Project Summary | **Collaborative Research: WIDER: EAGER: Increasing Faculty Use of Formative and Summative Assessment through Online Resources and Faculty Development**

Physics departments are under increasing pressure to assess the student learning outcomes of their classes and programs in order to reduce Drop/Fail/Withdraw rates, maintain program size, and receive or renew programmatic (e.g. with ABET) or departmental accreditation (e.g. with regional higher education associations). The field of physics education research (PER) has made significant progress in developing research-based assessment instruments, techniques for formative assessment, and alternative assessments for complex learning goals. However, there is a wide gap between the language and goals for assessment used by physics faculty members and department chairs and those used by physics education researchers. This gap results in a disconnect between researchers who do not answer the questions about assessment that most matter to faculty, and faculty who do not use assessments that are informed by research. The goal of this project is to build a bridge between these two groups by providing tools (online assessment resources and synthesis research) to arm faculty to do better assessment, and professional development (a workshop and online support for physics department chairs) to teach chairs, as agents of change, how to use those tools. This work will have three major impacts:

1. Department chairs will learn to assess learning in their departments in a way that is consistent with their goals and language and connected to results in PER, thus meeting their need for assessment tools and transforming the way assessment is done in physics departments throughout the country.
2. Physics education researchers will increase their understanding of the assessment needs related to program review, resulting in improved tools to meet these needs and potential new areas of research.
3. Assessment is a gateway drug that will lead to increased adoption of evidence-based teaching. By arming chairs with good assessment practices tied to their needs and goals, this project will give them the tools to engage their departments in a systematic process of examination and improvement of teaching and student learning. We will facilitate the connection between assessment and evidence-based teaching by connecting online assessment resources to existing resources for PER-based teaching methods on the PER User's Guide (http://perusersguide.org).

This project will achieve these impacts through the following activities:

- **Develop online assessment resources** including (1) a guide to the research behind and the use of many different types of formative and summative assessments, (2) a comprehensive collection of overviews of PER-based assessment instruments, and (3) a database system to collect and analyze results of research-based assessments. These resources will enable all other activities in the project.
- **Survey chairs** to identify the questions about assessment that are most important to them.
- **Develop an in-person workshop and online follow-up for department chairs** on incorporating PER-based assessments into their departments and developing departmental assessment plans.
- **Develop online modules and guides to address the questions identified by the survey** (example questions may include "How can I identify which students are going to fail out before they fail out?" and "How do I connect ABET criteria with student learning?")
- **Conduct synthesis research** to analyze data collected through the new assessment results database and the existing rapid analysis and web reports (RAWR) system in order to assess the state of PER-based teaching and answer research questions relevant to department chairs.

Broader Impacts: This project has the potential to transform how both assessment and teaching are done throughout the country by increasing the use of decades of physics education research. The impact will be maximized by targeting physics department chairs, who are already deeply motivated to do assessment for departmental and accreditation reasons, and are in positions of authority and able to affect departmental change. Assessment will start the transformation in an area where chairs are already eager for new tools, and leading naturally towards evidence-based teaching.

Intellectual Merit: The PER community has developed dozens of research-based assessment instruments, which have been given to many thousands of students throughout the country. However, the results of these assessments have not been collected or analyzed systematically. This project will create an assessment results database that will collect results from around the world and synthesize these to provide an overview of the state of PER-based teaching. Synthesis research will include updating and expanding the 1998 Hake study to compare the impact of many PER-based teaching methods in a variety of environments, and reinterpreting existing data sets to answer chairs' authentic assessment questions.

Overview

Physics departments are under increasing pressure to assess the student learning outcomes of their classes and programs in order to reduce Drop/Fail/Withdraw rates, maintain program size, and receive or renew programmatic (e.g. with ABET) or departmental accreditation (e.g. with regional higher education associations). The field of physics education research (PER) has made significant progress in developing research-based assessment instruments, techniques for formative assessment, and alternative assessments for complex learning goals. However, there is a wide gap between the language and goals for assessment used by physics faculty members and department chairs and those used by physics education researchers. This gap results in a disconnect between researchers who do not answer the questions about assessment that most matter to faculty, and faculty who do not use assessments that are informed by research. The goal of this project is to build a bridge between these two groups by providing tools (online assessment resources and synthesis research) to arm faculty to do better assessment, and professional development (a workshop and online support for physics department chairs) to teach chairs, as agents of change, how to use those tools. This work will have three major impacts:

