The Dissemination and Effective Use of Physics Education Research in Undergraduate Instruction

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THE DISSEMINATION AND EFFECTIVE USE OF PHYSICS EDUCATION RESEARCH IN UNDERGRADUATE INSTRUCTION

by

Trevor Stefanick

A Thesis
Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Master of Arts Department of Physics Advisor: Charles Henderson, Ph.D.

Western Michigan University Kalamazoo, Michigan August 2012
WE HEREBY APPROVE THE THESIS SUBMITTED BY

Trevor Stefanick

ENTITLED The Dissemination and Effective Use of Physics Education Research in Undergraduate Education

AS PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF Master of Arts

Physics (Department)

Physics (Program)

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August 2012

Dean of The Graduate College
Based on the results of a national survey of physics faculty, a set of interviews was conducted of 70 physics faculty from a diverse set of institutions. The interviews included questions about the dissemination and effective use of curricula and instructional strategies based on Physics Education Research (PER), focused to obtain recommendations to the PER community that might help to spread the use of these PER-based materials. Approximately half of the interviews (those with faculty who indicated knowledge about or use of Peer Instruction) have been previously analyzed. This project is the analysis of the 38 interviews that were conducted with faculty who indicated knowledge about or use of Workshop Physics, using the coding scheme and procedures from the analysis of the Peer Instruction interviews. A new set of interviews was conducted with 23 Higher Education administrators whose purview includes physics departments. These interviews are designed to address issues raised in the faculty interviews and the assessment of faculty teaching effectiveness. The interviews with the administrators are then analyzed to allow for comparison between faculty and administrator recommendations for PER and assessment of teaching effectiveness. Finally, five recommendations are collected from the comparison of the two interview sets.
ACKNOWLEDGMENTS

I would like to thank my wife, Nancy, for helping me so much, not just in terms of watching our son, but also as being a sounding board and constant source of encouragement. I would also like to thank Dr. Charles Henderson for all his guidance and aid throughout this process.

Trevor Stefanick
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CHAPTER 1
THE PROBLEMS FACING PHYSICS INSTRUCTION

Physics can be both extremely difficult and extremely rewarding to a college undergraduate, whether as a primary field of study or an educational requirement for another field of study. Since physics classes often possess this dichotomy of difficulty and reward, methods of improving instruction to reduce difficulty and increase understanding are desirable for the success of the instructor and the student. One goal of Physics Education Research (PER) is to develop and research the effectiveness of non-traditional methods of physics instruction as well as develop methods for instructors to measure the academic gain of their students. PER, as a formal discipline, dates back 20+ years (McDermott, 1999), yet research-based instructional strategies developed by PER have not proliferated across higher education. In fact, as suggested by Henderson and Dancy (2008, p. 79) using evidence from other empirical studies, opinions of committees from the National Science Foundation and National Research Council, among others, and opinions of PER practitioners, “most physics instructors continue to use traditional teaching practices and that dissemination of reforms is an important unsolved problem.” Indeed, as shown later in this thesis, most institutional assessment of instructor’s teaching effectiveness does not support innovation or scholarly
work in improving teaching effectiveness, and may even impede the use of research-based teaching methods. If faculty are not evaluated, incentivized, and rewarded to improve teaching practices, how can any improvement or change be expected?

This thesis aims to contribute to the resolution of these problems of use and dissemination by pulling together some important strings of the problem. This thesis is really two related studies of the overarching problem of the spread of research-based instruction strategies and the assessment of faculty; one of faculty viewpoints and suggestions, the other of administrator viewpoints and suggestions. By bringing “in the trenches” faculty viewpoints and suggestions together with viewpoints and suggestions from administrators “at the top,” a more robust picture can be developed of the problems with the implementation of PER, as well as suggestions for improving that implementation and dissemination.

Chapter 2 begins by briefly defining research-based instruction and why it is important to improving educational practices. It then focuses specifically on Physics Education Research and describes a few PER instructional practices and their effectiveness. Chapter 3 describes Study 1. This includes a discussion of the methodology of interviews that were conducted by Turpen et al. (2011) with higher education faculty about how they and their institutions evaluate their teaching effectiveness. Included in those interviews were questions about the field of PER and how the instructors viewed that field.
The interviews were analyzed regarding that PER information; half by Turpen et al. (2011) and the other half as part of this thesis. Chapter 4 describes Study 2. This includes a description of how, based on the results of the faculty interviews, another set of interview questions was created specifically for higher education administrators regarding their views on PER, other alternatives to traditional instruction, and faculty assessment processes. This new set of interview questions was posed to higher education administrators; the interviews transcribed, analyzed and coded using the same schema from the faculty interviews. Chapter 5 brings together the results from the two sets of interviews and proposes a succinct set of suggestions for the PER community and educational research community at large.
Overview

In this Chapter, the major problem addressed by this thesis is described. Despite research showing that traditional lecture instruction is not very effective, and that many research-based alternatives to traditional lecture instruction exist, most faculty still use lecture as their primary instructional tool. Physics Education Research (PER) is a field of study in which one goal is to create and research instructional strategies and tools to improve teaching effectiveness. However, many of these products are not in wide use (Weiman & Perkins 2005). Possible reasons for this lack of use include a lack of instructor time and resources to become properly versed in a strategy, an academic culture that perpetuates traditional lecture-based instructional methods, and a lack of incentives or encouragement to pursue instructional improvement (Penn 2011).

Although proven alternatives exist, most physics faculty teach traditionally

The choice of instructional methods in higher education has been traditionally made by the instructor, with little input from colleagues or administration. The subject matter expertise possessed by the instructor is presumed to be sufficient to support successful teaching of the material. In spite of the
tremendous amounts of research available about non-traditional instructional methods and a wide variety of instructional methods to choose from, numerous studies have shown that "traditional science instruction is used in the overwhelming majority of college physics courses," (Weiman & Perkins 2005, p. 36) and that most higher education instructors only expose their students to "facts and concepts at the lowest cognitive levels" (Gardiner 1994, p. 6) Additionally, most instructors use lecture as their primary instructional modality, though research has shown that retention of information from lectures is low, there are low attendance rates for lectures, and there are many more effective modalities besides lecture as an instructional method (Gardiner 1994). Often faculty, who typically receive little or no training in teaching methods, teach the way they were taught (Penn 2011). Since lecture has been the traditional method of instruction for hundreds of years, it should be no surprise that many instructors rely on lecture as their main instructional method. However, there exist many other instructional strategies that have shown much better results (Boller, 1999). Many of these other instructional modalities and strategies have been developed and tested using educational research methods.

Education in the modern world is often pushed in many different, and sometimes opposing, directions. In the light of rapidly rising tuition budgets and decreased availability of state and federal funds for higher education, there are growing pressures on higher education to demonstrate its value to
individuals and to society. These pressures continue to build, in spite of higher education proposing and implementing many fixes, such as online education and accrediting bodies. There are higher education faculty who desire to use more effective teaching practices, but as Penn (p. 10, 2011) puts it, "current structures and processes in our institutions are the result of decades of tradition from which we must struggle mightily for liberation." In other words, while there are pressures to change and adapt institutions of higher education, and even the internal will to do so, deeply rooted traditions within these institutions hold back most efforts at change.

*Instructional strategies based on Physics Education Research*

Physics Education Research (PER) is a relatively new field of scholarly research dedicated to better understanding the teaching and learning of physics. One important activity of PER is to develop, test, and disseminate research-based instruction geared specifically towards the subject of physics.

One may ask, "Why does physics require a field of educational research all to itself?" Physics is a valuable subject for cognitive development, and solving physics problems develops critical thinking and problem solving skills (Marxen, 1995), both of which are traits American higher education struggles to develop in students and American business cites as lacking in today's workforce. Young children exhibit curiosity and experimentation throughout their cognitive development, yet
that curiosity and experimentation tends to disappear by high school, when rigorous physics instruction begins (Seymour 2001). So it falls to higher educators to inform students’ physics conceptual and mathematical knowledge and engender problem solving skills and critical thinking (Hake 2000). Additionally, current physics instruction is not effectively teaching the connections between physics concepts and the mathematics used (Ambrose, 2009). Much PER proposes favoring a more active approach than traditional instruction. In Hake’s (1998) survey of six thousand mechanics students, he used three PER-developed assessment instruments to assess interactive engagement physics classrooms versus traditional classrooms. That survey showed that the interactive engagement classrooms showed significantly more gain in conceptual understanding than the traditional classrooms.

PER develops instructional strategies specifically for physics, in hope of improving on the lackluster outcomes of traditional instruction as described in the previous paragraph. A basic example of a question answered by PER is whether the instruction of problem-solving strategies at the beginning of the course can be helpful. Sezgin (2009) carried out research on this very question by using a research group of student teachers instructed in three problem-solving strategies (questioning, summarizing and graphic organizers) and a control group not taught these strategies. Sezgin et al. measured the effects of these strategies on students’ academic progress using the Physics
Course Achievement Test (PCAT), the students’ affect towards physics using the Scale of Attitude towards Physics (SAP), and the students’ motivation using the Achievement Motivation Scale (AMS). It is worth noting that all three of these tests have been developed using research practices; one for general education (AMS) and two (PCAT and SAP) exclusively by the PER community to capture more data for the development of PER. What they saw were improved gains on all three tests for the research group over the control group. Not only did the research group perform better academically, but this intervention also reduced anxiety, improved attitudes towards the subject of physics, and increased motivation for learning the subject. This study is a basic example of PER using a very basic instructional change, and shows the usefulness and effectiveness not only of the instructional change, but also of PER as a field.

Other examples of the products produced by PER that are designed to improve education are research-based evaluations of student learning such as the Force Concept Inventory (FCI), the Quantum Mechanics Conceptual Survey (QMCS), Peer Instruction, and Workshop Physics. The FCI and QMCS are survey tests of specific subjects developed to be given to students before a class is taken, and after that same class is ended. In this way, the tests can be used to determine learning gains made by students. The FCI is designed to survey students taking a classical mechanics course. These courses typically cover Newtonian mechanics (kinematics and dynamics), basic properties of matter
(atomic theory, phases and phase change), thermodynamics, and properties of sound; while the FCI primarily deals with Newtonian mechanics. The QMCS tests student understanding of quantum mechanics, designed to be used to survey modern physics courses and quantum mechanics classes (McKagan 2010). Modern physics courses typically cover relativity and quantum theory; while the QMCS is aimed at testing students understanding of quantum mechanics. These assessments become effective when the same test is given both pre- and post- instruction, typically at the beginning and end of a semester. Since both are the same test, gain on each question, and with each student, can be measured and the data gathered can be used to determine the effectiveness of an instructional strategy (or instructor). The Hake (1998) survey used three separate tests to measure the gain students showed, including the FCI. In many cases comparison data at the same institution or other institutions is available to help in assessing the instructional effectiveness.

