



FD04: AAPT Winter 2004 Conference, Miami Beach, FL

Instructors' Views on what Students should Think About when Solving Physics Problems

Metacognition in Physics Problem-Solving – Instructors' Views

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<http://groups.physics.umn.edu/physed/>

Supported in part by NSF grant #DUE-9972470



Outline

- What is **Metacognition**, & why do we care?
- What are we doing?
- What have we found?
 - Questions Raised
- Implications





What is **Metacognition**?

- **People's Thinking about their own Thinking**

Flavell, Freidrichs, & Hoyt, 1970; Bisanz, Vesonder, & Voss, 1978; Cavanaugh & Borkowski, 1979; Kluewe, 1982; Lodico, Ghatala, Levin, Pressley, & Bell, 1983; Schneider, 1985; Schoenfeld, 1987; Paris & Winograd, 1990; Nelson & Dunlosky, 1991; Borkowski & Muthukrishna, 1992

**Underlies all higher order thinking,
especially problem solving!**



Why do we care?

- **Research has indicated** (Schoenfeld, 1983, 1985a, 1985b, 1987; Lester, Garofalo, & Kroll, 1989)
 - **Expert problem solvers spend more time ...**
planning the directions that may be taken ...
monitor and ***evaluate*** their actions and
cognitive processes throughout problem-
solving episodes than do less successful
problem solvers

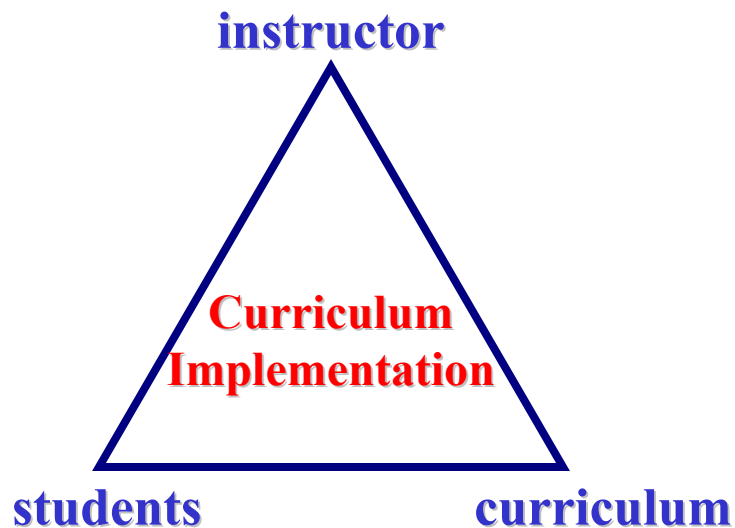
Since majority of our introductory students are largely unaware of their own thinking processes and do not (or cannot) do this, **instruction is needed**

What are we doing?

**Learning of physics through problem solving
in this study ...**

**Instructors' beliefs and values about the teaching
and learning of problem solving in physics**

why instructors?



the task is ...