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There is substantial evidence that implementing meaningful department-wide assessment practices can have a strong impact on increasing the use of research-based teaching methods. For example, in a study of the results of ten years of assessment of introductory physics courses using research-based assessment instruments at the University of Colorado (CU), Pollock and Finkelstein report, “Collecting and analyzing these data is good not only for individual course assessments, but also for studying and supporting systematic transformation. We can use such data to move beyond assessments of a single instructor and a single course to observe the factors that support the widespread adoption and effective implementation of educational practices. For instance, at CU, *the data serve as a mechanism for change*. Collecting and reporting these data has become a part of departmental practice. Faculty are privately informed of their performance each semester, and given anonymized versions of these plots to contextualize their performance. While far from perfect, it helps us move beyond the standard end-of-term student evaluation as the sole metric of quality. We are beginning to couple teaching with learning.” (emphasis added)[1]

There is further evidence that systematic assessment is not only helpful, but also necessary, for meaningful transformation of teaching practice. In a literature review of 191 articles on promoting instructional change in undergraduate STEM education, Henderson et al. report, “Successful strategies focused on disseminating curriculum and pedagogy typically involve more than one of the following components: coordinated and focused efforts lasting over an extended period of time, *use of performance evaluation and feedback*, and deliberate focus on changing faculty conceptions.”[2]

Further, STEM department chairs are motivated by increasing calls to implement effective assessment programs to fulfill accreditation requirements: “Acknowledging the growing consensus that student learning outcomes are the ultimate test of the quality of academic programs, accreditors have also refocused their criteria, reducing the emphasis on quantitative measures of inputs and resources and requiring judgments of educational effectiveness from measurable outcomes.”[3] Research has found “evidence of a connection between changes in accreditation and the subsequent improvement of programs, curricula, teaching, and learning in undergraduate programs.”[3]

Results of Prior Support

PER User's Guide

The PER User's Guide[4] is a growing web resource to help physics educators learn about and apply the results of PER in their classrooms, developed by the American Association of Physics Teachers (AAPT) in conjunction with the ComPADRE digital library[5]. A national survey of physics faculty conducted before the launch of the User's Guide found the majority of faculty (70%) are interested in using more PER products in their teaching but report failing to do so mostly because of time constraints (50%) and lack of access to and knowledge about resources (25%). The PER User's Guide directly addresses these significant reform barriers by summarizing, condensing, and translating the vast web of knowledge from PER for use by non-experts, to better support instructors desiring to reform their teaching towards research-based practices. An NSF grant (DUE 0822342, PI:McKagan) funded the development of a pilot site and initial user testing.

Site Development

The pilot site currently contains: overviews of over 50 research-based teaching methods; a list of resources in PER; answers to frequently asked questions and concerns about PER; a guide to what makes PER-based teaching methods work; and a wizard to help instructors find methods to use given their environments and priorities. The wizard allows instructors to filter teaching methods based on criteria such as the instructional environment, the instructor's goals, and various types of research validation. Additional features currently under development include: explanations and references for the research-validation of all teaching methods listed on the site, an article summarizing the top 10 results of PER that every physics instructor should know, and detailed implementation guides to selected methods. Each of these implementation guides contain approximately 20 pages of text, graphics, and multimedia demonstrating the method through suggestions for implementation, ways to address common challenges and questions, a summary of the research base behind the method, classroom videos, reviews by other adopters, case studies of successful adopters, and ways to connect with other adopters.

We have placed our initial focus on PER-based teaching methods because the field of PER has focused heavily on the development and dissemination of specific methods, including curricula, techniques, and resources, as a key mechanism of educational reform[6]. There are also many other important mechanisms and other aspects of PER that are useful to instructors, for example, content-specific teaching suggestions, which are the focus of other pending proposals. The current proposal will allow expansion of the site to include PER-based assessment resources.