Besides assessment instruments, there are instructional strategies ranging from something that can be inserted into an otherwise traditional course, to strategies that require a redesign of the entire semester of instruction. Peer Instruction is an instructional strategy pioneered by Eric Mazur on large lecture sections of undergraduate physics and represents a strategy that can be inserted into an otherwise traditionally taught course. Mazur began developing Peer Instruction when he came across research stating that most students who pass
undergraduate physics (even students with excellent grades) often cannot answer basic conceptual physics questions. After reading this research, he tested his own classes and despite his impression that his students learned and performed very well, he found that his students also performed poorly on conceptual questions he felt they should be able to answer (Boller, 1999). In a paper published with his colleague Catherine Crouch, they describe Peer Instruction (PI):

A class taught with PI is divided into a series of short presentations, each focused on a central point and followed by a related conceptual question, called a ConcepTest, which probes students’ understanding of the ideas just presented. Students are given one or two minutes to formulate individual answers and report their answers to the instructor. Students then discuss their answers with others sitting around them; the instructor urges students to try to convince each other of the correctness of their own answer by explaining the underlying reasoning. During the discussion, which typically lasts two to four minutes, the instructor moves around the room listening. Finally, the instructor calls an end to the discussion, polls students for their answers again—which may have changed based on the discussion—explains the answer, and moves on to the next topic. Students are not graded on their answers to the ConcepTests, but do receive a small amount of credit for participating consistently over the semester. They also have a strong incentive to participate because the midterm and final exams include a significant number of ConcepTest-like questions. (Crouch, 2001, p. 970)

Peer instruction, as developed and tested by Mazur and Crouch (2001) over ten years of instruction showed gains on two of the PER-developed assessment tools, including the FCI. They
also saw significant improvement in student motivation and positive student reaction to the strategy.

Another PER innovation is Workshop Physics. Where Peer Instruction is an attempt to modify and improve lecture-like class periods, Workshop Physics is a complete overhaul of a physics class period where “formal lectures have been abandoned to create a maximum amount of time for active learning” (Laws, 1989). The general concept of Workshop Physics is to merge lecture and laboratory using actual physical phenomena whenever possible and use computers to gather and analyze data as well as provide simulations when the actual physical phenomena cannot be easily observed. In this way, a semi-guided, hands-on lesson can be created for the student to actively participate in the learning process. Workshop Physics uses computers “not as tutorial devices or teaching machines, but rather for the acquisition of qualitative and quantitative data about physical phenomena” (Laws, 1989). The students move freely between observing phenomena and conjecturing about it, with the instructor there as a facilitator and more-experienced learner. As Laws points out, “preliminary assessments of the Workshop Physics project at Dickinson College show dramatic increases in the motivation of students while they are taking introductory physics courses,” (Laws, 1989) and as many researchers have pointed out, motivation is a key element for learning (Zimmerman & Schunk, 2007). Laws used PER-developed assessments, portions of the AP physics examination, standard college course evaluation
forms, and additional student evaluations about the Workshop Physics experience in particular to evaluate the strategy. Additionally, tests were given some months after instruction, as well as gathering students' performance in subsequent courses and on MCAT examinations. Not only were the positive motivation results mentioned earlier obtained, but in addition modest gains on the academic measures were also seen.

Research-based assessments instruments (e.g., FCI, QMCS), research-based modifications of the traditional lecture format (e.g., Peer Instruction), and complete research-based overhauls of a physics course (e.g., Workshop Physics) are all PER products that have created generally positive results shown by Laws (1989), Crouch (2001), Hake (1998), and McKagan (2010). These results, both the instructor's deeper knowledge of student learning, or the students creation of deeper connections to physics material, are a primary goal of Physics Education Research.

Although there are many more research-based instructional strategies that have been developed by PER -- see McDermott & Redish (1999) and Redish (2003) for more information about many more of the instructional strategies developed by PER -- the author has focused particularly on Peer Instruction and Workshop Physics, because the first set of interviews analyzed by Turpen (2011) were with instructors familiar with or using Peer Instruction and the second set of interviews analyzed as part of this thesis were with instructors familiar with or using Workshop Physics.
Physics. As one could infer, these two examples of PER might attract two different kinds of instructors, and therefore analysis of each may provide quite a wide range of data and faculty viewpoints on PER.

If it is so useful, why are PER products and results not widely used?

The incorporation of PER-based knowledge into physics classrooms seems to be proceeding at a much slower pace than that at which the research-based knowledge is created. To understand why this is the case, it is necessary to examine the ways PER results are propagated. This includes dissemination of PER-based instructional strategies and the ways instructors learn and use these new techniques. One must also examine the academic culture in which physics faculty exist.

The dissemination of PER-based instructional strategies is accomplished through two major paths: academic literature, and conferences or workshops. While it is true that most PER literature is published in academic journals that are cataloged by libraries and other research databases, this only provides access to PER for those willing to sift through and keep up on current literature, requiring time and resources that instructors may not possess. The other primary propagation method -- through conferences and workshops-- is where the reform methods’ results are reported, and the techniques can also be taught to instructors (Felder 2008). There are even a small number of
semester-long classes and curricula developed and offered at some higher education institutions that are specifically about PER techniques (Thompson 2011). What is important to note about both of these methods of dissemination is that neither are compulsory. An instructor may choose to read a journal or not, may choose to learn more about a technique they see, and may then choose whether or not they wish to fully explore this new technique or be properly trained in its use (Wong 1997). There may be administrators who wish to see these new techniques distributed, and so require their departments to attend the workshops and conferences, but the correct implementation of the technique is still ultimately a choice made by the instructor (Hardré 2010). There are very few, if any, programs that require department-wide use of PER based instructional strategies.

There is undoubtedly a third way PER is disseminated -- although it may be difficult to acquire data describing this way -- and that is word-of-mouth. A physics instructor may hear about a new instructional strategy, try it out, and then tell colleagues about it. While word-of-mouth is slow, it also carries some weight, as an instructor is more likely to trust another physics instructor they personally know. This can be both advantageous and disadvantageous, as the instructor may not have been properly trained in the technique. So any results, for good or ill, may not be trustworthy. In a budding field such as PER, these inaccuracies can be very dangerous, and lead to an undeserved or unearned reputation.
A hindrance to PER dissemination is rooted in academic culture. Traditional, lecture-based instruction is called traditional for a very good reason; it has been the primary mode of instruction for hundreds of years. As Penn (2011) and others have pointed out, most instructors teach the same way they were taught, and as most secondary educators and higher educators teach typically in traditional lecture format, future physics educators will be more comfortable with lecture and therefore primarily teach using lecture.

Henderson and Dancy (2009) found that while many physics instructors (87.1%) in postsecondary education had heard of at least one PER technique, and even nearly half (48.1%) use at least one technique, the discontinuance rate among four of the most popular techniques ranged from 32% to 54%. They conclude that much of the discontinuance is a result of modifications of the techniques that are not provided by the original authors, once again pointing to poor training on the use of these techniques. An alternative theory they posit to poor training is that faculty do not want to use the fully-formed, polished curricula that the PER community typically wants to create, but instead wish to take smaller ideas containing the core of what a particular PER method is about, and then develop it to fit their own situation. Thus, barriers to the implementation of PER results may occur not only at the cultural and institutional levels, but the PER community itself may create unnecessary barriers because of the way it disseminates PER techniques.
Assessment of teaching effectiveness as a barrier

Besides the barriers of training and inherent dissemination problems, the assessment of teaching effectiveness can impose a barrier to the spread of effective teaching techniques. Penn (2011) points out, assessments of general education are criticized because of "philosophical foundations, the quality of assessment measures, the relationship between teaching practices and assessment, and the role of academic freedom and external accountability." These criticisms can produce pervasive skepticism from the very faculty being evaluated. Without a common belief in these assessments, their effectiveness is reduced. The most intensive evaluation of faculty teaching effectiveness happens at two stages: in the hiring process and in the promotion and tenure process. Meizish and Kaplan (2008) found that institutions in the hiring process requested items such as teaching philosophies, letters of recommendation concerning teaching effectiveness, and student ratings. Few of the institutions formally requested these types of information in their job postings, though over half would request these documents during the interview process. A minority asked for a talk on teaching or asked to see a prospective hire teach a real class. All in all, they say that institutions "infer" how well a candidate may teach based on indirect information, hardly a concrete method of evaluating whether a new hire is an effective teacher. Once hired, faculty are almost exclusively evaluated
using student evaluations (Bastick 2001), forms that require students to rate their satisfaction and perceptions of the course and instructor on a 4 or 5 point scale. Bastick proposes the exclusive use of student evaluation stems from there being no cost-effective or accurate alternative methods to choose from. He describes methods such as Peer observations to not be cost effective, nor to have the standardization that would be required to make them applicable in wide use. He expresses no direct opinion on self-reflective methods, like teaching portfolios and self-assessments. The author believes that self-reflective methods have a place in a comprehensive teaching effectiveness evaluation, but must be augmented and assisted by several other measures.

Faculty themselves use more formative methods of evaluating their teaching practice. The categories created from the analysis of both sets of interviews conducted by Turpen, et. al, (2011) are descriptive of methods used by faculty. They included: Student Evaluations of Teaching, Peer Observations of Teaching, Teaching Portfolios, PER-based assessments, Student Performance on Exams, Quizzes, or Homework, Systematic Formative Assessment (e.g., taking classroom votes), Informal Formative Assessment (e.g., looks in students eyes, whether they are awake, etc.), and Informal Post-course Feedback from Students.

