Understanding Instructor Practices and Attitudes Towards the Use of Research-Based Instructional Strategies In Introductory College Physics

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Problem

The last 30 years has seen the development and dissemination of many Research-Based Instructional Strategies (RBIS) for use in introductory college-level STEM courses. Although substantial time and money has gone into developing these RBIS, little effort has gone into understanding whether typical physics instructors use or even know about these products. In this poster we describe the results of a two-phase study of physics faculty knowledge about and use of RBIS in physics.*

*This study focused on college-level quantitative physics. By quantitative physics we are referring to the algebra- or calculus-based introductory physics classes that often go by the names of "college physics" or "university physics."

Phase 1: Web Survey

Research Questions

1. Which RBIS do faculty know about?
2. Which RBIS do faculty use?
3. To what extent are RBIS modified during use?
4. Why don't physics faculty use more RBIS?

Methods

A web-based survey was developed by the authors in consultation with researchers at the American Institute of Physics Statistical Research Center (SRC). Part of the web survey asked faculty to rate their level of knowledge and/or use of 24 specific RBIS.

The survey was administered in Fall 2008 by SRC. Sample included three types of institutions: 1) two year colleges, 2) four year colleges that offer a physics bachelor's degree as the highest physics degree, and 3) four year colleges that offer a graduate degree in physics. SRC staff randomly selected institutions within each of the three types. Once selected, SRC staff asked department chairs to identify faculty who had taught an introductory quantitative course in the last two years and who were full time or permanent employees. The overall response rate was 50.3% resulting in 722 useable responses.

Phase 2: Phone Interviews

Research Questions

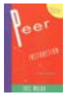
1. How do faculty learn about RBIS?
2. How 'faithfully' do faculty implement RBIS?
3. What do faculty see as the pros and cons of using RBIS?

Methods

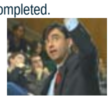
Semi-structured interviews with a subset of 70 web survey respondents. Interviews focused on RBIS: Peer Instruction and Workshop Physics. 72% of faculty contacted participated in the interview study.

Peer Instruction

- Most known and most used of the RBIS.
- Relatively easy to incorporate into 'traditional' course.



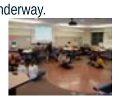
- Interviews with:
  - Users (N=15)
  - Former Users (N=6)
  - Knowledgeable Nonusers (N=14)
- Preliminary analysis completed.



Workshop Physics

- Well-known, but less well used.
- Requires substantial changes from 'traditional instruction'.

- Interviews with:
  - Users (N=9)
  - Former Users (N=10)
  - Knowledgeable Nonusers (N=16)
- Preliminary analysis underway.



Phase 1 Results: Knowledge and Use

- 87.3% of faculty report that they know about 1 or more RBIS.
- 50.3% know about six or more.
- 48.1% of faculty say that they use 1 or more RBIS

RBIS	Faculty with Knowledge	Faculty Who Use
Peer Instruction	63.5%	29.2%
Physlets	56.3	13.0
Cooperative Group Problem Solving	49.3	13.7
Workshop Physics	48.2	6.7
Just in Time Teaching	47.7	8.4
Tutorials in Introductory Physics	47.0	7.9
Interactive Lecture Demonstrations	45.4	13.9
Activity Based Problem Tutorials	43.0	6.0
Ranking Tasks	38.7	15.4
SCALE-UP	34.5	3.3
Active Learning Problem Sheets	34.3	5.9
Modeling	32.7	3.2
Real Time Physics Labs	32.4	7.3
Context Rich Problems	30.4	8.3
Overview Case Study Physics	24.7	1.7
Open Source Physics	21.8	1.9
Investigative Science Learning Environment	21.1	1.6
TIPERS: Tasks Inspired by Physics Education Research	20.9	6.6
Open Source Tutorials	20.8	1.7
Video Lab	18.8	3.1
Workbook for Introductory Physics	18.5	0.9
Experiment Problems	17.3	4.0
Socratic Dialog Inducing Labs	16.3	1.9
Thinking Problems	15.1	1.1

TABLE 2: Ranking of the 24 RBIS according to level of Knowledge (percentage of faculty who indicate that they are current users, former users, or knowledgeable nonusers of the RBIS). Also shown is percentage of faculty who indicate that they currently use each RBIS.

Phase 1 Results: Modifications

- RBIS are not typically used as recommended by the developer.
- Faculty do not always realize the extent of modification they have made.

Faculty Self-Reported Modifications

	PI (N=195)	RT (N=99)	CGPS (N=96)	RTPL (N=47)
I used it basically as described by the developer.	16.9%	33.3%	8.3%	25.5%
I made some relatively minor modifications	35.9	38.4	16.7	53.2
I used some of the ideas, but made significant modifications	41.0	21.2	47.9	21.3
I am not familiar enough with the developer's description to answer this question	6.2	7.1	27.1	0.0
All Users	100	100	100	100

TABLE 3: Extent of modification identified by self-reported users of all or part of each of four RBIS: Peer Instruction (PI), Ranking Tasks (RT), Cooperative Group Problem Solving (CGPS), and Real Time Physics Labs (RTPL).

Self-Reported Use of Peer Instruction

- Only 6.2% of faculty use five components of Peer Instruction. Results from Cooperative Group Problem Solving are similarly small (1.0%).