User Testing

We have conducted user tests of the pilot site, including the navigation bar, the teaching method overviews and wizard, and the Frequently Asked Questions (FAQ) page. These user tests consist of interviews with potential users of the site, in which the interviewer evaluates usability by watching users think out loud while using the site to complete authentic tasks. This method is similar to that used by the PI and others in the PhET Interactive Science Simulations Project[7] to evaluate web-based educational materials[8]. Five[9] physics educators participated in these usability interviews. The interviews allowed us to evaluate the effectiveness of the site, learn more about what users were looking for, and determine ways to modify and expand the site. The results indicated that the site was very easy to use and contained useful information. The interviews also uncovered many areas for improvement and expansion of the site. Several small usability and wording issues discovered in the interviews were addressed immediately. Larger issues will be addressed in a future project (proposal pending).

An additional result of our previous user testing was a proof of concept of the feasibility of conducting interviews remotely. We conducted two interviews in person and three interviews remotely, using *Skype* and *Call Recorder for Skype* to enable the interviewer and interviewee to talk, and to record the conversation and the screen of the interviewee. We found that even interviewees who claimed to have very little proficiency with computers were able to install *Skype* and use it. Further, in the remote interviews, interviewees were able to use their own computers in their own offices, which appeared to help them have a more comfortable and authentic experience. We plan to conduct all interviews remotely in the current proposal, which will allow us to recruit from a much wider pool of potential interviewees and cut travel costs dramatically.

Rapid Analysis and Web Reports (RAWR) System

The Response Curve is a recent innovation in evaluation that allows measurement of student understanding on time-scales inaccessible to traditional pre/post-testing, weeks or finer. With response curves, evaluators can observe the dynamics of student learning and measure temporal phenomena such as constructive and destructive interference between topics.

At the heart of response curve analysis is a large-N between-student analysis in which the class is divided into groups of students. Each group is tested in different weeks, and the conceptual understanding of the class (or epistemological or affective issues) is thus tracked over a semester. The between-student nature of the testing insures that there are no test-retest effects (each student performs the task only once) nor false isomorphism between questions (questions are reused each time). The between-student design also requires that enrollments be large (>300 students/semester for weekly testing).

Because the traditional administration of a large number of paper tests is unwieldy, we developed RAWR: the Rapid Assessment and Web Reports system (DUE 1240782, PI: Sayre). RAWR was seeded with conceptual and epistemological questions from introductory physics; this domain was chosen because of a large extant body of research on student understanding and validated questions that could be modified for online administration. RAWR has been administered to over 8000 students at the Rochester Institute of Technology (RIT) and the United States Military Academy, West Point.

Response curves from RAWR and related studies using paper-based assessment have investigated the dynamics of students' understanding in electrostatics[10] circuits and magnetic field direction[11], Newton's Third Law[12], force and motion[11], epistemology and self-efficacy[13], and vectors[14]. The RAWR system will be available to this project for data analysis purposes; department chairs may also wish to implement RAWR for faculty in their departments to use as part of systematic departmental assessment projects.

Physics and Astronomy New Faculty Workshops

In 1996 the American Association of Physics Teachers (AAPT), in cooperation with the American Physical Society (APS), received a grant from NSF (DUE 0813481, PI: Hilborn) to conduct a series of workshops for new tenure-track physics faculty in the first three years of their appointments. The workshop proved to be very successful and a second grant was received from NSF in 2001 to continue the workshop with the addition of the American Astronomical Society (AAS) as a cooperating partner.

For the workshops held from 1996 through 2007, 843 new physics and astronomy faculty members representing 344 distinct colleges and universities attended the Physics and Astronomy New Faculty Workshop (NFW) held each fall at the American Center for Physics in College Park, MD. This group's home departments constitute approximately 43% of the 797 degree-granting physics and astronomy departments in the US. In addition, 170 departments (21% of all departments in the US) have had more than one faculty member attend the NFW. A new grant awarded in 2008 allowed AAPT, APS, and AAS to offer two workshops per year and nearly double the number of participants. We have now reached over 1400 new faculty members in physics and astronomy. As a result, each year we host almost half of all early career (assistant professor tenure-track) hires in physics and astronomy across the country.

Charles Henderson, NFW external evaluator, conducted follow-up surveys with NFW participants and their department chairs.[15] He found that most of the participants implement at least some of the pedagogical strategies learned in the workshop and that the department chairs believe that the participants are having a positive impact on student learning and the department's receptivity to enhancements in teaching. While recognizing the limitations of these kinds of surveys, we argue that the workshops do seem to have a significant impact on both the participants and their home departments.