There is a third dimension to the assessment debate, at least from within the PER community. As mentioned previously, PER has developed many multiple-choice inventories designed to
measure student conceptual understanding of a particular set of physics content. Typically these inventories are given at the beginning of a course or unit and then at the end of the course or unit, to assess the gain in students' conceptual understanding due to the course. The author feels that these are important formative and summative assessment strategies, and deserve to occupy positions in both faculty and institutional evaluations of teaching effectiveness.

However, while both PER and formative assessments are useful in describing student learning, it is uncommon for either to play a role in institutional evaluation of teaching effectiveness. Some argue that the institutional reliance on student evaluations has led to a stagnation of teaching innovation, and has lead to faculty “pandering to students with the resulting decline in student learning” (Crumbley & Reichelt, 2009). If faculty are going to be given promotion and tenure based on student surveys, then it makes sense that they would do things to bring up student evaluation scores, which does not always coincide with improving student learning (Shevlin, et. al, 2000).
CHAPTER 3

STUDY 1: PEER INSTRUCTION AND WORKSHOP PHYSICS FACULTY INTERVIEWS

Overview

Chapter 3 describes the first study completed as a part of this thesis. As mentioned earlier, the first study involves the analysis of interviews previously conducted by Turpen et al. (2011). Turpen et al. developed and administered an interview to faculty familiar with either Workshop Physics (WP) or Peer Instruction (PI). They analyzed approximately half of the interviews (those dealing with Peer Instruction) for recommendations that the interviewees had for how to improve the use of PER instructional strategies by non-PER faculty. The parallel analysis of the WP interviews and the comparison of WP to PI results were completed by the author as part of this thesis. The methodology of the interviews and analysis is described here, followed by analysis of the findings. The assessment data for the faculty and its subsequent analysis is included in Chapter 4 with the administrator's data, since both sets of data were required for complete analysis and the drawing of conclusions.
Research Questions

(1) How do faculty think that institutions assess faculty teaching effectiveness?

(2) How do faculty assess their own teaching effectiveness?

(3) What suggestions do faculty have for what the PER community can do to improve the dissemination and implementation of research-based instructional strategies?

Methodology

Recently, a series of interviews were conducted (Turpen, et al., 2011) with physics instructors that were familiar with (i.e. users, former users, or knowledgeable nonusers) Peer Instruction and/or Workshop Physics. The interviewees were selected from another survey of physics instructors conducted by Henderson and Dancy (2009). Seventy instructors were interviewed and their interviews recorded and transcribed. Half were selected by having some knowledge of Mazur’s Peer Instruction (PI), while the other half of the interviewees had knowledge of Workshop Physics (WP). The semi-structured interview protocols had focus questions about the pedagogical effectiveness of PER, the dissemination of PER-based knowledge and products, and recommendations for things the PER community could do to increase the use of PER-based knowledge and products. Half of the
interviews were then analyzed and coded for a variety of responses by Turpen, et al. (2011). The analysis of these interviews involved identifying recommendations that interviewees had for the PER community that would help increase the use of PER ideas in teaching. As part of the analysis of the PI interviews, an emergent coding scheme was developed. There were three main categories: “Improving Dissemination,” “More Research Needed,” and “Department Culture.” A fourth category of “Other” was used for comments that offered suggestions for improvement or criticisms of PER, but did not fit into the other three categories. Statements from the interview transcripts related to recommendations for PER were categorized in one or more of these four main categories. Each statement was also further placed in a subcategory.

For the analysis of the WP interviews as part of this thesis, the set of categories and subcategories from the Peer Instruction interviews was used as the starting point. When a statement did not fit well within one of the existing subcategories, additional subcategories were added to accommodate it. The statements were then tallied for each interview. To reduce the possibility of over analysis, the final results only note whether an interview contains at least one mention of a category or subcategory. Multiple statements in the same subcategory are not reported in the final analysis (for example, to represent the strength of ideas).
Results

The percentage of faculty expressing ideas in each of the main categories for the first half of the faculty interviews, which contains the interviews with PI faculty and were analyzed by Turpen et al. (2011) and are shown in Figure 1 below.

Figure 1 - Peer instruction interview tally by category

The percentage of faculty expressing ideas in each of the main categories for the second half of the faculty interviews, which contains the interviews with WP faculty, were analyzed using the same scheme as the first half, but were executed by the author for this thesis, and are shown below in Figure 2.
Table 1, below, contains each category, its sub-categories, and a representative quote from each, to give the reader a sense of some of the data taken.

**Table 1 - Representative category quote from PI and WP interviews.** The quotes are attributed to faculty by PER technique (PI or WP) and by institution type (Two year college or community college = T, Institution where the highest physics degree offered is a Bachelor’s degree = B, Institution where graduate degrees in Physics are offered = G)

<table>
<thead>
<tr>
<th>Category or sub-category</th>
<th>Percentage citing this category (PI%, WP%)</th>
<th>Representative quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Department and institutional culture</td>
<td>(31%, 84%)</td>
<td></td>
</tr>
<tr>
<td>1.1 Instructional Improvement not valued by departments/institutions</td>
<td>(19%, 39%)</td>
<td>WPGL: Again, I think there would have been resistance if we tried to switch all our sections [to Workshop Physics] because it would have required a lot more sections, or at least several more sections, and that would have—It's not clear that we had the faculty resources to add a couple more sections in general physics. And it wasn't clear that we were going to get any more faculty resources from the college. So I think we might have run into some resistance there.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>1.2 Assessment of faculty teaching not based on measures of student learning</td>
<td>(9%, 50%)</td>
<td>WPB2: Or just some— a little bit—it would be exciting, from my perspective, to see a little bit more introspection at the department level of, &quot;What are we doing?&quot;; you know, &quot;What should we try?&quot; Instead of—what I mostly perceive is that the teaching is sort of viewed as a very personal thing, so each professor just gets to do whatever they want to do and it's just—that's sort of just sort of the day-to-day work of the department and then it just sort of happens.</td>
</tr>
<tr>
<td>1.3 Other</td>
<td>(13%, 50%)</td>
<td>PIB4: And at these big departments, I would talk to some of these people who were interested in that and they would often mention that they weren't many people out of the department however who were interested. Most of the people weren't interested. Most of the faculty members weren't interested in the physics education research. It was just a handful of people.</td>
</tr>
<tr>
<td>2. More research needed on PER methods</td>
<td>(38%, 79%)</td>
<td></td>
</tr>
</tbody>
</table>

24
<p>| 2.1 What is the evidence based support | (16%,39%) | WPT1: I think the education world needs to say, needs to take more people out and say, &quot;Look, you don't have any data to make that claim. That might be an interesting idea, but that's not—there's no research in what you claimed. All you did was come up with your particular way of the way you like to teach. It sounds very good. You claim it works for you, we won't argue with it, but you don't get to publish that in the American Journal of Physics; you don't have any data.&quot; So if you want to why more people don't—having said that, I don't why. My opinion is, is that, that the physics education community—the true heart of the physics education community doesn't get the respect it deserves from the rest of the physics community because the physics education community is surrounded by people claiming the mantle of physics education research. They're claiming they're researchers but what they're really doing is saying, &quot;This is how I like to teach. Aren't I cool? I'm a PER person.&quot; |
| 2.2 Discuss how PER works in different situations | (16%,18%) | PIB2: And it's like any educational technique, the reviews are mixed. The reviews from students are mixed. But I think all of these techniques are definitely worth looking into. I should mention one problem I have with what I see as the entire physics education research conundrum, I guess. Is that in order to good educational research, you need large body counts. And so, it makes sense that researchers in that area go for places with large body counts. But what that does is it selects a student body that doesn't always apply to small liberal arts colleges. |</p>
<table>
<thead>
<tr>
<th>2.3 More Research on parts of PER that make a difference</th>
<th>(3%, 5%)</th>
<th>PIG1: Well, you know, this is just—oh, you know, based on me—and I guess I am not an overly rigid person, and I would say getting to know really what is—peer instruction really—what is really at the bottom of it. You know, what are the—what is the critical thing that, you know, makes it work? Just knowing and feeling, like, “Yup, I am convinced that that really works”; that would be one thing. What is it and does it really work?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4 PER should focus beyond conceptual understanding</td>
<td>(13%, 16%)</td>
<td>WPG3: Part of the problem was the faculty as a whole was not too impressed with the efficacy of the workshop approach; it tended to—see, most of our teaching commitment is for the School of Engineering. We have a School of Engineering and we—you know, we teach them the Introductory Physics course, calculus-based physics, and it was very non-quantitative. I mean they were gaining a good qualitative understanding of experiments, but they were not learning to integrate their math to the problem-solving and to think analytically in mathematical terms.</td>
</tr>
<tr>
<td>2.5 Other</td>
<td>(3%, 37%)</td>
<td>WPB5: I think it was—the weakness is really the attitude of the students. They are designed in a way where I think human psychology is not taken into consideration. That’s how I feel personally. And the strength which is, of course—the conceptual stuff is very important in really learning the subject. However, when you do that, you still need to do the quantitative material as well to support the course. And because of the time limitations that we have, we spend only a certain number of hours with the students. It was very hard to fit everything in.</td>
</tr>
<tr>
<td>3.PER needs to improve dissemination efforts</td>
<td>(78%, 68%)</td>
<td></td>
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<tr>
<td>--------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>3.1 There is a lot of PER, and it can be hard to sort through</td>
<td>(34%, 32%)</td>
<td></td>
</tr>
<tr>
<td>PIB1: I think it would nice to have access to more materials; easier access to more materials.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Higher profile dissemination efforts</td>
<td>(22%, 5%)</td>
<td></td>
</tr>
<tr>
<td>PIT4: Yes. And it would be nice if high ranking, highly visible people in the physics community could advocate more for Peer Instruction through things like Physics Teacher Magazine and so on. And I know that the physics community are very receptive to that right now, but again, there’s a lot of inertia from the traditional side of things.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3 There are isolated faculty who do not know of PER methods</td>
<td>(3%, 8%)</td>
<td></td>
</tr>
<tr>
<td>WPG2: Well, I think that the people are also misinformed of what’s out there. I mean there are some colleagues of mine, they are like in their mid 40’s - earlier 50’s to say but they got tenure say 10 - 15 years ago. And so, some of them only taught that since then graduate classes or upper division classes. And so, I bet they don’t even know what peer instruction is or studio physics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4 Must start slowly when making instructional changes</td>
<td>(9%, 0%)</td>
<td></td>
</tr>
<tr>
<td>PIG3: But if somebody came to me and said you know there’s this thing you haven’t heard about, and I know you’ve been trying other things, but here’s this, why don’t you give it a try and here’s how you can incorporate it into your lectures without making any radical changes. And I’d probably say whatever it cost me to try it once. Anyway maybe I’m talking more about myself than other people but that’s the thing I know the best.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5 Must learn about things in more detail</td>
<td>(16%, 26%)</td>
<td>WPT4: And I guess probably on the negative side is that there isn’t a well-tested, prescribed list of things, “This is the way you should do it.” So it’s a ... it’s a toss-up on that. Some good things about that, and I thought especially for the faculty we had at that time - where ... very experienced faculty with very ... you know, many years of teaching experience of many courses - would like that flexibility even though some of the materials that I came up with and other people came up with and adapted from other places aren’t thoroughly tested in the way that Workshop Physics is.</td>
</tr>
<tr>
<td>3.6 Disseminate to support customization</td>
<td>(25%, 29%)</td>
<td>WPB3: But I think the caveat to that is there are now lots of different approaches out there. You have to pick and choose based on your institution what will work and what won’t work. And it could be a hybrid of different approaches.</td>
</tr>
<tr>
<td>3.7 Other</td>
<td>(16%, 8%)</td>
<td>PIG2: So I think what you need to do is you need to do a lot of promotional things where you get them out of their shell and you engage them into a product or so by presenting it to them and see how well it could work. I think one should do a lot of workshops, a lot of videos of teaching practices that work and then people might be engaged and get interested in it. I’m not necessarily sure that that should be the responsibility of the faculty or the department; that should be probably more the responsibility of the people that want to sell their book or want to sell their product.</td>
</tr>
</tbody>
</table>
4. Other (41%, 21%)

