Faculty Perspectives On Using Peer Instruction: A National Study

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Abstract. We previously reported on the results of a national web survey of physics faculty about their instructional practices in introductory physics. A subset of 72 survey respondents were interviewed to better characterize how faculty interact with research-based instructional strategies (RBIS), use RBIS, and perceive their institutional contexts. Drawing from 15 interviews with self-reported users of Peer Instruction, we describe what faculty mean when they identify themselves as users of Peer Instruction. Meanings range from professors adopting the general philosophy of the instructional strategy (or what they believe to be the general philosophy) while inventing how it concretely applies in their classrooms to professors who use the instructional strategy as is, without significant modification. We describe common modifications that are made to Peer Instruction and the associated prevalence of these modifications.

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INTRODUCTION

Since the Sputnik era, NSF and other funding agencies have supported the development of many research-based science curricula [1]. However, the success of these curricula and related materials is highly variable [2]. We do not clearly understand how materials and practices travel between classroom settings. In order for research-based science curricula to support widespread educational change, the process by which curricula are implemented in specific, complex educational settings must be better understood.

Early pilot work identified divergent expectations between physics faculty and educational researchers: the typical dissemination model of educational researchers is to disseminate curricular innovations and have faculty adopt them with minimal changes, while faculty expect researchers to work with them to incorporate research-based knowledge and materials into their unique instructional situations [3]. We seek to better understand how physics faculty come to know about and use research-based instructional strategies (RBIS) in order to better inform change efforts. Towards this end, this paper addresses the following research questions: 1) What features of RBIS do faculty, who describe themselves as users of the RBIS, report using? 2) What modifications do faculty commonly make to RBIS? As part of a larger study, we focus here on self-described users of Peer Instruction (PI) [4] and characterize their reported instructional practices in introductory physics.

METHODS

In the Fall of 2008, a sample of physics faculty from across the country were asked to complete a survey about their instructional goals and practices as well as their knowledge and use of RBIS (see Ref. 5 for more details). The survey focused on teaching practices in introductory quantitative physics (calculus- or algebra-based). Three types of institutions participated in this study: two-year colleges (T), four-year colleges that offer a physics bachelor's degree as the highest physics degree (B) and four-year colleges that offer a graduate degree in physics (G). The overall response rate for the survey study was 50.3%. A subset of survey respondents was purposefully chosen to participate in an associated interview study.

We chose to interview faculty about two specific RBIS: Peer Instruction (PI) [4], a modification that is compatible with many aspects of traditional instruction, and Workshop Physics (WP) [6], a method that requires abandonment of most aspects of traditional instruction. Across institution types, we interviewed faculty from each of three user categories:

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TABLE 1. Definitions of PI Features

Definitions of PI Features
Adapts: Typically adapts how class proceeds based on students' responses to PI activities.
Answer not graded: Typically does NOT grade students' responses to in-class PI questions.
Commit to answer: Typically gives students a dedicated time to think independently about the question and has students commit to an answer based on their individual thinking.
Conceptual questions: Typically uses conceptual questions in-class.
Conceptual exams: Typically uses some conceptual questions on exams.
In-class tasks draw on student ideas: Typically has in-class PI tasks draw on common student prior ideas or difficulties.
Out-of-class assignments: Moves some student work to out-of-class time (e.g., student reading textbook, students study example problem solutions), which allows the instructor to have more flexibility in using class time.
PI tasks multiple-choice: Typically uses in-class PI tasks which have discrete answer options such as multiple-choice, Yes/No, or True/False (rather than open-ended problems or short-answer questions).
Questions interspersed: Typically intersperses PI questions throughout the lecture (rather than cordoned off at the beginning or end of class as a separate activity from the "regular" lecture).
Students discuss: Typically has students discuss their ideas with their peer concerning questions posed in class.
Vote after discussion: Typically students commit to an answer after discussing the question with their peers.
Walks around classroom: Typically walks around the classroom during PI activities (possibly talking with students or just listening to student conversations).

User, Former User, and Knowledgeable Non-user (~36 interviews for each instructional strategy).

During the semi-structured interview, PI users were asked to describe their instructional practices in introductory quantitative physics, their implementation of various features of PI, how and why they began to use PI, and their departmental context. Each researcher was randomly assigned to conduct specific interviews. Interviews typically lasted over one hour and were audio-recorded and subsequently transcribed.