Project Plan

This project will achieve its impacts and build on previous work through the following activities:

- **Develop online assessment resources** including (1) a guide to the research behind and the use of many different types of formative and summative assessments, (2) a comprehensive collection of overviews of PER-based assessment instruments, and (3) a database system to collect and analyze results of research-based assessments. These resources will enable all other activities in the project.
- **Survey chairs** to identify the questions about assessment that are most important to them.

- **Develop an in-person workshop and online follow-up for department chairs** on incorporating PER-based assessments into their departments and developing departmental assessment plans.
- **Develop online modules and guides to address the questions identified by the survey** (example questions may include "How can I identify which students are going to fail out before they fail out?" and "How do I connect ABET criteria with student learning?")
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Timeline

<table>
<tr><th></th><th>Online assess-ment resources</th><th>Survey of chairs</th><th>Workshop for chairs</th><th>Online modules and guides</th><th>Synthesis research</th></tr>
<tr><td>Wi-Sp 13</td><td rowspan="3">Develop online assessment resources, user testing</td><td>Develop survey</td><td rowspan="3"></td><td></td><td></td></tr>
<tr><td>Sum 13</td><td>Conduct survey</td><td></td><td></td></tr>
<tr><td>Fall 13</td><td>Analyze results</td><td rowspan="4">Develop modules based on survey results and workshop feedback</td><td rowspan="4">Conduct analysis of results of multiple assessments</td></tr>
<tr><td>Wi-Sp 14</td><td rowspan="3">Refine resources based on user testing and survey results</td><td rowspan="3"></td><td>Develop workshop</td></tr>
<tr><td>Sum 14</td><td>In-person workshop</td></tr>
<tr><td>Fall 14</td><td>Online follow-up</td></tr>
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Impact

We estimate that our workshop will have a significant and long-term impact on approximately 20 chairs (with a smaller impact on many more), who will initiate reforms in their respective departments that will impact 200 faculty members (10 per chair), who will impact 20,000 students per year (100 per faculty member). In addition, our online resources will have a direct impact on 600 more faculty members (approximated as10% of the current 6000 unique visitors per year to the PER User's Guide), impacting another 60,000 students per year.

Online assessment resources

1. Guide to assessment

Many physics faculty members, even those who are not interested in PER-based teaching methods, are eager for better ways of assessing their students' learning. Over the last several decades, the field of PER has developed a variety of effective methods for assessing both teaching and learning. These include multiple-choice surveys given to students before and after instruction for summative assessment of students' learning gains[16,17], observational protocols for evaluating reformed teaching[18], formative assessment practices such as Peer Instruction[19] or RAWR[10-11], and the overall approach of systematic development of learning goals and regular assessment of these goals to improve teaching on a departmental level[20]. However, it is difficult for instructors to find information about these tools or how to use them effectively. As a first step in helping faculty and departments assess teaching and learning systematically and use research-based techniques, we will provide overviews for faculty on a variety of research-based assessments in their classrooms. These overviews will cover a range of types of assessment, including summative, formative, and programmatic. It will be targeted towards physics faculty in general, not only chairs, but developed with the aim of providing useful tools for chairs implementing research-based assessment in their departments.

2. Assessment instrument guide

PER-based assessment instruments[16,17] have had a major impact on physics education reform by providing a universal and convincing measure of student understanding that instructors can use to test the effectiveness of their teaching. The Force Concept Inventory (FCI)[16], a test of basic concepts of forces and acceleration, has been given to thousands of students throughout the world and the results show that PER-based teaching methods lead to dramatic improvements in students' conceptual understanding of mechanics, as summarized by the 1998 Hake study[21]. Surprisingly poor results on the