**WPT3**: This campus was built almost completely staffed about 35 years ago. And many of those old timers are still here. They're just starting to leave. And, pretty much the union at our campus is very strong. The union at our school is very strong. And administration has learned if they push too hard in a particular direction, they will - it will generate grief which they would prefer to avoid.

**PUGD5**: But it seems to me that that's one way of effecting change is, you know, educating our graduate students about what education research looks like. It would have a big impact and in a fairly reasonable time frame.

The broad results from each category are discussed in the following paragraphs.

Department Culture. 31% of PI interviewees and 84% of WP interviewees felt that there should be a focus on impacting department and institutional culture, such as issues with departments or institutions not valuing instructional improvement and assessment of faculty not being based on measures of student learning. Additionally, there was an "other" sub-category that tallied miscellaneous statements on department culture that were seen from multiple interviewees: PER techniques taking more time to execute effectively than their institutions may be comfortable with, that to be effective the whole department should adopt these techniques, and an attitude that spending too much time and
energy on introductory courses (where much PER is focused) is
discouraged as it takes these resources from upper level courses.

More Research. 38% of the PI interviewees and 79% of the
WP interviewees felt that more research on PER methods are
needed, citing feelings that there wasn’t enough evidence to
support PER pedagogies, their need to see explicit research on
how PER works in different situations, and that PER should focus
beyond conceptual understanding, thereby expanding focus into
other important areas such as scientific thinking or problem
solving. Additionally, there was an “other” sub-category that
tallied miscellaneous statements on research that were seen from
multiple interviewees: research would be helpful to find if the
typical PER strategy tradeoff of breadth for depth in content
coverage adversely affects student learning, and that there needs
to be research on how to reduce student resistance.

Improve Dissemination. 78% of the PI interviewees and 68%
of the WP interviewees felt that PER dissemination efforts need
to improve. Some broad suggestions for improvement and reasons
for the need of improvement from the interviewees included: being
overwhelmed by the amount of research, supporting more
customization of PER techniques to individual classrooms,
creating higher profile dissemination, and increasing the amount
of time and details during transition from traditional
instructional methods to newer, research-based instructional
methods.
Other. There were a sizable number of respondents (PI=41%, WP =21%) from both interview sets that gave comments that did not fit within one of the three main categories, such as the idea that “older” faculty won’t change—they must be waited out, and that PER ideas should also be used in graduate classes thereby expose future physics instructors to these techniques to positively impact future generations of physicists.

The PI interview results were analyzed to see if there were any differences based on the type of institution: Two year colleges or community colleges (T), Institutions who’s highest physics degree offered was a Bachelor’s degree (B), and Institutions who offered either Master’s or Doctorates in Physics (G). If one looks at the breakdown by Institution type (Figure 3), one can see that among PI faculty, the faculty at all three types of institutions made recommendations in the Improving Dissemination category more frequently than in the other categories (T=60%, B=73%, G=100%).

What is important to note is that faculty at all three types of institutions agreed that Improve Dissemination was their most important recommendation to the PER community. In the author’s opinion, this stems from the success (from any level of success to successful research they studied) seen with PI. They believe that if the message just gets out to the Higher Education Community at large then these methods can really start to take hold and produce results. The PI interviewees said things like:
"I see that the biggest problem now is that those educational research methods are not getting to the workforces," or "There were a lot of departments especially at big schools, the universities, where there would be some faculty members in physics who would be very interested in physics education research." Taking these quotes, the quotes in the table, and the data from analysis into consideration gives strong evidence for why PI faculty would be more prone to suggesting improvement in dissemination of PER. This is an interesting result, because a difference was seen when analysis of the WP interviews was complete.

The WP interview data was given the same treatment, and broken down into three separate groups based on the type of institution: "T" institutions, "B" institutions, and "G" institutions. If one looks at the breakdown by Institution type
(Figure 4), one can see that among the WP interviews, faculty made recommendations in each of the three categories at roughly equal levels. Due to the relatively small sample sizes, the differences shown in the graph are most likely not statistically significant.

**Figure 4 - Workshop physics interview tally by institution type**

What is important is that the WP interviewees expressed concerns roughly evenly across all categories. The author believes that the differences seen between WP and PI faculty can be explained by looking at the difference in level of commitment required for these two RBIS, and is explored deeper in the Result sections of Chapter 3. For now, the important feature to note is that a majority of WP faculty think that PER has serious gains to
make in all categories (Department Culture= 84%, More Research= 79%, Improve Dissemination= 68%), compared to the single category that a majority of PI faculty chose. The quotes in the table and the data from analysis show how a majority of WP faculty sees many of their problems with implementation of PER techniques stemming from above them, in the department as a whole or even the institution as a whole, with some small disagreements comparing data from different types of institutions.

Conclusions

From combined analysis of the PI and WP interviews, a majority of the PI interviewees agreed that improving dissemination should be the focus of the PER community, whereas a majority of WP interviewees chose all three of the categories (Department Culture, More Research, and Improve Dissemination) as recommendations for the PER community’s focus, with the highest percentage in Department Culture. The gaps between the results of the PI interviews and the WP interviews are significant in some areas and require some analysis. First of all, the two sets of interviews were coded and classified by two different teams (the WP interviews were analyzed by the author), which could result in different readings of the interviews, but by looking only at whether a category was mentioned or not mentioned, over-reading or under-reading by different analysts should be minimized. An alternative perspective is to look at the differences inherent in
the faculty interviewed. If PI and WP are reduced to basic elements, a fairly large gap in terms of time commitment and literature familiarity can be seen between the two techniques. PI is an instructional strategy that can be implemented easily, with a smaller amount of resources and effort than WP. Looking at time commitment and ease of implementation, PI is on the lower end of this spectrum and WP on the higher end. The author takes this gap in ease of implementation as a reflection on the types of instructors that would take interest and attempt to use these two strategies, and thereby a reflection of their respective paradigms of education. Both kinds of instructors feel that their instruction needs to be improved, but while PI faculty are not prepared to disassemble their entire mode of instruction, WP faculty are ready to start from scratch. The author is not implying that one has more merit than the other, only that they are two different mindsets.

Peer Instruction (PI) is easily adapted and inserted into a traditional lecture classroom, and as such, would be attractive to faculty who are attempting to fine tune their instructional methods. Since implementation of PI would not require a lot of institutional resources (indeed, most resources needed, such as clickers and projection screens are becoming standard in college classrooms nationwide), the PI instructor can create a more engaged classroom with a minimum of disruption, preserving most of the traditional classroom, with which they are much more familiar. PI instructors then run into difficulties when
attempting to find resources to further develop their PI instruction. In the PI interviews, most suggested satisfaction with PI, but had problems with finding more information on the technique, or further materials to help them develop its further use in their classrooms (78%). They also found problems with other faculty being accepting and helpful to their use of PI (31%).

Workshop Physics (WP), being much more labor and resource intensive, would suggest faculty members who have looked deeply into PER and accept it as largely superior to traditional instruction. These are faculty who are familiar and comfortable with the research, and know where to find any PER resources they would require. So instead of finding shortfalls in their implementation, they run into a majority of their implementation problems with the allocation of institutional resources. Since WP requires a ground-up reconstruction of content delivery, it naturally needs more time and resources to execute properly. This would then lead to collisions within the department and with administration as these resources are requested. Additionally, drastic instructional changes will become known across departments fairly quickly, perhaps leading to the solidifying of previous biases against PER by other faculty members and administrators, leading to inter-faculty friction. While WP faculty agreed with PI faculty about improving dissemination (68%), and many WP faculty felt that more research would be
useful (79%), many also expressed concerns about departmental and institutional culture (84%).

All of these suggestions and concerns, whether they are factually true or not, represent the views of physics instructors "in the trenches" and as such, should be taken very seriously. The likelihood of success of a faculty member implementing a new instructional strategy is significantly shaped by the administrators at their institution. Thus, the aim of the second study was to go up a level, to these administrators, and check for agreement or disagreement with the problems seen at the faculty level.
CHAPTER 4

STUDY 2: HIGHER EDUCATION ADMINISTRATOR INTERVIEWS

Overview

This chapter describes the second study completed as a part of this thesis. Interviews were conducted with Higher Education Administrators (HA) in order to get an institutional perspective on the slow propagation of PER-based teaching innovations. The methodology of the interviews and analysis is described here, followed by analysis of the findings. Also included in the results section is the assessment data from the faculty interviews (previously analyzed) as well as a comparison between the faculty and administrator results.