Of the 51 faculty initially contacted for interviews about PI, 69% (N=35) agreed to participate in the interview study (the remaining 31% either declined to participate or did not respond to repeated inquiries). Within the 35 interviews conducted concerning PI, 15 interviews were conducted with professors who self-described as PI users. Analyses of these 15 interviews with PI users are presented here. All interviews will be analyzed and comparisons made across self-described user categorizations in future work.

Prior to designing our interview protocol and conducting interviews, a preliminary list of PI features was constructed [7]. The interviews were analyzed using emergent coding with the assistance of qualitative analysis software (Atlas.ti). After the researchers analyzed four initial interviews collaboratively, a fairly stable coding scheme was developed. The coding scheme was refined, with definitions becoming more fully explicated, through analysis of additional interviews. Refined definitions of each PI feature are given in Table 1. During our qualitative coding of each interview, evidence of the presence or absence of each feature was captured. Each interview was coded by two researchers.

DATA AND RESULTS

Characterizing PI Users' Reported Implementation of PI

For each PI feature, the researcher reviewed the related coded quotations and assessed if the feature was present (Y), if a small change was made to the PI feature (m), or if a large change (or deletion) was made to the PI feature (M). We consider small changes to, large changes to, or the deletion of a PI feature to represent modifications made to PI. The results from this analysis are presented in Table 2. If the feature was not explicitly discussed in the interview or if insufficient evidence was available, no characterization was made; the corresponding cells in Table 2 are shaded. Two researchers independently assessed the interviewee's PI implementation, then discussed, and came to consensus.

From these characterizations, we see that five participants (33%) modified between 0-1 feature of PI, seven participants (47%) modified between 2-3 features of PI, and three participants (20%) modified 6-7 features of PI. On average, participants modified approximately 30% of features that we characterized. The two features that were most likely to be modified by faculty are *PI tasks multiple-choice* (8/15 modified) and *Vote after discussion* (7/14 modified). For the two most commonly changed features, we briefly describe how each feature was modified.

TABLE 2. Characterization of each participant's self-reported PI implementation. Columns show interviewees by institution type. Each PI feature is characterized as present (Y), small modification made to PI feature (m), or large modification (or deletion) made to PI feature (M). Shaded cells indicate that insufficient evidence was available to characterize.

PI Feature	T1	T2	T3	T4	T5	T6	B1	B2	B3	B4	B5	G1	G3	G4	G5
Adapts	Y	m	Y	Y	Y	Y	Y	Y	▨	Y	Y	m	m	▨	▨
Answer not graded	Y	Y	▨	Y	Y	▨	Y	▨	Y	Y	Y	▨	Y	▨	▨
Commit to answer	Y	m	Y	Y	Y	Y	Y	M	m	Y	Y	Y	M	Y	M
Conceptual questions	Y	m	Y	Y	Y	m	Y	Y	Y	Y	Y	Y	Y	Y	m
Conceptual exams	M	▨	▨	m	Y	Y	Y	Y	Y	Y	m	Y	m	Y	▨
In-class tasks draw on student ideas	m	▨	▨	Y	Y	m	m	Y	Y	Y	Y	Y	Y	▨	m
Out-of-class assignments	▨	▨	▨	▨	▨	▨	Y	Y	m	▨	Y	▨	M	▨	m
PI tasks multiple choice	m	m	Y	m	Y	Y	Y	m	m	Y	Y	Y	M	m	M
Questions interspersed	Y	m	Y	▨	Y	Y	Y	Y	Y	Y	Y	▨	Y	M	m
Students discuss	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	M	m	Y	Y
Vote after discussion	Y	m	Y	m	Y	Y	Y	m	▨	Y	Y	m	m	M	M
Walks around classroom	Y	▨	Y	Y	m	▨	Y	Y	▨	m	Y	▨	▨	Y	Y
% modified by person	27	75	0	30	9	22	8	27	33	9	8	38	64	38	78
Fraction modified by person	$\frac{3}{11}$	$\frac{6}{8}$	$\frac{0}{8}$	$\frac{3}{10}$	$\frac{1}{11}$	$\frac{2}{9}$	$\frac{1}{12}$	$\frac{3}{11}$	$\frac{3}{9}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{3}{8}$	$\frac{7}{11}$	$\frac{3}{8}$	$\frac{7}{9}$

Eight physics faculty decided to modify the use of multiple-choice questions during PI. Some physics faculty considered their use of in-class "worksheet activities" or Ranking Tasks [8] to be Peer Instruction (N=5). Some faculty designed their own worksheets from scratch, others used published materials, and some began with published materials and proceeded to change them. A subset of physics faculty choose to design their own open-ended problems, questions, or discussion topics for students to work on (N=5) such as "discuss how conservation of angular momentum would apply to a spinning top" (L28, T2).