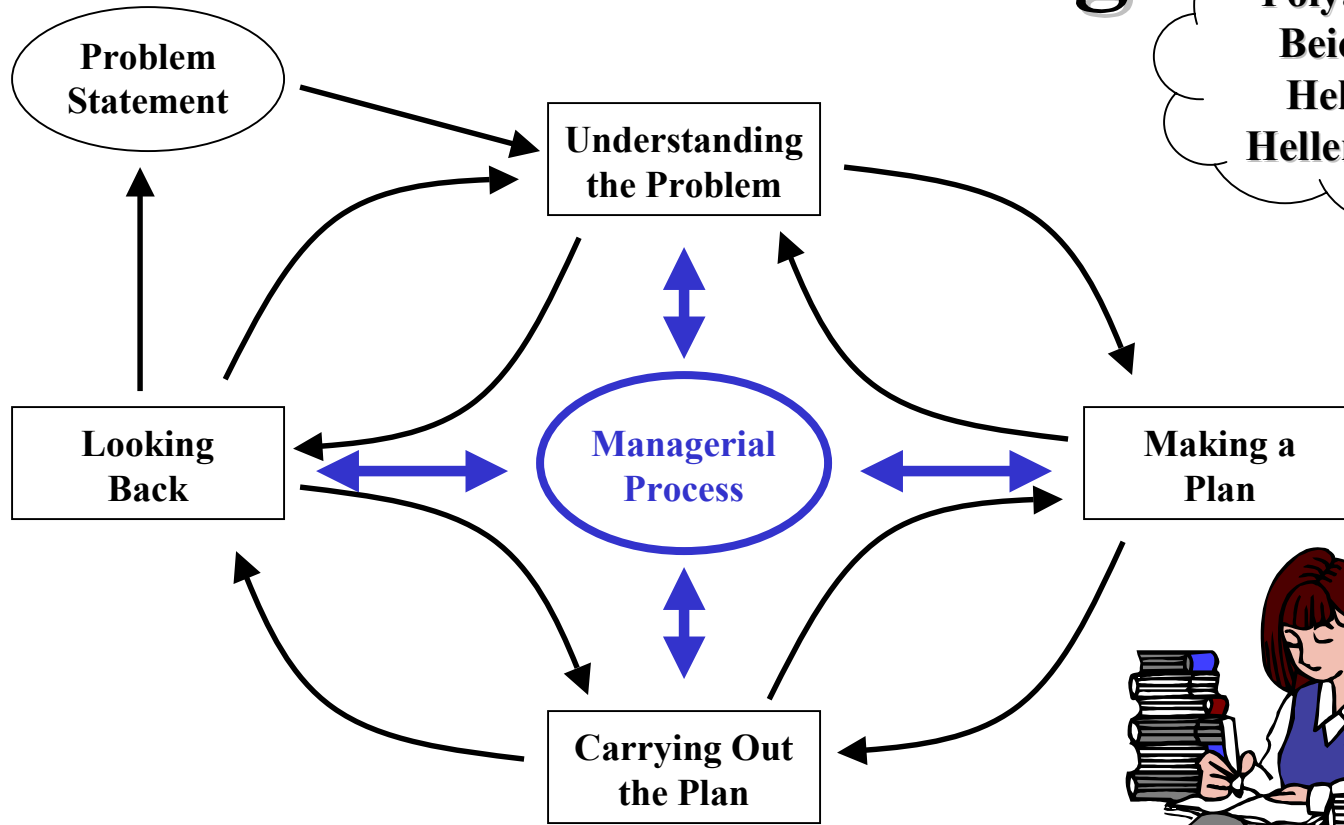
**to identify those
beliefs and values**



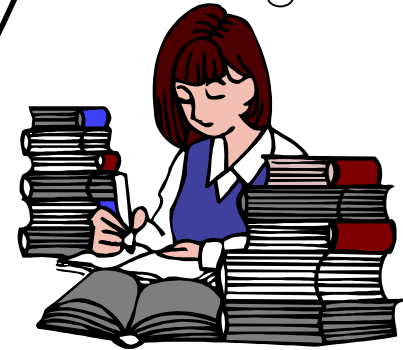
Shavelson & Stern, 1981; Carter & Doyle, 1987, 1995; Nespor, 1987; Pajare, 1992; Thompson, 1992; Huibregtse, Korthagen, & Wubbels, 1994; Kember & Gow, 1994; vanDriel, Verloop, & de Vos, 1998



What are we doing?



Polya, Reif,
Beichner,
Heller &
Heller, etc ...