Research Questions

(1) How do administrators think that faculty assess their teaching effectiveness?

(2) How do administrators think that the institution assesses faculty teaching effectiveness?

(3) What suggestions do administrators have for what the PER community can do to improve the dissemination and implementation of research-based instructional strategies?
Methodology

From the author’s analysis of the Workshop Physics interviews, and combining it with the data obtained from the Peer Instruction interviews, a new set of interview questions was designed, specifically aimed at higher education administrators (department heads, deans, administration in charge of undergraduate studies, and people associated with faculty development). The goal of these interviews was to obtain complementary data to the PI and WP interviews, but instead from an administrator’s perspective. When these two data sets are compared, similar suggestions and trends can be seen and used to create recommendations for the PER community to advance the use of PER products. See Appendix 1 for the semi-structured interview protocol.

The administrators interviewed were selected to represent the same type of institutions as the faculty interviews: two year institutions (T), four year institutions where the highest Physics degree offered is a Bachelor’s degree (B), and four year institutions where the highest Physics degree offered is a Master’s and/or Ph.D. (G). These institutions were all within Michigan out of convenience. There is no reason to think that administrators in Michigan are different than those elsewhere in the United States. To select institutions for the study, a comprehensive list was first created of Michigan institutions that included Carnegie classification to determine whether a four-year institution fell into the B or G category, the
institution's total 2010-2011 enrollment, and the institution's location. From there, a diverse set was chosen to conform to the criteria stated above. For each selected institution ideal candidates for the study were chosen by studying administrative flow charts to select administrators who fit the stated criteria in the previous paragraph.

The possible participants were contacted via email (see Appendix 3 for initial and follow-up form emails), with a follow-up email sent one to two weeks following the initial contact if no response was received. If no response was received to the follow-up email then a phone call was placed to the possible participant following the phone script in Appendix 4. Nine institutions (three of each type) were contacted and are included in the study. There were four explicit “decline to participate” responses, and six possible participants who did not respond to any of the three contact attempts. Administrators were given the option to have the interview conducted in-person or over the phone. However, with the busy schedules of the administrators, phone interviews were the only option used. The phone conversations were recorded once consent was granted, and each participant read and agreed to the Human Subjects Institutional Review Board (HSIRB) approved Informed Consent Form (see Appendix 5). The entire process was conducted with the approval of the HSIRB, whose approval form is included as Appendix 6. Once the conversations were recorded, they were transcribed verbatim, by the author, for analysis. A table of the institutions, with a
description of type, number of interviews obtained, and type of administrator interviewed, is below.

Table 2 – HA Interviewee Breakdown by Type, Number, and Title

<table>
<thead>
<tr>
<th>Inst. Number</th>
<th>Inst. type</th>
<th>Number of Interviews obtained</th>
<th>General Title of Interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T</td>
<td>3</td>
<td>Associate Dean</td>
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<td></td>
<td></td>
<td></td>
<td>Dean Physical Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Department Chair</td>
</tr>
<tr>
<td>2</td>
<td>T</td>
<td>2</td>
<td>Physical Science Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chair Vice President</td>
</tr>
<tr>
<td>3</td>
<td>T</td>
<td>2</td>
<td>Dean Vice President</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>3</td>
<td>Provost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dean Physics Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chair</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>3</td>
<td>Faculty Development Center</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Director Curriculum Developer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physics Department Chair</td>
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<tr>
<td>6</td>
<td>B</td>
<td>2</td>
<td>Faculty Development Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director Physics Department</td>
</tr>
<tr>
<td>7</td>
<td>G</td>
<td>3</td>
<td>Faculty Development Center</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Director of Undergraduate</td>
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<td></td>
<td></td>
<td></td>
<td>Programs Physics Department</td>
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<tr>
<td>8</td>
<td>G</td>
<td>3</td>
<td>Faculty Development Center</td>
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<td></td>
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<td></td>
<td>Director Vice President</td>
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<td></td>
<td></td>
<td></td>
<td>Physics Department Chair</td>
</tr>
<tr>
<td>9</td>
<td>G</td>
<td>2</td>
<td>Faculty Development Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director Dean</td>
</tr>
</tbody>
</table>

In order to have the interviewees feel at ease, and to get honest and frank answers to the interview questions, anonymity was given to every interviewee. Therefore identifying data beyond that shown in Table 2 will not be presented.

These interviews not only specifically addressed the concerns and suggestions found in the faculty interviews relating
to the four broad categories from the analysis, but contained questions to reveal viewpoints on PER held by administration. The interview questions are contained in Appendix 1. Initially, questions were asked about culture and structures of the institution, including what encouragement existed for instructional improvement, possible discouragement of instructional improvement, general faculty attitudes toward instructional improvement, and methods of evaluation of teaching effectiveness. The interview then continued with asking questions about the interviewee’s familiarity with specific RBIS, and concluded by asking the interviewee to make suggestions for the educational research community that might increase the spread of Research-based Instructional Strategies (RBIS). The first set of questions were designed to obtain data on general attitudes on and resources for instructional improvement, since PER and educational research in general creates and provides RBIS, and information on the use and dissemination of these strategies is core to this thesis. The additional questions on teaching effectiveness gave some data on how, if at all, RBIS may fit into the evaluation structure. Several interesting and popular responses to the last question, on suggestions for the educational research community, are collected in Chapter 5 of this Thesis. It is also hoped that the interviews obtained for this thesis, specifically the set of questions on specific RBIS, as well as the detailed questions on the evaluation systems, may be of further use for other projects.
Each interviewee read and agreed to a HSIRB approved consent form, and gave their permission for audio recording for later transcription use. The interviews were then transcribed and analyzed using similar qualitative techniques as used to analyze the Peer Instruction and Workshop Physics interview sets. The analysis used the same four categories used in the faculty interviews (PER dissemination, PER in department/ institutional culture, further research on PER methods, and other) and similar codes within each broad category. The author also kept an emerging coding scheme separate from the four previous categories to tally up specific suggestions from the administrators. Please see Appendix 2 for the coding structure used, and the individual breakdown of codes within larger categories, as well as the Suggestion codes.

**Results - Recommendations for PER**

In order to compare with the faculty results, the analysis and coding protocol from the faculty interviews was used. The coding of the interviews was a qualitative process, identifying responses that could be coded under one of the four broad categories; specifically under several subcategories within each broad category (See Appendix 2). The results from the Higher Education Administration interviews are shown in Figure 5 below.
As previously stated, the high area of concern for the PI interviewees was Improve Dissemination (78%) and for the WP interviewees it was Department Culture (92%). The Higher Education Administrator (HA) interviewees’ area of concern was Department Culture (87%), approximately twice as high as Improve Dissemination (47%) and More Research (43%). Thus, the HA interviewees appear to agree with the overall WP interviewees that department and institutional culture presents the largest barriers to instructional improvement. Table 3, below, lists a representative quote from each sub-category. Note that four sub-categories did not appear in the HA interview set. These four are also codes with single digit percentage occurrences in the PI and WP interviews, which is not surprising. Those four codes are
very implementation centered, and would not necessarily occur to an administrator to mention.

Table 3 - Representative category quote from HA interviews. The quotes are attributed by HA (Higher Education Administration) and institution type (Two year college or community college = T, Institution where the highest physics degree offered is a Bachelor’s degree = B, Institution where the graduate degrees in Physics are offered = G)

<table>
<thead>
<tr>
<th>Category or sub-category</th>
<th>Percentage citing this category</th>
<th>Representative quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Department and institutional culture</td>
<td>87%</td>
<td></td>
</tr>
<tr>
<td>1.1 Instructional Improvement not valued by departments/ institutions</td>
<td>65%</td>
<td>HAG6: So basically, our promotion and tenure [system] gives lip service to teaching. When it really comes down to it, in terms of the outstanding researcher who is a mediocre teacher at best, will sail through the system. The outstanding, innovative, contributing teacher who is adequate at research, will have a very hard time making it through the system. And it would be naive to think that the smart people that we hire as assistant professors don't understand that from the day they walk in.</td>
</tr>
<tr>
<td>1.2 Assessment of faculty teaching not based on measures of student learning</td>
<td>48%</td>
<td>HAT2: I think that often times new, nontenured faculty will, you know, people will take two different approaches. Some of them will say, “I'm going to make my mark and try making some changes,” and others will shy away from making changes for fear of maybe not getting tenure or ruffling some feathers in the department, and fearing that they might not get tenured. So I think that happens at probably every institution, you know, for fear. And again, the new faculty can approach it in two different ways. They can</td>
</tr>
<tr>
<td>1.3 Other</td>
<td>9%</td>
<td>HAB1: The main problem we bump up against in implementing the physics education research strategies is budgetary; you know they're very expensive to implement. Because they require small class sizes or if they are not small class sizes then there is a lot of technology required. HAB3: Another obstacle is just the size of the workload. And so you find what's been working for you and you tend just keep doing what you've been doing.</td>
</tr>
<tr>
<td>2. More research needed on PER methods</td>
<td>43%</td>
<td>HAT1: I think, I think sometimes there's not enough data to really draw conclusions. And sometimes I think the statistics, the way it's applied, is a little iffy. But I do like just to read anecdotal kind of - you know we did this and we thought it worked real well and the students enjoyed it - but I did think, you know I just went to a conference ... and a lot of the presentations, the statistics were just horrible. I mean, they just weren't correct. They were drawing conclusions that, you know weren't... supported by the numbers, and they didn't do... You know, like the t-tests and all that sort of things to show that there actually is a difference in this data. So I think there needs to be more emphasis on actual data. And I know that's really hard to get sometimes, because teaching is so... It's so... It's just so much more of an art than a science I think.</td>
</tr>
<tr>
<td>2.1 What is the evidence based support</td>
<td>30%</td>
<td></td>
</tr>
</tbody>
</table>

46
| 2.2 Discuss how PER works in different situations | 9% | HAB4: So right now a lot of faculty are doing this “flipping the classroom” business. Where they do a lot more engaged discussion and problem solving in the class ... and you know people are on that bandwagon a bit, without a lot of research that shows whether or not it works in all situations. |
| 2.3 More Research on parts of PER that make a difference | 0% | No mentions of this code in the HA interviews. |
| 2.4 PER should focus beyond conceptual understanding | 9% | HAG1: I think, so I guess one thought or issue that comes to mind regarding these techniques is... It does have to do with the goals and, for example - there is the idea of understanding, conceptual understanding versus the ability to grind out whatever mathematics... You know as a computational scientist there are lots of things you have to do to convince yourself that what you're getting out is not garbage. And so, you are thinking critically about it, you are running tests and so on and so forth. But you know at the heart of that work is essentially grinding out solutions, you may not fully understand all of the details, all of the concepts... And in doing so, in achieving your results, in being successful in grinding this out, I am able to in the end, that process of grinding it out is how I learned. About what it means. So, if we take that experience and try to translate it into a classroom, well I could shoot for kind of a broad and central understanding issue that might make it more comfortable for you at a cocktail party to talk to your friends about what you are doing, but it's totally worthless to you in terms of being able to do something meaningful as a scientist. |
2.5 Other 48%

HAG2: You know, I am going by, we are going by a very common sense approach. I do know a lot of physics research, and research on physics education, my concern about it is so much emphasis is put in small amount. You know when you're teaching introductory physics course, it is a broad base, giving a foundation. Now many of the things - I've heard a lot of talks on physics education research - people spend so much enormous amount [of time] on like force... Then well, that's not the only thing. You must give a broad base of knowledge to students. Then they can go deeper. But if you spend all of your time in just a few things the whole semester, you are not doing a good job for the student. You know they must get an overall, broad base understanding. That's my perception.

