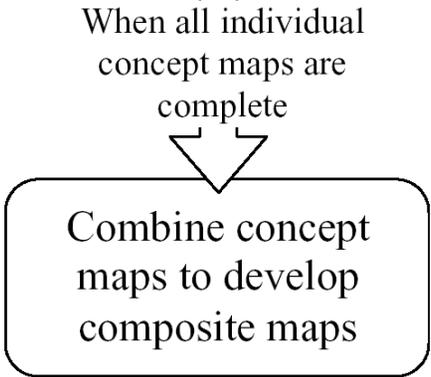
Initial Model: (Faculty conceptions of how students learn how to solve physics problems)





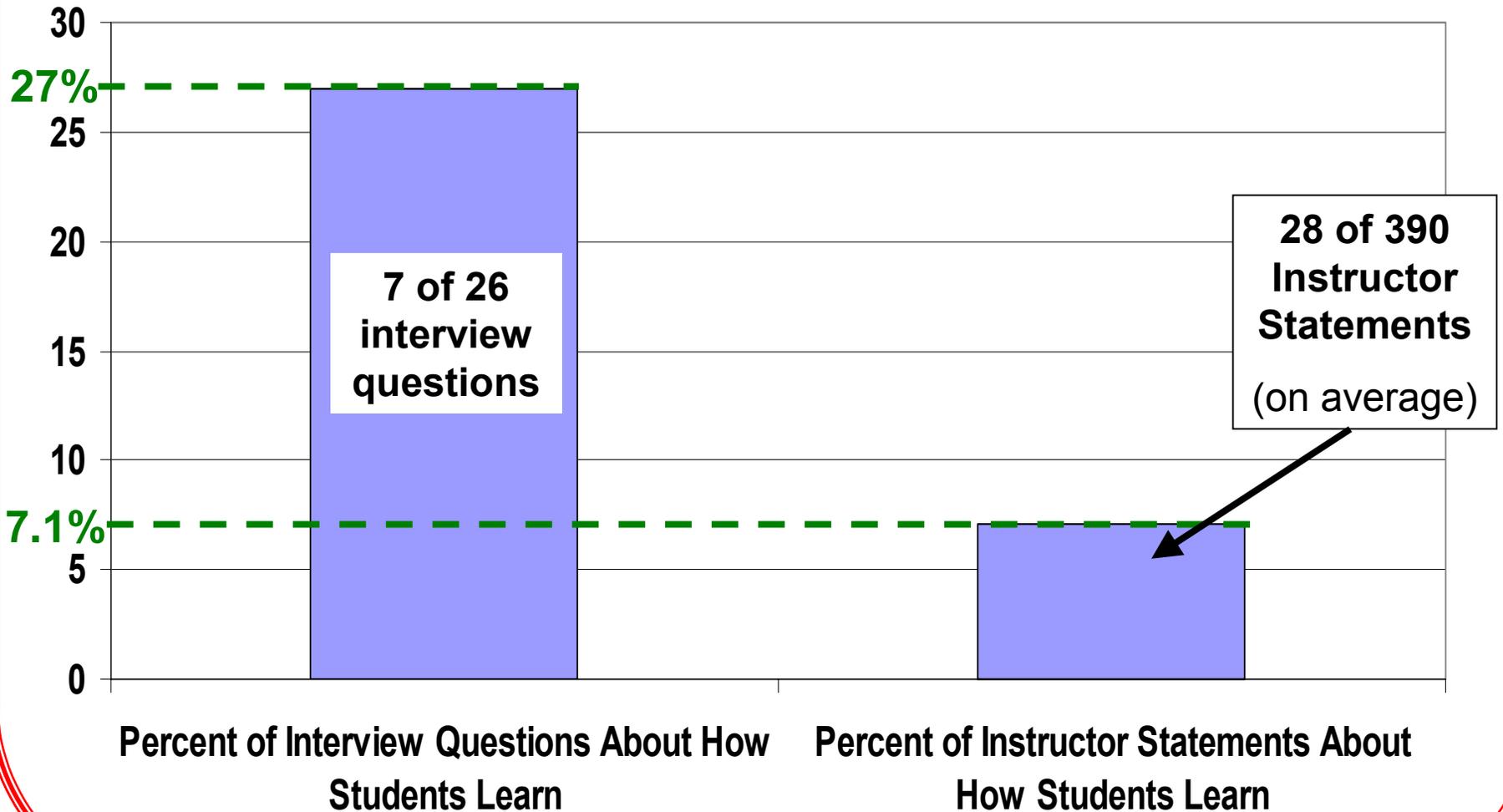
**Make Concept Maps
for Each Instructor**