Seven faculty decided to modify having students vote or commit to an answer after peer discussion. Faculty who modified this feature chose not to poll the entire class about the question posed, but rather to ask the class informally what they thought either through a whole-class discussion or through walking around the room and trying to assess students' level of understanding group by group. This modification was particularly common amongst faculty that did not give students multiple-choice questions to work on.

Reported difficulties with PI implementation & resultant modifications

In discussions with physics faculty about their use of PI, faculty commonly expressed four concerns: encountering student resistance to PI, finding "good" PI questions, combining PI with other RBIS, and reducing content coverage. Due to limited space, we only discuss two here.

Student resistance to PI

"It is really interesting how sometimes getting them to talk to each other is like pulling teeth. Somehow they seem like they're brought up in that they're not allowed to talk in class" (L80, T3). Most (11/15) faculty mentioned having problems with student resistance towards, dislike of, or complaints about PI. These professors discussed the difficulty of changing students' expectations about in-class activities. Some of these professors (10/15) had developed strategies for dealing with this problem which addressed, although did not always eliminate the problem. These strategies include 1) Milling around the room listening to and engaging students (N=5), 2) Telling students why they were doing PI (N=4), and 3) Joking with students (N=2). Other strategies, which were only mentioned by a single faculty member, include starting the semester with easier questions to build students' confidence, encouraging students to correct each other, explicitly intervening in the organization of groups early in the term, changing from flashcards to clickers, and using contemporary physics examples from daily life.

It is interesting to note that student resistance was a common implementation barrier and that faculty worked hard, and often creatively, to address it. However, they did so with little guidance from the educational research community. Although research on resistance to change is common in the business management literature [9], it has not been systematically studied in higher education. Additional research in this area could generate strategies to assist faculty in changing their students' expectations in class. This is an area where researchers and disseminators could better support faculty's implementation of RBIS.

Finding 'good' PI questions

"It's way easier to just pull the quantitative problem out of the book than to come up with a conceptual question that's really the one that kind of digs down to the heart of what they don't understand" (L247, B2). The vast majority of faculty (14/15) clearly described using questions beyond those published by Mazur. Twelve faculty described drawing from one or more sources other than Mazur for PI questions, such as textbooks (N=8), other RBIS (N=8), other colleagues (N=3), other materials—vague (N=3), the Physics Teacher magazine (N=1), and Force Concept Inventory questions (N=1). Twelve faculty described writing some of PI activities themselves. Eight of the fifteen faculty described encountering difficulty in finding or writing "good" PI questions.

Due to the diversity of sources for PI questions, additional research is needed to more clearly understand the degree to which the faculty's PI questions are conceptually-oriented and have answer options that represent common student ideas. Faculty's inclinations to write their own questions suggest that disseminators may want to explicitly scaffold faculty in learning how to write 'good' PI questions.

DISCUSSION & CONCLUSIONS

In the context of PI, we have found that physics professors often modify the curricula they adopt. We will be interested to compare the number and extent of modifications that Workshop Physics users make during implementation. Additional work to characterize broader classroom implementation of RBIS based on classroom observations would be highly valuable. We do not judge the merits of the modifications made, as there is currently no evidence upon which to judge the efficacy of these modifications. However, we do suggest that curriculum developers, who propose certain instructional strategies, should investigate and test the effectiveness of common alterations such as the ones reported here for PI. Pending results of the efficacy of common alterations, one could imagine an approach to dissemination which offers several different examples of successful RBIS use rather than just one.

We also note that faculty who self-ascribe as users of PI mean a wide range of things. Some faculty describe using most or all of the PI features, while others are using less than half of the PI features. It is important for researchers to be aware of this ambiguity and the broader range of interpretations that faculty may have when reporting to use a RBIS.

This research study also found that many PI users describe encountering difficulties in implementing PI and at times devising their own solutions to these difficulties. We can potentially learn from the solutions that PI users have designed. As we proceed with our analysis, it will be interesting to see if PI former users encountered similar difficulties and whether they were as successful at coming up with strategies to address these difficulties. Comparing PI former users and PI users may provide concrete ideas for supporting faculty's early use of RBIS and encouraging continued use of the RBIS.

By adding to our knowledge about the modifications made to RBIS and problems encountered during implementation, we hope this and similar studies inform future change efforts.

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