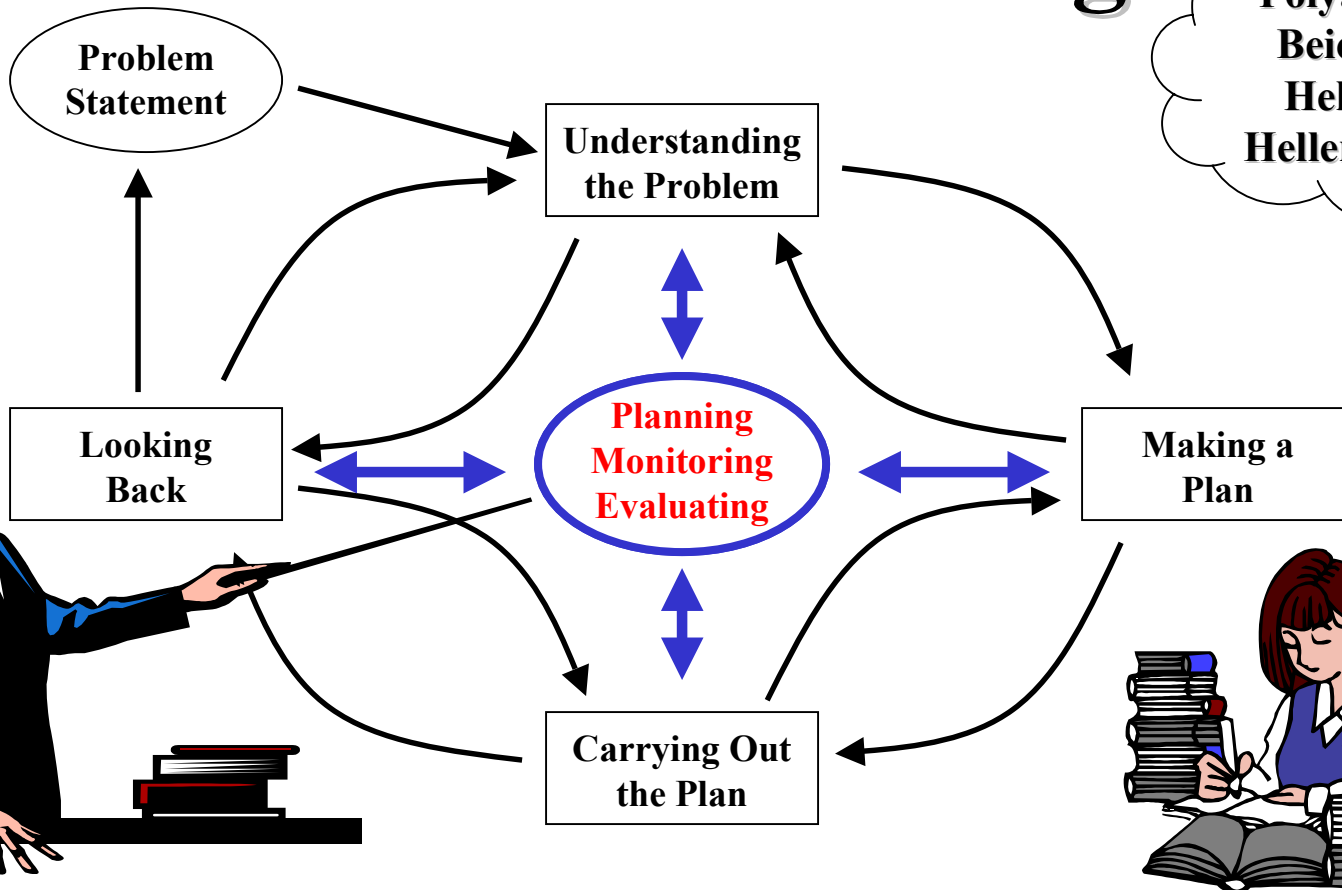


Fernandez, M.L., Hadaway, N., & Wilson, J.W. (1994). Problem Solving: Managing It All. *Connecting Research to Teaching*, 87:3, 195-199.



What are we doing?

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Disclaimer: *Instructors' values, as inferred from what they talk about when describing the problem-solving process during the interview, are about valuing **metacognition** in students' problem solving, not about how they actually solve problems or what they actually teach*

Fernandez, M.L., Hadaway, N., & Wilson, J.W. (1994). Problem Solving: Managing It All. *Connecting Research to Teaching*, 87:3, 195-199.



What are we doing?

As previously reported*, the study consists of:

- **Interview tool based on instructional artifacts focused around a single problem**
 - **3 Instructor Solutions**
 - **5 Student Solutions**
 - **4 Problem Types**
- **General & Specific Questions**
- **Sample of 30 physics instructors from 4 types of higher education institutions in the state of Minnesota**
 - **Research University (6)**
 - **State University (8)**
 - **Private College (9)**
 - **Community College (7)**

Generate hypotheses to be tested with larger sample!

* AAPT Conference Presentations (Summer 2000 to Winter 2003);
PERC 2001 Proceedings; PERC 2002 Proceedings; Henderson Dissertation (2002)

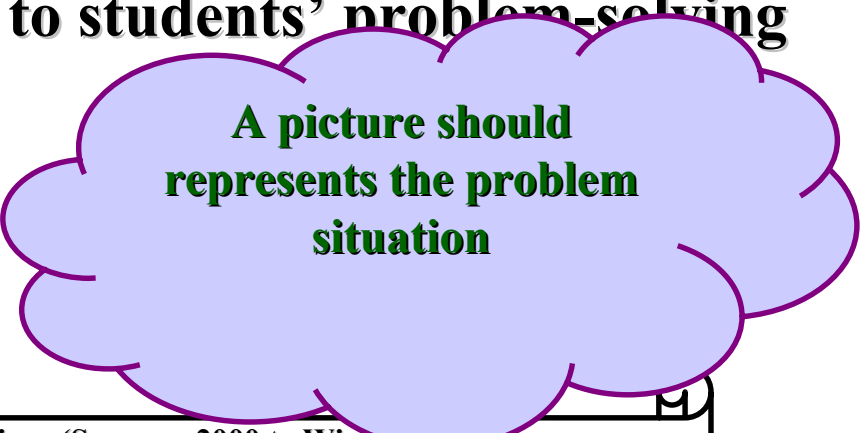


What are we doing?