3. PER needs to improve dissemination efforts 48%

3.1 There is a lot of PER, and it can be hard to sort through 13%

HAT3: Oh gosh. I think that - and I don't just say that because I have some faculty teaching about nine courses a semester - but I think that the world of community college teaching, where really the minimum number of classes is going to be four or five, minimum. And where a lot is expected in terms of service to the college beyond the teaching, I think you need to make that research very accessible, very relevant, and very well... Accessible, easy to access. So, I find that it is not likely that I or most of my faculty are going to pick up a journal of educational research... And honestly, they are rewarded for their good teaching, but they are not rewarded for their own scholarship, particularly... So I think we - electronic means of accessing useful, immediate bits of information is helpful.
| 3.2 Higher profile dissemination efforts | 17% | HAG5: I would certainly make it known, what's effective and do the research on what effective teaching is all about. Not that there's any lack of that, but continued to do that work... Well, the media is really great at picking up on certain things, particularly right now the cost of higher education. But maybe there's a way that we can get people to talk a little more deeply into the quality of education, and educational delivery. Not exactly sure how you do that. |
| 3.3 There are isolated faculty who do not know of PER methods | 0% | No mentions of this code in the HA interviews. |
| 3.4 Must start slowly when making instructional changes | 0% | No mentions of this code in the HA interviews. |
| 3.5 Must learn about things in more detail | 22% | HAB2: ...practical applications. Some of the things we struggle with and providing some of the educational research is that people don't see how to apply it. So, giving concrete examples of the implications or how this particular technique can be implemented. People need to be able to see themselves in the work. |
| 3.6 Disseminate to support customization | 0% | No mentions of this code in the HA interviews. |
| 3.7 Other | 4% | HAB5: They were like, you know, physics education research is like this whole separate thread from science education research. And that people are reading enough of the literature in science education. And I think science education research is more the K-12 or elementary. Where physics education is all about undergrad... but there could be more crossover. And most physics education researchers have a physics
degree, and haven't taken any education classes. So you know there was some skepticism in that direction.

4. Other 17%

HAG3: And then how do we get academia to have faculty, before they come here, take more - how do you require people to take formal pedagogy? People need that. I mean, look at K-12 teachers, they have to do it.

HAG4: It's not, you know for the most part you learn by doing, which is not always a great way. There are definitely easier and better ways. But our current model in Higher Ed is that if you have a PhD and you are an expert in your content, you should be able to teach your content, which is kind of ridiculous.

HAT5: I do think it's an institution's obligation to teach its faculty how to acquire, store, retrieve, and use data. And analyze data.

Once again, the HA data was broken down by institution type (T, B, and G). Figure 6, below, shows the breakdown of HA data according to institution.

Administrators at all three types of institutions most commonly made recommendations for PER that involved the need to change Department Cultures (T=86%, B=88%, G=88%). These quotes and data show how administrators see the implementation of educational research techniques impeded from their own actions, or actions and attitudes at the department level.
Figure 6 - Higher education administration interview tally by institution

Results - Assessment of Teaching Effectiveness

As a separate analysis, both sets of interviews were analyzed for statements about what kinds of assessments of teaching effectiveness were used at their institutions. These statements were then separated by whether the assessment was used by faculty or used by the institutions. The faculty interviews were previously analyzed by Turpen, et. al, (2011) and the administrator interviews were analyzed by the author. The assessment of teaching effectiveness sources reported used by faculty and institutions (as found in the Turpen 2011 analysis) from the WP and PI interviews are included in Figure 7 below.
The assessment of teaching effectiveness sources reported to be used by faculty and institutions from the HA interviews are included in Figure 8 below.
Conclusions

A majority of the HA interviewees recommended that changes in department culture would best serve the educational research community. Additionally, the analysis of the assessment of teaching evaluation data from the HA interviews showed that institutions primarily use student evaluations of teaching, peer observations, and teaching portfolios whereas faculty use informal and systematic formative assessments to evaluate teaching effectiveness. Discussed here are some popular suggestions and problems for PER found in the HA interviews, as well as some interesting (not necessarily popular) suggestions and problems found in the HA interviews. There are four popular suggestions discussed here: overhaul of systems of faculty evaluation, research on departmental/institutional cultures where instructional improvement is successful, a centralized way to access PER (e.g. a website), and for faculty to receive pedagogical training. The three interesting suggestions and problems discussed here are the creation of an accrediting body for Physics, a research study on face-to-face instruction versus online instruction, and that administrators don’t receive their information on research methods from primary sources.

A theme that showed up often, in 43% of the interviews, was the idea that the current systems of faculty evaluation does not measure, nor incentivize instructional improvements recommended by educational research (such as outcome-based assessment, inquiry-based instruction, and student engagement/active
classrooms). This problem was mentioned by department chairs and higher administrators across all three institution types. Here are a few quotes illustrating that position.

HAG1: Well when you talk about research-based strategies, the first thing from an educational community is we have to make it a priority. And we have to incentivize it. Because if there's no incentive to do it - and when I say there's an incentive to do it, it can either be tangible or intangible - individuals are going to do it.

HAT1: And I think if we saw community college's move more towards merit based, clear merit-based tenure and promotion criteria, we would probably see more of an emphasis on scholarship and research that may be in a faculty member's discipline area, but would, I think, even more likely be in teaching and learning, because that's where most of their interest is. So in some ways what I'm saying, community college reward systems don't necessarily value the education research you are talking about.

HAB2: Most of, well all of us have taught here more than 10 years and kind of feel like we know what we're doing, and don't feel a need for it particularly. Even if we do. You know, how do you make a priority to go to a two-day-long seminar on teaching?

Something to note is that these quotes are representative of the thoughts that were expressed about improving teaching effectiveness evaluations. The last quote, by HAB2, doesn't directly say that it should be incentivized, but note that the question of "how do you make a priority to go to a two-day-long seminar on teaching?" has the implication that there is no reason to make it a priority. There is no incentive to attend such a seminar. A call for reform of teacher evaluation was echoed by
nearly all of these interviewees, mostly because they felt that these teaching practices should be incentivized; but in order to incentivize them, they must develop evaluation systems that measure how well these improvements were being utilized.

Another suggestion, seen from 22% of the interviews, and once again across all three institution types, was hopes that the educational research community could research departments and institutions where cultures and attitudes of instructional improvement are embraced and encouraged. Many of the administrators felt that there were pockets of “good teaching” inside of their institution. Indeed, most administrators, when asked about how much RBIS is used in their institution said some variation of that there are some departments where it flourishes, and there are some where it is barely given lip service. They said that while they appreciated that culture, they had only assumptions on how it was started. They felt that some research that gave suggestions on how to encourage a culture of teaching improvement would be very welcome. Some representative quotes follow.

HAG2: Well, the other research area I think has to be in how you found and implement cultural change on campus, in relationship to teaching. That's kind of a look, I think at the top-down versus bottom-up approach for changing climate, as well is a hybrid model for cultural change on campus. I don't think historically we [Higher Education] are very good at cultural change

HAT3: And I think also one of the questions, it will be interesting to differentiate between one's own institutional research - or even at the outcomes
level, the instructor research - bubbling upward, is there a culture of that in other places or not. Because I can send people to conferences all day long, but it's also - but good ideas don't just come from the guy from out of town. It's also good, it would be interesting to see how many places are, how they spread knowledge... Like Joe X at the college has this great idea teaching in his physics class, or its really working for him, or he's adopted some sort of thing based on other people's research. Is he the one promoting it other people the department? You know what I mean. It's that, that sort of thing. How does it go from the instructor level up and out.

HAG6: [A culture of appreciating instructional improvement] has to bubble up, and it has to come from the top. Both have to happen simultaneously. Because if they don't, then you've got that if it comes from the bottom, if it bubbles up and no one at the top recognizes it, then they are just block it. If you go from the top and it doesn't bubble up, then they are just going to say, "Well, we are just going to wait them out. Because the next Provost won't care." So you've got to consciously do this from both directions.

Two more suggestions showed up in 17% of the interviews, and while that may not be a large number, the author feels that both are important. The first was a request for more succinct and accessible ways to find out about educational research, like a central website. This is interesting, because this suggestion showed up in both the PI and WP interviews as well. While there may be websites and collections that already exist, they are obviously not being marketed correctly, or perhaps the delivery of the techniques is not accessible enough for the average faculty member to take full advantage.