	Components of Peer Instruction: Traditional Lecture (for nearly Every Class or multiple times every class)	Students discuss ideas in small groups (multiple times every class)	Students solve/discuss qualitative/conceptual problem (multiple times every class)	Whole class voting (multiple times every class)	Conceptual questions (used on all tests)	Uses all 5 components	Uses 4 of the 5 components	Uses 3 of the 5 components
Peer Instruction Users	54.9%	27.2%	26.7%	37.9%	63.6%	6.2%	14.9%	13.8%

TABLE 4: Instructor use of developer-recommended aspects of Peer Instruction. Table represents all self-described users of Peer Instruction.

Why do faculty not use more research-based practices?

- 70% of faculty report being interested in using more research based strategies.
- 92% report that their department is either very encouraging or somewhat encouraging about efforts to improve instruction.
- Faculty report goals generally consistent with research-based strategies.

For the 70% of respondents who said they were interested in using more research-based strategies they were asked "What prevents you from using more of these strategies?"

TIME	**52.7%**
Time to learn about and implement changes	28.6
Time (not elaborated)	24.1
LACK OF KNOWLEDGE ABOUT/ ACCESS to RBIS	**25.5%**
Lack of familiarity with many RBIS	22.4
Lack of access to RBIS	3.1
WEAKNESSES OF RBIS	**19.8%**
Difficult to cover material (uses too much class time)	8.0
Not convinced of benefit	6.6
Requires too much instructor time to use	2.4
Student resistance (real or perceived)	2.1
Lack of ready-to-use materials	0.7
LACK OF FIT WITH DEPARTMENT OR INSTITUTION	**16.9%**
Cost to implement (e.g., lab equipment, additional staff)	4.0
Need to coordinate changes with colleagues	3.8
Lack of appropriate classroom space/class scheduling	3.7
Cost (not elaborated)	2.6
Colleagues would not approve	2.1
Cost for students (e.g., books, clickers)	0.7
LACK OF MOTIVATION TO ADOPT RBIS (other than TIME)	**9.2%**
I don't follow one method, but adapt pieces of many to fit my teaching style.	6.1
Nothing	1.9
Inertia	1.2
UNCLEAR	**4.7%**
Unclear response	4.7

TABLE 5: Reasons given for not using more research-based strategies. (coded qualitative data)

Conclusions

- Dissemination efforts have impacted the knowledge and practice of many faculty.
  - Most faculty know that RBIS exist and appear to value them.
  - Use lags significantly behind knowledge.
  - Most faculty are interested in using more RBIS in their teaching and cite 'time' as the biggest barrier.
- Faculty do not learn about RBIS through reading. They read after they become interested.
- RBIS are typically not used as recommended by the developer. Faculty do not always realize the extent of modification they have made.
- Self-described user status is not an accurate measure of RBIS features used.
- To encourage adoption along with productive modifications, change agents may need to provide substantial support and guidance during the implementation and customization process.

Phase 2 Results: How do Faculty Learn About RBIS?

- Faculty are first exposed to RBIS through discussions with colleagues or a formal talk/workshop, NOT through reading.

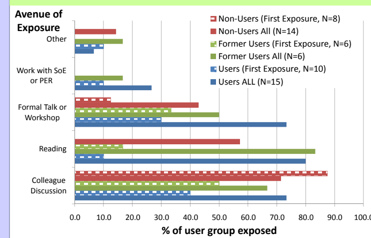


FIGURE 1: Avenues of exposure to Peer Instruction. Note that not all interviewees were able to recall their first exposure.

Phase 2: Fidelity of Implementations

- Self-described users only use (on average) 66% of RBIS features.

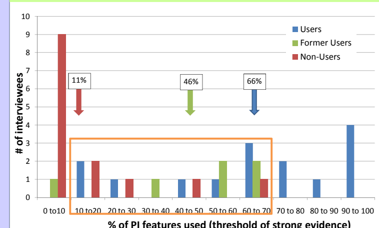


FIGURE 2: Percentage of 9 Peer Instruction features used by self-described users, former users, and knowledgeable non-users.

Features of Peer Instruction

Adapts: Instructor adapts to student responses to in-class tasks
Answers not graded: Students are not graded on in-class tasks
Commit to answer: Individual students have a dedicated time to think about in-class tasks and commit to answers independently
Conceptual questions: Uses conceptual in-class tasks
Tasks draw on student ideas: In-class tasks draw on common student prior ideas or common student difficulties
Multiple choice questions: In-class tasks have discrete answer options
Questions interspersed: In-class tasks are interspersed throughout class period
Students discuss: Students discuss their ideas about in-class tasks with their peers
Vote after discussion: Students commit to an answer after peer discussion

TABLE 6: Nine Features of Peer Instruction. Developed in consultation with Eric Mazur.

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Journal Publications

- Henderson, C. & Dancy, M. (2009) The Impact of Physics Education Research on the Teaching of Introductory Quantitative Physics in the United States, *Physical Review Special Topics: Physics Education Research,* 5 (2), 020107.
- Dancy, M. & Henderson, C. (2010) Pedagogical Practices and Instructional Change of Physics Faculty, *American Journal of Physics, Physics*, 78 (10), 1056-1063.
- Henderson, C., Dancy, M., & Niewiadomska-Bugaj, M. (submitted) The relationship between Instructor and Situational Characteristics and the Use of Research-Based Instructional Strategies in Introductory Physics, Submitted June 2010.

See the web sites listed above for these articles, as well as other publications and presentations related to this project.