Current Study: Procedure (an iterative process)





The Instructors Didn't Talk Much About How Students Learn



Instructors' Conceptions of how Students Learn Problem Solving

Three Learning Activities:

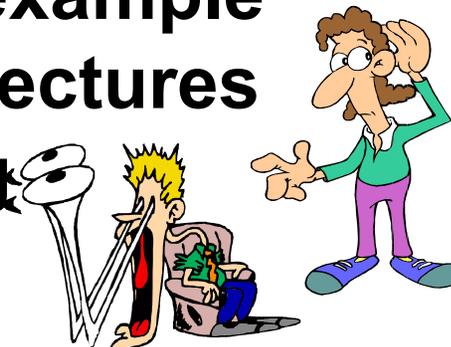
1. Working on problems



2. Using feedback while/after working on problems

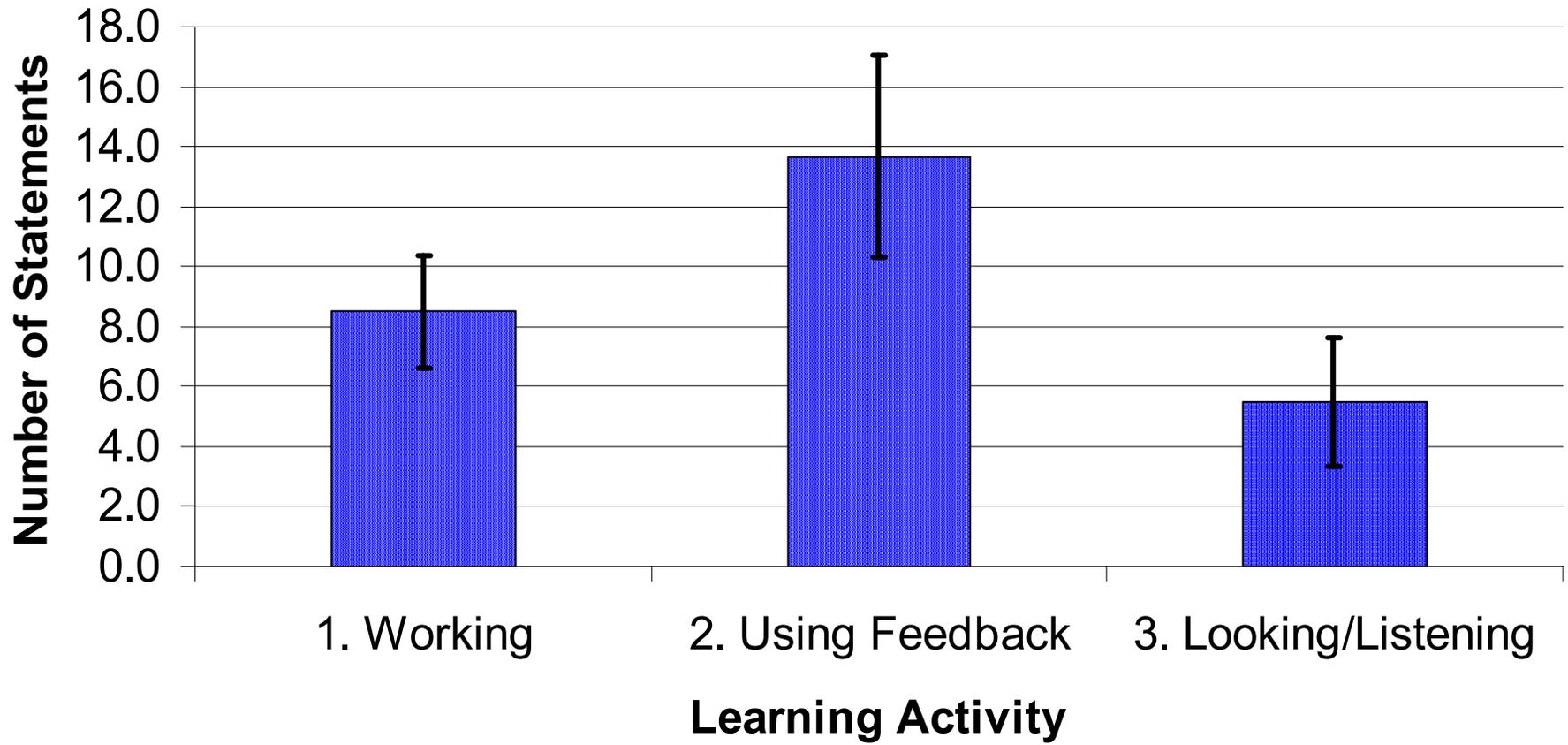


3. Looking/Listening to example problem solutions or lectures about problem solving techniques





These Instructors Talk Most About Learning Activities Involving the Use of Feedback