The other suggestion was for faculty to receive some pedagogical training. While a few interviewees felt that providing pedagogical training is the responsibility of the
institution that hires them, several more interviewees thought that pedagogical training should be a part of all graduate education. The reasoning many of the administrators gave was that if the major employment that persons with Master’s degrees and Doctorates were to eventually arrive at was at an institution of higher education, where a major responsibility (the largest responsibility according to some interviewees) would be teaching, then some teaching methodology and cognitive theory should be a part of graduate education. Many of these interviewees expressed a frustration with the traditional model for faculty, where knowledge of content area was the qualifier for the teaching portion of any faculty hire. As HAG3 put it: “How do you require [faculty] to take formal pedagogy? People need that. I mean, look at K-12 teachers, they have to do it.” There can seem to be a double standard, where society considers both content knowledge and pedagogical training necessary to teach K-12, but it is accepted that in higher education only content knowledge is required to do what some would consider more complex teaching. Some exposure to pedagogical methods would not only give future faculty tools to use when they eventually start teaching, but also reduce the resistance seen by many of the interviewees from other faculty towards non-traditional methods of instruction.

There were three suggestions and problems that the author found worthy of further consideration; they were not necessarily mentioned often, but nonetheless deserve some attention. The first was only suggested by 9% of the interviewees, but was a
subject discussed by many others. The difference between programs that must report to an accrediting body, and programs that do not, was noted in direct reference to engineering programs and physics programs. Accreditation boards provide standards for higher education curricula, and require certain essential skills to be taught and assessed in order for a program to receive accreditation. It was noted that Engineering programs must conform to ABET (the Accreditation Board for Engineering and Technology) standards, and while a particular program may not follow the spirit of the standards, it was a "step in the right direction." ABET was juxtaposed with Physics, which has no accrediting body at present, and it was suggested that physics programs could benefit from such an agency.

The next interesting suggestion was for research comparing "good" face-to-face teaching with "good" online courses, in order to assess which one was truly helpful. It is interesting today as many online programs such as the Khan Academy, and MIT OpenCourseWare begin to gain popularity, that some research on the efficacy of these programs are desired by administrators. Administrators acknowledged that many studies into the efficacy of online instruction have been conducted, but as HAG6 puts it, "I don't know that anybody has done a really good study - maybe you're aware of it - as to which [online or face-to-face] is better when it is done really, really well." Administrators see that these studies need to be done with exemplary examples of each in order to truly compare them.
The final interesting problem, in that several administrators (17%) stated that they do not read primary research, and primarily find out about educational research findings through general books or journals that collect or synthesize current findings. It is important to note that although many of these research suggestions may have already been done in one form or another, the administrators who can implement change in Institutions of Higher Education may not even see these studies. This could be aided by the suggestion from faculty interviews to create a central repository for PER and other educational research and make it well known not just to faculty, but also to administrators.

The major HA interviewee suggestion, to improve faculty evaluation, is supported by a comparison analysis of the assessment data from the faculty interviews and HA interviews. If one looks to Figures 7 and 8, it can be seen that the major trends from the faculty interviews hold true in the administrative interviews. Both administrators and faculty report that their institutions primarily use Student Assessments of Teaching (SETs) and Peer Observations to gauge teaching effectiveness in faculty. However, both sets of interviewees also agree that faculty judge most of their teaching effectiveness from Exams and Homework Performance, Systematic Formative Assessments and Informal Formative Assessments. This is a large disconnect, and could point to a major flaw in the Educational Research Community’s assumptions; namely, that
faculty will be naturally motivated to improve their teaching since teaching is a large part of their job. However, if they are not evaluated (or do not feel they are evaluated) by measures that accurately reflect their teaching, but rather on how well they appear to be doing in front of their students (measured by SETs) and in front of their peers (measured by peer observation) then perhaps they are performing a simple cost-benefit analysis. The result of this analysis is that research-based teaching, while intrinsically rewarding for students and instructors in the long run, may not show immediate success and result in several negative consequences. These consequences could be poor peer observations and poor student evaluations, with the end result of the faculty member losing their employment. If the implementation of RBIS takes time and effort to be done well, and may even lead to some failures along the way, why should a faculty member possibly risk their job by getting bad peer and student reviews due to the faculty member acclimating to the RBIS? This seems to be a fundamental disconnect between where faculty feel they get the most data that reflects their performance, and where their performance is actually assessed. This is especially curious since administrators agreed with the faculty, in that there is a disconnect between what institutions use to evaluate teaching effectiveness and what faculty use to do the same. If this disconnect is seen by administrators, with whom it is conventionally assumed hold the power to alter this assessment, then why are they not addressing the difference?
However, many administrators pointed out that the promotion and tenure requirements are reached through contract negotiations and bylaws of the institution. There appears to be a stalemate, where both faculty and administration are aware there exist deep flaws in their teaching evaluation, yet there is no movement or agreement on how to fix it.
CHAPTER 5

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

In summary, the faculty interviewees agreed that department culture raises barriers to implementation of RBIS, and even once RBIS are used, dissemination of support materials for RBIS needs to be improved. The administrators agreed with the above recommendations and added that research on successful cultures of instructional improvement would be helpful. Another area of agreement was that faculty need some pedagogical training, whether provided by their institution of employment, or through their graduate education. The analysis of the interviews, and the assessment data from both sets of interviews show that the largest element of departmental culture that should be realigned is teaching evaluation. A broader accumulation of information on student learning is required to create an evaluation system that is not only evaluative of what the students' have learned, but also of the instructor's methods, and can provide meaningful feedback for instructional improvement. The problems seen in the HA interviews, of administrators not reading primary research and accreditation bodies can both be addressed inside of the previous suggestions. Wider dissemination efforts in more popular publications would answer both the PI recommendation of improving dissemination and help with the problem with administrators not reading primary research, whereas an accrediting body would require meeting certain learning outcomes and provide metrics for
teaching evaluation. Below are five specific recommendations resulting from this study.

Recommendations

(1) Teaching effectiveness evaluation must be improved. The assessment disconnect, where faculty measure their teaching effectiveness differently than how institutions measure it, must be resolved. There are several avenues for correction that can be taken. Accrediting bodies could be created for content areas, such as physics, that do not have one. Research can be done to develop comprehensive evaluation systems that can be standardized across institutions of Higher Education. Rich systems of evaluation should include more of the eight methods involved in the assessment analysis, but all must be fleshed out and standardized criteria created.

(2) The instructional strategies that institutions or departments wish to implement should be incentivized. The use of RBIS and instruction based in research should be rewarded and recognized. If there are strategies that administration wishes to see used (all HA interviews said they think research-based instruction should be more widely used on their campus) then there should at the very least be recognition for the implementation and successful use of these strategies.
(3) Studies on the development of institutional cultures where instructional improvement is encouraged and flourishes should be conducted, to help provide frameworks for other institutions who wish to develop this culture that administrators requested. This can also solve the problems seen in the faculty interviews, where other faculty are not very accepting towards faculty who push instructive improvement and the complaint that instructional improvement is not valued by institutions.

(4) Educational research should be more succinct and accessible, collected in a convenient tool (like a website) for easy access and dissemination. This was echoed in the faculty interviews and the administrator interviews. It would help the PI and WP recommendation to improve dissemination, as well as provide a resource for administrators to use.

(5) Faculty need training in teaching methodology, preferably as a part of their graduate education. To be robust, pedagogical training should come both in graduate education and from the institution. Exposure at the graduate level will help reduce skepticism as graduate students become faculty, and will also lay a solid pedagogical foundation for institutional training to build on.
A recommendation that cannot be directly addressed by the PER and educational research communities is a lack of funding at the state and federal level. The author feels that this problem needs to be discussed, but sees no direct way for PER to increase this funding shortfall.

What is agreed across the interviews and supported by the background research for this thesis, is that educational research is not proliferating throughout Higher Education. If educational researchers and those who believe in educational research wish to move the discipline forward, these suggestions offer a road map and possible future research topics to pursue. Additionally, the problems seen in this research show that there may be several flawed assumptions about the resources to provide instructional improvement, assessment of teaching effectiveness, and dissemination of RBIS. Any research done without taking these possibly flawed assumptions into account, may well be doomed from the start.
REFERENCES


APPENDIX A

Higher Education Administration Interview Protocol

Introduction

Thank you for agreeing to talk with me today. As I mentioned in the email, we are interested in better understanding how educational research influences teaching practices used by faculty at your institution. Part of our motivation is to identify ways that educational researchers can do a better job of matching the needs and interests of faculty and institutional leaders.

General Questions

I'd like to start with some questions that will help me develop a better idea about the culture and structures at your institution that relate to teaching improvement.

1. What are the ways that your institution encourages faculty to improve their teaching practices? [Note: want as many specifics as possible about each type of encouragement.] (possible follow up: In institutional encouragement, is there an emphasis on specific instructional strategies or research-based instructional strategies? If so, which ones are emphasized and how are these selected?)

a. What resources does your institution provide for teaching improvement?
   (possible follow up: Some of the forms of resources we have heard of from previous faculty surveys are: release time for course development, arranging for conference or workshop attendance, extra staffing for reduced class size, and funding for room redesign or extra equipment. Does your institution use any of these or has it considered using any of them?)

2. What are the ways that your institution discourages, intentionally or unintentionally, faculty from improving their teaching practices? I realize that there is probably not any official policy of discouraging faculty from improving their teaching, but there may be cultural or structural barriers that you are aware of that have the unintended consequence of discouraging faculty. [Note: want as many specifics as possible about each type of
discouragement.] (possible follow up: Have there been any discussions on campus about changing this thing? If so, how have the discussions gone?)

3. In your opinion, what attitudes do your faculty members hold about instructional improvement?

4. How does your institution evaluate teaching effectiveness? (If multiple tools are used, how is each weighted?) How much is this information used to decide promotions, tenure level, etc.? What do you think faculty with this information? Are there other types of information faculty use to measure their own teaching effectiveness? (Does the interviewee think institutional teaching measures work? What about faculty methods?)

The next set of questions has to do with your impression of research-based strategies and your thoughts about what the educational research community might be able to do to better support the use of these strategies.

5. How familiar are you with instructional strategies or teaching recommendations from [Physics] Education Research [only use physics with people in physics departments – otherwise, be more general unless they express a special knowledge of physics]? (Try to get as much information as possible about specific strategies they are aware of and what they think of these strategies.)

6. To what extent are research-based strategies used on your campus [in your department]. (If they are widely used, ask how they became established)

7. Do you think it would be beneficial for there to be more use of research-based strategies on your campus [in your department]. (Ask why they feel this way.)

8. What do you think that the [physics] education research community could increase the use of research based instructional strategies (either on your campus/department or more generally)?