As previously reported*, the study consists of:

- **A targeted analysis:**

- **Identify** parts of interview where statements about the **problem-solving process** were found in previous study
 - based on results from extensive analysis of interview with research university instructors
- **Code statements relevant to students' problem-solving process into**
 - Mechanical
 - Procedural
 - **Metacognitive**



**A picture should
represent the problem
situation**

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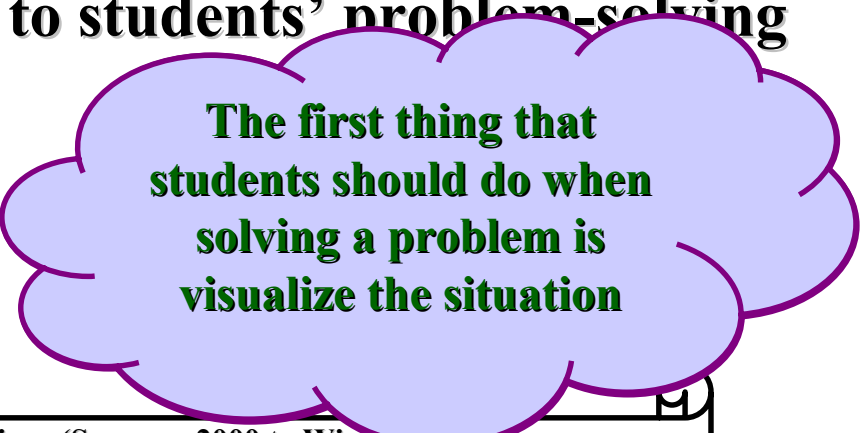
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The first thing that students should do when solving a problem is visualize the situation

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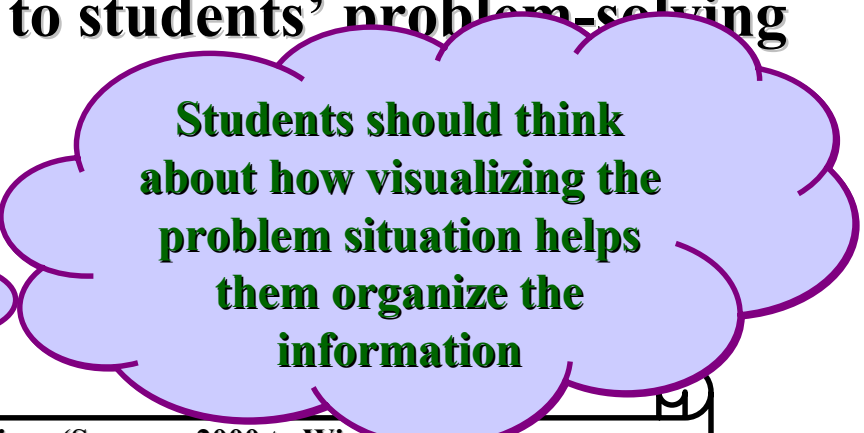
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Students should think about how visualizing the problem situation helps them organize the information

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What are we doing?

Separating **metacognitive** statements into

Planning

Statements related to starting a solution to a problem

Monitoring

Statements related to checking the progress of solution

Evaluating

Statements related to checking the reasonableness of solution



*Here are some things that you **might** think*

1. Instructors from different Institutions **might** value seeing metacognition in students' problem-solving process differently
2. Instructors with different amounts of Teaching Experience **might** value seeing metacognition in students' problem-solving process differently
3. When instructors value metacognition in students' problem-solving, they value **Planning, Monitoring, and Evaluating** equally