FCI have convinced many instructors (most notably Eric Mazur, the developer of Peer Instruction[19]) to adopt PER-based methods and radically change their teaching. Similar research-based assessment instruments have been developed in nearly every subject area of physics, but these instruments are often poorly documented and difficult for instructors to find and access. Existing lists of research-based assessment instruments[22] are not widely known among physics educators, are difficult to maintain with the efforts of volunteer labor, and do not contain the information necessary for educators to understand the research validation of an instrument, to understand how to use it correctly, or to compare their students' scores to those of other students in similar classes. Our assessment instrument guide will improve on these lists by providing information about how to use these instruments to assess teaching and student learning, making the instruments themselves easily accessible in one location, by being regularly updated by the PER User's Guide editor, and by adding summaries and research descriptions that have been reviewed by the PER User's Guide Editorial Board. This guide will provide a service both to instructors, by providing documentation and easy access to assessment instruments, and to the PER research community, by relieving assessment instrument authors of the burden of responding to password requests. (ComPADRE currently hosts 8 lesser-known assessment instruments and, with no advertising, the editors receive 5-8 password requests per week.)

The assessment instrument guide design will build on the PER User's Guide teaching method wizard[4]. The wizard is easily modifiable to create a comprehensive collection of overviews of research-based assessment instruments that users could filter in the same way they can now filter teaching methods, using categories such as subject, level, research validation, type, and format. Each assessment instrument overview will provide a short description of the assessment instrument and its research and development, typical scores, and how to access and use it. We will host a password-protected collection of all assessment instruments that we receive permission to host from the developers[23], with a web form that makes it easy for users to request the password, and an AAPT or ComPADRE staff member to monitor and approve password requests.

3. Assessment results database

There have been repeated calls by physics education researchers and educators for a comprehensive database of PER-based assessment instrument scores, where instructors can submit scores from their students and compare them with those of students in similar classes around the country. Such a database would allow instructors to see typical scores that they can use to evaluate and interpret results from their own classes. It would thus provide a basis for comparison between instructors and pedagogies that would enable instructors to assess the effectiveness of their instruction on a variety of topics, promoting the spread of systematic PER-based assessment and the adoption of more effective teaching methods. It would also allow researchers, including but not limited to those funded by this proposal, to systematically analyze the results of assessments given to thousands of students throughout the country, and thus to assess the impact of PER-based reforms in a wide variety of contexts.

The assessment results database prototype will be developed in collaboration with Dr. DJ Wagner, a professor of Physics at Grove City College. Wagner and a student have developed a prototype database, which will be refined and incorporated into this project, hosted on the PER User's Guide, and integrated into the assessment instrument guide. The database will allow faculty members throughout the country to upload student scores, removing identifying information in accordance with human subjects requirements.

After developing the database, we will encourage faculty members to upload data via announcements to listservs and AAPT mailing lists, along with direct requests to faculty we know personally. (We have contacts with numerous faculty members who have been collecting data for many years.) In addition, we will hire an undergraduate student to enter data for faculty who do not wish to enter it themselves. We will then use the data to provide typical scores for instruments in the assessment instrument guide, and to perform the synthesis research discussed below.

Survey of physics department chairs

Department chairs face assessment pressure from several sources, including external accreditation (such as ABET for engineers or teacher licensing requirements for pre-service teachers) and institutional reviews. We will survey chairs to determine what they need to help them use research-supported evaluation methods to address these needs. We will develop the survey in consultation with the Advisory Board, who collectively have expertise as chairs in different kinds of institutions, as PER researchers, and as agents for assessment-driven faculty culture change.

We will send the survey to participants at the last three APS/AAPT Physics Department Chairs Conferences. We will also solicit responses from the department chairs who have sent faculty to the New Faculty Workshop and Two-Year College New Faculty Workshop for the past five years. These chairs have already demonstrated their interest in evidence-based teaching by sending their new faculty to workshops.

The survey will be available online. We will follow-up with solicited faculty to ensure broad participation, and with faculty responders to elaborate their responses and concerns.

Workshop for chairs

The in-person workshop for chairs will be coordinated with the bi-annual AAPT/APS Physics Department Chairs Conference (which over 100 chairs attended this year) or associated with a major APS meeting. At this workshop, we will introduce participants to assessment practices using the language of departmental needs and solutions as determined by the department chair survey. We will cover both survey-based and observation-based assessment methods, as well as an overview of the research that supports them. Because the participants are department chairs, we will focus on summative and programmatic assessment methods, but will also include information about formative learning assessments and their use.

The online assessment resources described above will be an integral part of the workshop, as introducing participants to them will foster their use. We will use the results of the chairs survey to inform and refine the workshop activities so that they are most relevant to the audience's needs and interests.