These Instructors Tended to Describe Learning Activities in Very General Terms

1. Working on Problems



General
Description

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Working on Appropriate Problems -- often called "practicing" (6 of 6 instructors)

Clarify to yourself why you are doing each step and not something else (2 of 6

Guess an answer before starting and then compare at the end (1 of 6 instructors)

Specific
Description

S



These Instructors Tended to Describe Learning Activities in Very General Terms

2. Using Feedback While/After Working on Problems



General Description

Delayed Feedback (6 of 6)

Real-time feedback -- often called "coaching" (4 of 6)

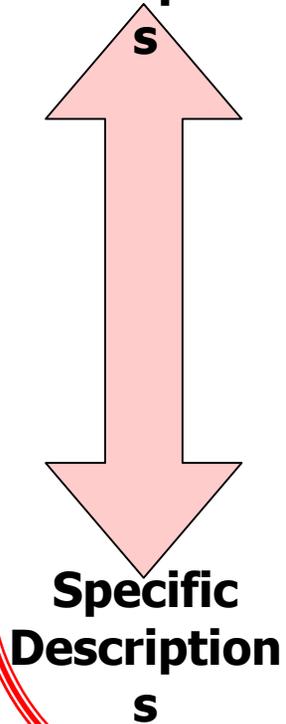
Analyze their mistakes by comparing their solutions to mine (6 of 6)

Use graded tests to evaluate where they are (2 of 6)

- **Work with other students (4 of 6)**
- **Come to office hours (3 of 6)**

Focus on the structure of the problem (rather than the specific details) (1 of 6)

Get help with specific difficulties and then continue working (1 of 6)



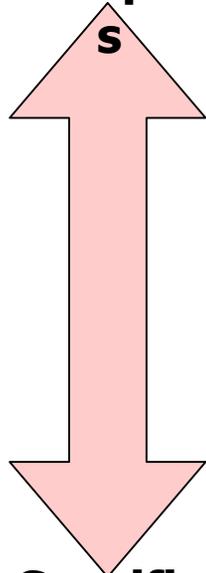
These Instructors Tended to Describe Learning Activities in Very General Terms

3. Looking/Listening

You can't learn just by Looking/Listening (1 of 6)

Looking/Listening is not as good as working yourself (1 of 6)

General Description



Specific Description

S

Looking/Listening to example problem solutions (5 of 6)

Think about what is going on (1 of 6)

Looking/Listening to lectures about problem solving techniques (not attached to a particular problem) (4 of 6)



Conclusions

- The instructors talk about three distinct ways that students can learn how to solve physics problems
 1. Working on Problems
 2. Using Feedback While/After Working on Problems
 3. Looking/Listening to Example Problem Solutions or Lectures
- Of these, the instructors appear to believe that Looking/Listening is the least effective.

Implications

- These instructors do not have stereotypical teacher-centered conceptions of learning (i.e. that students learn by primarily by watching the teacher solve and discuss problems on the board).
- If this holds true → Physics instructors do not avoid curricula that involve active learning (i.e. students working rather than looking/listening) based on their belief that these curricula would not lead to student learning.

Conclusions

- **These instructors did not talk much about how students learn (even though they were specifically asked) – they tended to talk about their teaching activities**
- **When they did talk about student learning, they tended to talk about it in very general terms and did not talk much about specific details.**

This Suggests:

- **The instructors do not have an explicit model of the mechanisms by which students learn.**

Implications

- **If this holds true →**
 - 1. curriculum developers need to communicate curricular innovations to instructors in a way that does not require the instructors to understand specific mechanisms that enable students to learn.**

Or
 - 2. Curriculum developers need to find a way to introduce instructors to the existence and importance of such learning mechanisms.**



The End

**For more information,
visit our web site at:**

<http://www.physics.umn.edu/groups/phised/>

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