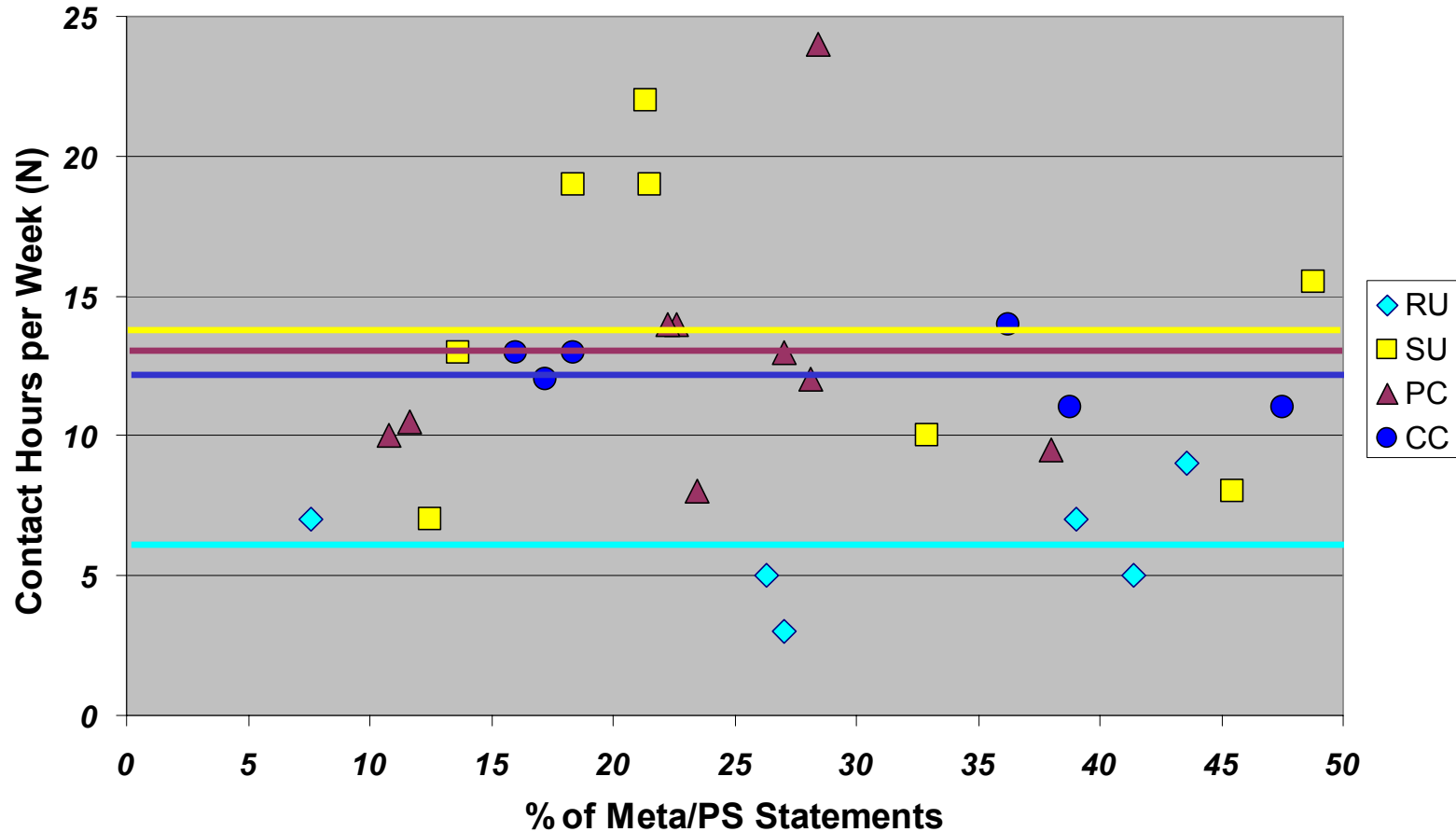
*Then again, you **might** think something else ...*



What have we found?