9. Those are all of my formal questions. Are there any questions related to these issues that you think I should have asked or any additional things that you think are related to the topics we have discussed that would help me better understand the situation?
APPENDIX B

Coding Breakdown Used In Interview Analysis

Increasing the Impact of PER: Identified Difficulties and Recommendations

1. Department and Institutional culture
   1.1. Instructional improvement is not valued by departments/institutions
      1.1.1. More lobbying departments to support faculty (especially junior) who want to try PER strategies.
      1.1.2. Get institutions to value Scholarship of Teaching & Learning (SoTL)
      1.1.3. Class sizes too large to practice most PER, or perform instructional improvement.
      1.1.4. Departmental inertia – “This is the way we’ve always done it.”
      1.1.5. Research is valued equally or over teaching effectiveness.
      1.1.6. Faculty workload is too great to try new instructional strategies.
   1.2. Assessment of faculty teaching not based on measures student learning
      1.2.1. Faculty (especially untenured) see it as dangerous to experiment with PER and maybe get poor teaching evaluations.
      1.2.2. Part of the problem is that research is easier to evaluate than teaching – better teaching evaluation tools needed.
      1.2.3. Due to assessment not based on teaching or not effective evaluation, each professor considers his/her own classes sacrosanct
   1.3. Other
      1.3.1. Shouldn’t spend too much departmental energy on intro courses – this saps energy (time and $) from physic majors.
      1.3.2. There are a lot of good PER things, but to be most effective, the whole department should adopt a similar philosophy.
      1.3.3. PER can help with assessment issues (i.e., growing emphasis on assessment).
      1.3.4. PER techniques take time, reduces perceived efficiency of class time

2. More research on PER methods is needed
   2.1. What is the evidence-based support for different PER pedagogies
      2.1.1. PER research results are not believable -- Assessment methods in PER are biased towards the method being studied.
2.1.2. PER studies show success due to novelty of approach, not necessarily effectiveness of method.

2.1.3. Faculty were taught using lecture; why isn’t that still good? Evidence from hundreds of years of producing physicists.

2.1.4. More variables considered; i.e. retention rates

2.2. Discuss how PER ideas work in different situations

2.2.1. (i.e., types of institutions and students). Much of PER is done at large RI schools.

2.2.2. Can PER be used for large (>100) class sizes?

Most info is on small (<20) classes.

2.2.3. PER labs for traditional lecture and vice versa

2.3. More research on parts of PER ideas that make a difference

2.3.1. What aspects of PI make a difference

2.3.2. How does conceptual understanding improve problem solving?

2.4. PER should focus beyond conceptual understanding

2.4.1. Students need to learn how to solve problems in a physics class - many PER strategies focus on conceptual understanding.

2.5. Other

2.5.1. Breadth vs. depth tradeoff

2.5.2. Focus more on upper-level physics

2.5.3. How to reduce student resistance

2.5.4. Success in PER is enthusiasm and spontaneity, not actual technique

3. PER needs to improve dissemination efforts

3.1. There is so much PER stuff out there and it can be hard to find and sort through

3.1.1. Need easier access to PER materials. Like a website or web tool.

3.1.2. Need ways to keep up with new ideas.

3.1.3. Have consultants to recommend solutions to departments.

3.2. Higher profile dissemination efforts

3.2.1. for example, articles in Physics Today

3.3. There are many isolated faculty (typically at smaller schools or TYC or “pureblood” physicists) that may not know about PER products

3.4. It is important to start slowly when making instructional changes

3.4.1. PER should support this - or at least emphasize that it is OK

3.4.2. There should be models or recommendations about how to make this shift

3.5. It is important to have ways to learn about things in more detail

3.5.1. (not that it exists, like NFW, but how to really use it

3.5.2. Longitudinal study on effectiveness of PER
3.5.3. Instructor Training is key, seeing how the strategy works.
3.5.4. Need better ways to guide faculty through implementation

3.6. Disseminate to support customization
3.6.1. Need to do more to get faculty engaged in thinking about how well a PER product could work for them.
3.6.2. Teaching methods need to fit with personality (e.g., Prather is very gregarious and I am shy – how he manages class is not a good model for me), career stage (early, mid, late, etc.), and authority (should be options for faculty to implement without rocking boat)
3.6.3. PER strategies should be customizable – Authors should plan for this eventuality

3.7. Other

4. Other
4.1.1. You can’t change older faculty - you just have to wait
4.1.2. Astronomy does a better job at impacting faculty than physics does.
4.1.3. TYC folks can feel slighted when R1 schools get recognized for innovative teaching (something TYC faculty feel that they have been doing all along)
4.1.4. Expose grad students to PER ideas
4.1.5. Ways to involve non PER faculty in PER projects.

A. Suggestions and Problems
A1. Research should be more succinct and accessible, use less jargon
A2. Physics needs an outside accrediting body
A3. Teaching effectiveness Evaluation must be improved (Incentivize instructional improvement)
A4. Research how to change department culture and study successful cultures
A5. Research how good face-to-face compares to good online/hybrid courses
A6. Faculty needs pedagogical training (i.e. Outcomes) as well as content training
A7. Lack of funding for instructional improvement
A8. Administrators don’t read primary research.
APPENDIX C

E-mails Describing Study For Possible Participants

SUBJECT: Invitation to participate in interview

Dear XXX,

I am a graduate student at Western Michigan University and am working with Dr. Charles Henderson, who is a faculty member in the Department of Physics.

I would like to invite you to participate in a research project titled "The Influence of Educational Research on Teaching Practices". As part of this project I am planning to talk to decision-makers at a variety of higher education institutions. I am hoping that you would have time for a brief (~30 min) interview, either in-person or via the telephone to discuss your views about how educational research has influenced teaching practices at your institution and how you think this impact can be improved. If you are able to accept this invitation, please respond to this email and suggest a time that you would be available to participate in an interview. [or, alternatively, If you are able to accept this invitation... I will be on your campus the day of XXX and could meet with you any time between YYY and ZZZ.]

Please let me know if you have questions about the study.

I look forward to hearing from you.
Trevor Stefanick
Western Michigan University
trevor.stefanick@wmich.edu

FOLLOW-UP EMAIL

Dear YYY,

I have not heard back from you regarding the invitation to participate in an interview study. I hope you are able to participate. I look forward to hearing from you.

Sincerely,
Trevor Stefanick
Western Michigan University
trevor.stefanick@wmich.edu

[Original message below]
APPENDIX D

Phone Invitation Script

TREVOR STEFANICK: Hello XXX, my name is Trevor Stefanick and I am a graduate student at Western Michigan University. I sent you a couple of emails asking if you would be willing to participate in an interview study on decision making in Higher Education. Did you receive these emails, and if so, are you interested in learning more about participating?

IF ANSWER IS NO

TREVOR STEFANICK: I understand, thank you for your time.

IF ANSWER IS YES

TREVOR STEFANICK: Thank you. Would you like to schedule a phone interview, or is there a time I can meet with you on campus? We will send an informed consent document for you to look over and sign shortly.

IF ANSWER IS “I did not receive those emails”

TREVOR STEFANICK: I understand. Would you like to hear about it now?
   (If yes, proceed/If no, offer to resend emails or set up alternative time to call)
Like I said before, I am a graduate student at Western Michigan University and am working with Dr. Charles Henderson, who is a faculty member in the Department of Physics. I would like to invite you to participate in a research project titled "The Influence of Educational Research on Teaching Practices". As part of this project I am planning to talk to decision-makers at a variety of higher education institutions. I am hoping that you would have time for a brief-approximately 30 minute- interview, either in-person or via the telephone to discuss your views about how educational research has influenced teaching practices at your institution and how you think this impact can be improved. If you would be interested in this invitation, we can set up a time that you would be available to participate in an interview, either over the phone or in-person.
(If they are interested, proceed to set up a phone interview or a date and time to meet in person and send informed consent document. If they are not interested—)

TREVOR STEFANICK: I understand, thank you for your time and attention.
APPENDIX E

HSIRB Informed Consent Form

Western Michigan University
Department of Physics

Principal Investigator: Charles Henderson
Student Investigator: Trevor Stefanick
Title of Study: The Influence of Educational Research on Teaching Practices

You are invited to participate in a research project titled “The Influence of Educational Research on Teaching Practices.” This project will serve as Trevor Stefanick’s thesis for the Master’s of Arts in Physics. The project goal is to better understand administrator’s views about barriers and affordances to the use of educational research results to improve college teaching. Interviews are planned with administrators that have an influence on teaching practices used in undergraduate physics courses (e.g., Dean, Department Chair, Director of Undergraduate Studies, etc.).

What will you be asked to do if you choose to participate in this study?
Participation in this study involves one interview that will last from 30-60 minutes. This interview will be conducted at a mutually agreeable time either in person or via telephone. The interview will contain questions about your experiences with educational research results and institutional policies and practices that relate to the use of these results in teaching. The interview will be audio recorded for later transcription and analysis. Only Trevor Stefanick and Charles Henderson will have access to your information and identifying factors. Additionally, any information used from your interview that may appear in publications or be presented in any venue will have any identifying information removed.

What are the risks and benefits of participating in this study and how will these risks be minimized?
We would like you to express frank and personal views to the questions we ask, but we realize that criticism of colleagues or policies could be used against you. In order to minimize this risk, all reporting of data will be carefully ‘cleaned’ to remove any distinguishing features. Although there are no direct benefits to you, the goal of this project is to improve undergraduate teaching.

Are there any costs or compensation related to this study?
There are no costs to you should you participate in this study, but neither is there compensation, monetary or otherwise, should you choose to participate.

You can choose to stop participating in the study at any time for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study.

Should you have any questions prior to or during the study, you can contact the primary investigator, Charles Henderson at 269-387-4951 or Charles.henderson@wmich.edu, or the student investigator, Trevor Stefanick at 269-760-8182 or trevor.stefanick@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

Please Print Your Name

Participant’s signature Date
Date: December 1, 2011

To: Charles Henderson, Principal Investigator
   Trevor Stefanick, Student Investigator for thesis

From: Victoria Janson, Interim Chair

Re: HSIRB Project Number 11-11-26

This letter will serve as confirmation that your research project titled "The Influence of Educational Research on Teaching Practices" has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: December 1, 2012