Contact Hours per Week vs. % of Metacognition/PS Statements

Contact Hours per Week vs. % of Meta/PS Statements



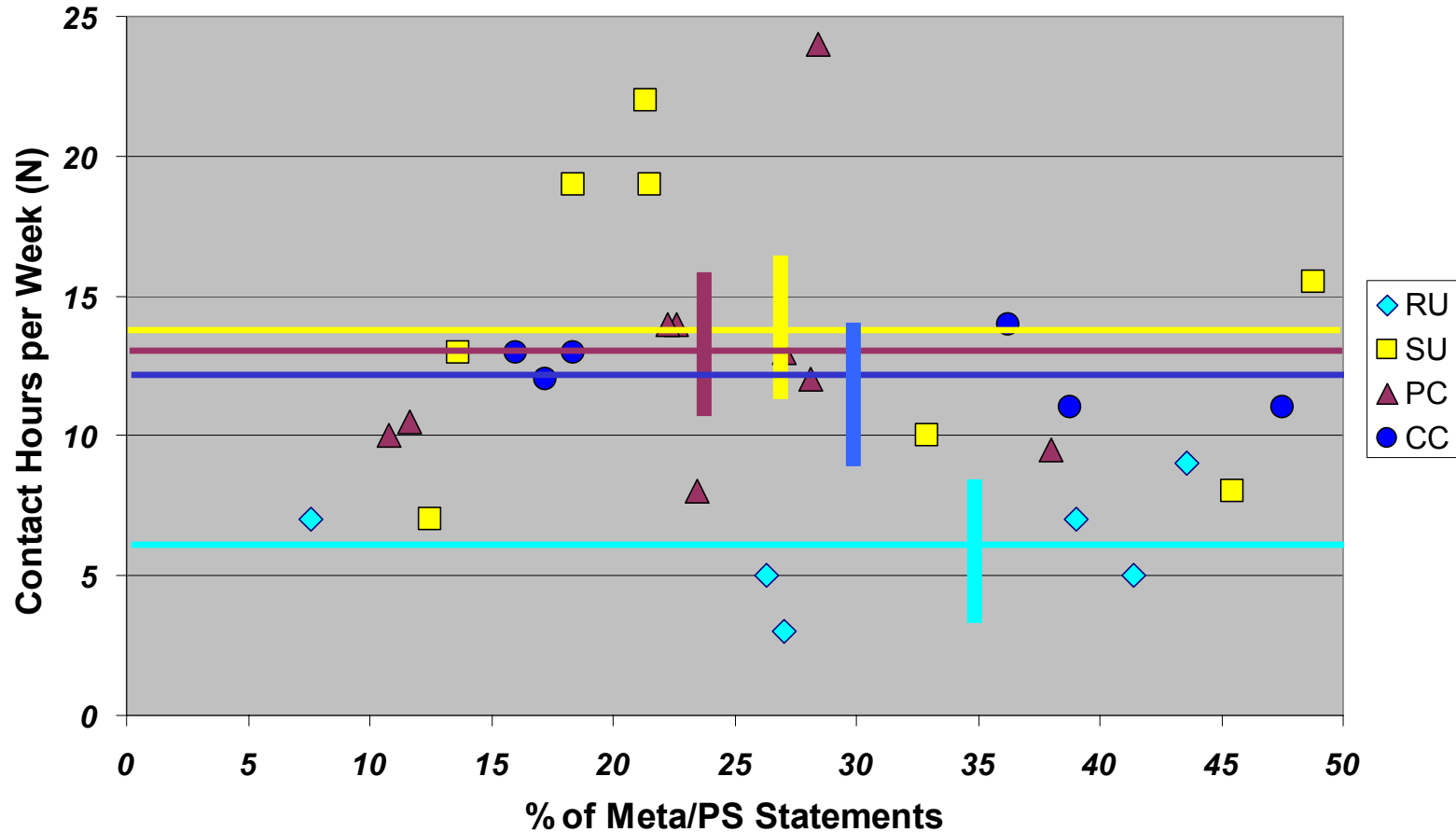
Range of % Meta/PS Statements from ~ 5% to ~ 50%



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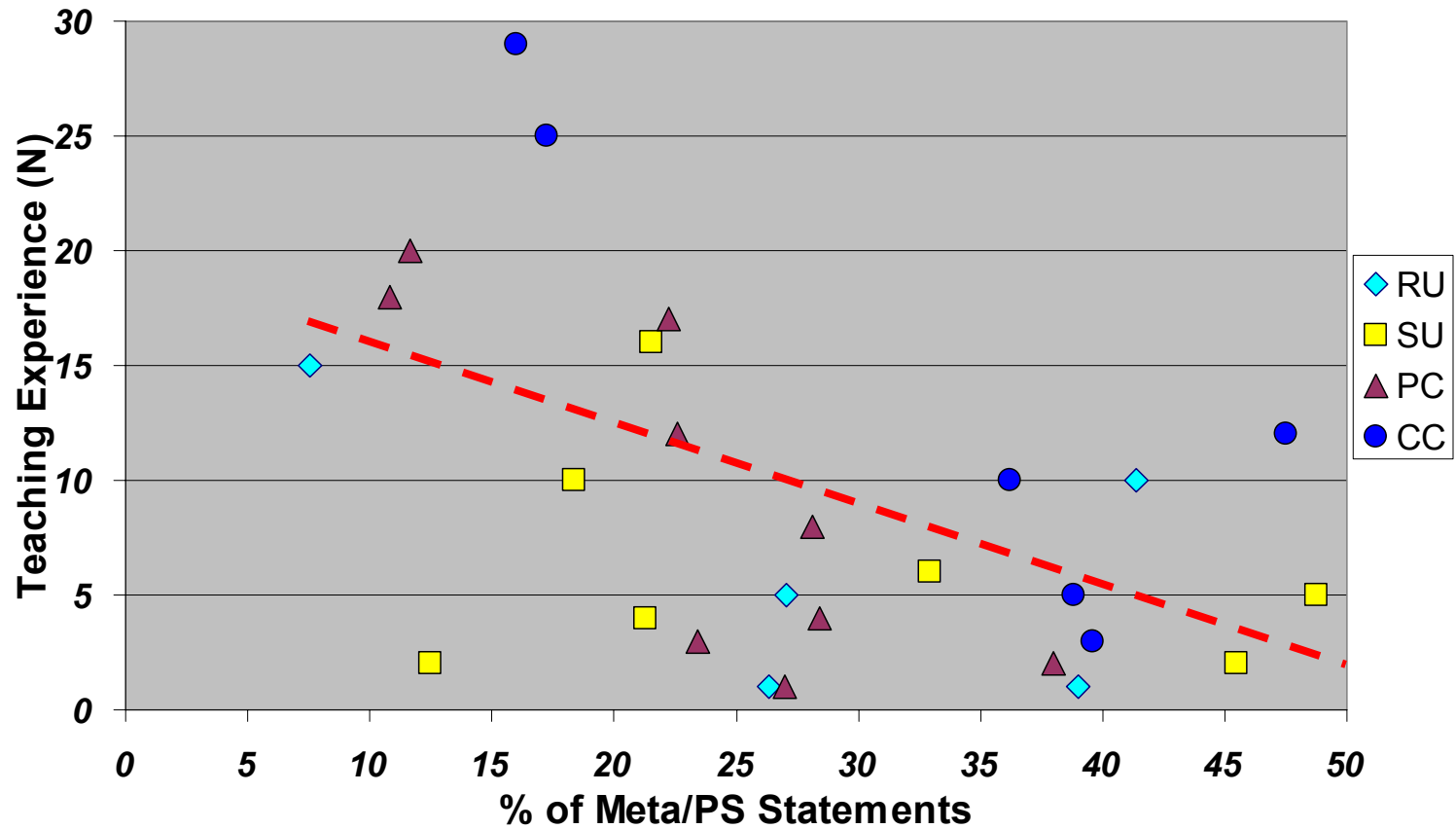
% Meta/PS: RU significantly higher than all others ($p < 0.02$)



What have we found?

Teaching Experience vs. % of Metacognition/PS Statements

Teaching Experience vs. % of Meta/PS Statements



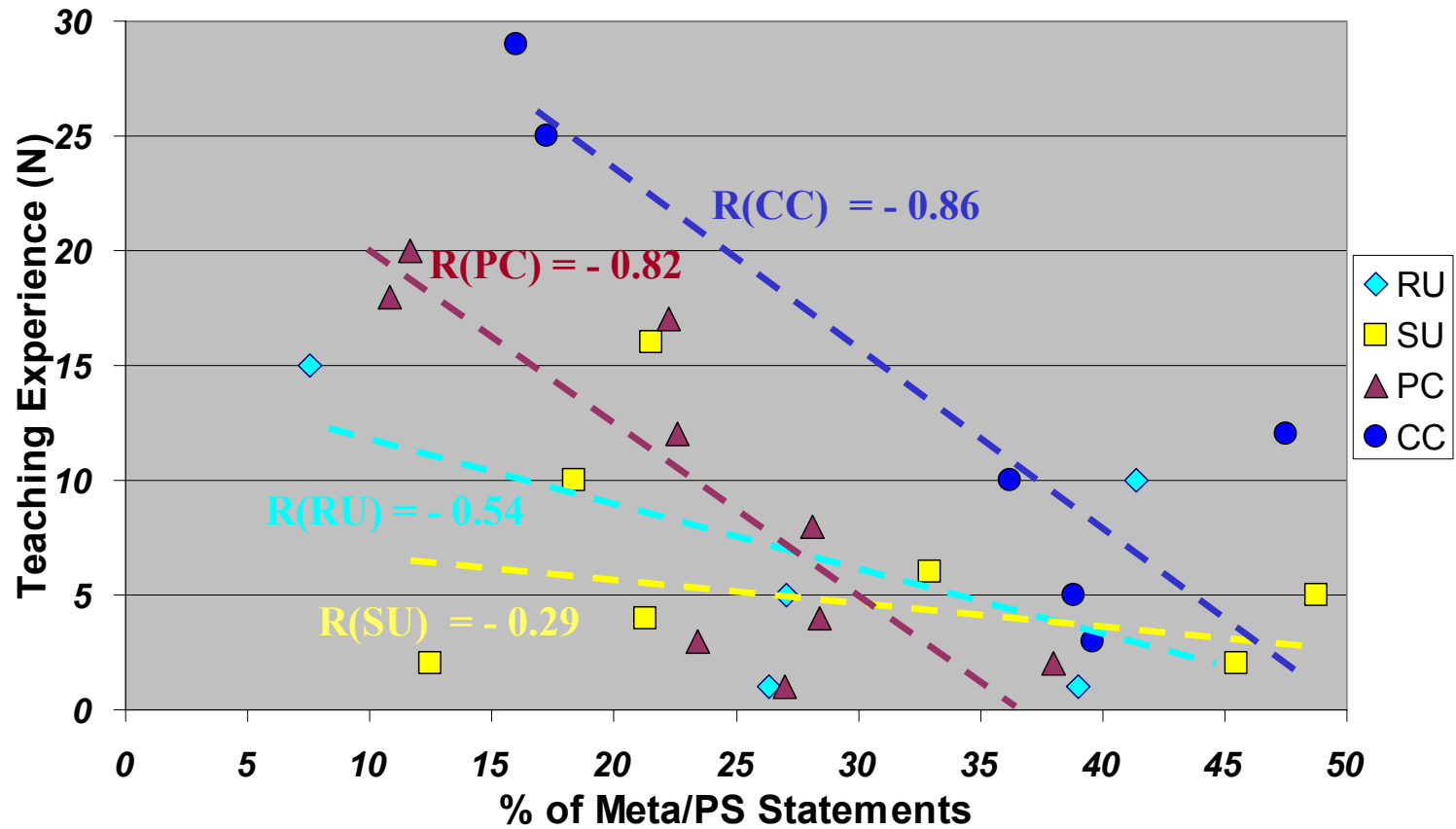
Significant correlation $R = -0.51$ ($p < 0.01$)!



What have we found?

Teaching Experience vs. % of Metacognition/PS Statements

Teaching Experience vs. % of Meta/PS Statements





What have we found?

- Count of *Planning*, *Monitoring*, & *Evaluating* statements
 - Instructors stated significantly more statements about *Planning* than *Monitoring* or *Evaluating*
 - ~ 70% more *Planning* statements than *Monitoring* statements
 - more than twice as much *Planning* statements as *Evaluating* statements



Questions Raised

From this small sample

In students' problem-solving processes:

- 1. Do **RU** instructors value metacognition **more**?*
- 2. Do instructors with **less contact** with students and their work value metacognition **more**?*
- 3. Do instructors with **less teaching experience** value metacognition **more**?*
- 4. Do instructors value **Planning** **more** than **Monitoring** and **Evaluating**?*



Speculations

From this small sample

- Offer a speculation to the questions on **Contact (2)** & **Teaching Experience (3)**
 - *Instructors repeatedly encountered students who cannot solve their problems*
 - *See procedural & mechanical difficulties*
 - *Try to change that by directly addressing those difficulties*
 - *Not as apparent for instructors that teaching **metacognitive** processes addresses those difficulties*



Implications

- Instruction is needed to help students develop their **[metacognitive]** processes while emphasizing the important role that these processes play in problem solving
- **Original hypothesis:** Instructors do not adopt curricular material due to a mismatch between their beliefs and values and the emphasis of the curricular material

**From a curriculum
development standpoint:**

*Problem solving curricular material that
emphasizes **metacognition** may not be
adopted by physics instructors*



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**From a curriculum
development standpoint:**

*So, either that curricular material must
match instructors' values, or that
instructors must be convinced of the value
of emphasizing **metacognition***



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**From a curriculum
development standpoint:**

*In either case, we need to find out more
about instructors' beliefs and values about
the teaching and learning of problem
solving in physics !!*



The End

**Please visit our website for
more information:**

<http://groups.physics.umn.edu/physed/>

Or send Email to:

vkou@physics.umn.edu