Because research has shown that one-time workshops are insufficient for lasting change[2], which requires "coordinated and focused efforts lasting over an extended period of time," we will extend our workshop with an online follow-up project. Project participants will develop and enact departmental assessment plans and receive ongoing feedback and assistance on these plans from project staff and from each other. The follow-up project will include online modules, an email discussion list, and a check-in phone call to each workshop participant 1 month and 6 months after the workshop. (Longer-term follow-up will be the subject of a future proposal.)

Online modules and guides

We will design online modules and guides to address specific questions about assessment that are important to chairs. (e.g. "How can I identify which students are going to fail out before they fail out?" and "How do I connect ABET criteria with student learning?") These questions (and answers) will be determined through our survey, feedback from chairs during the workshop, and consultation with our advisory board. These online modules and guides will be used in the workshop follow-up program. As with the online assessment resources, they will be developed in collaboration with a user interface design expert and refined through user testing, as described below.

Synthesis research

We will use data uploaded to the assessment results database, as well as data that already exist in the RAWR system, to conduct synthesis research to provide a systematic overview of the state of PER-based teaching. Synthesis research will include updating and expanding the 1998 Hake study[21], which compared FCI results for traditional and PER-based teaching methods for over 6000 students in 62 courses at over 20 institutions. We will replicate this study with more recent data from a wider range of institutions, courses, teaching methods, and assessment instruments. We will also consider the impact of using alternative forms of statistical analysis. In addition, we will identify and answer research questions that address the authentic concerns of chairs about departmental assessment and teaching practices. Example research questions may include "Which teaching practices are correlated with reduced DFW rates?" or "What pre-course measures correlate with students failing out of physics courses?"

Evaluation Plan

To ensure that our work is relevant and useful to physics faculty, especially chairs, we will conduct frequent checks with faculty outside of the research team. Our advisory board includes a former chair of a large physics department (Zollman), a current chair of a small physics department (McCullough), and a leader in departmental reform and systematic assessment (Pollock). All three members of our advisory board are physics education researchers in addition to having experience in departmental assessment, so they are familiar with the language and goals of both of the groups this project aims to connect. We will

consult with our advisory board on framing issues for faculty, developing the online resources and faculty survey, and developing a workshop and online follow-up modules for chairs. We will have bi-annual meetings via Skype with our entire advisory board, and consult with individual members regularly via email or phone.

Our external evaluator, Henderson, has extensive experience conducting research on faculty change, including a recent literature review of change strategies in higher education in which he determined which strategies are most and least effective for creating faculty change. Henderson will meet regularly with the PIs remotely and/or in person at national meetings; review the overall progress of the grant including the timeline and goals; examine and advise on the research study designs, methodologies, and findings; review and advise on the resource design, development, content, and dissemination.

In developing the online assessment resources, modules, and guides, we will consult with a user interface design expert to ensure that we incorporate best-practice design principles. The online resources will then undergo rigorous user interface testing with faculty at diverse institutions using the methodology described above, using an iterative process of testing and redesign.

Project Staff

Sarah "Sam" McKagan (PI) will lead the development of the online assessment resources and modules, supervise the postdoctoral researcher in developing surveys and conducting synthesis research, and assist in the development of the assessment workshop. McKagan is the creator and editor of the PER User's Guide for the American Association of Physics Teachers (AAPT), and an education research consultant for Seattle Pacific University, Augsburg College, and the University of Colorado. As a developer of online resources to help faculty learn about PER-based teaching methods, she has observed classrooms, interviewed developers and adopters, and developed expertise in a wide variety of research-based teaching and assessment methods.

Eleanor Sayre (PI) will lead the development of the assessment workshop and assist in developing the survey of chairs, following up with workshop participants, and mentoring the postdoctoral researcher, particularly in the area of quantitative data analysis. Sayre is an Assistant Professor of Physics at Kansas State University (KSU). Before arriving at KSU, Dr. Sayre led departmental assessment efforts at Wabash College, focusing on how PER assessment methods can be adapted to the small liberal arts setting, and how results can inform departmental reviews. Dr. Sayre developed the Response Curves methodology which measures student learning and forgetting on the scale of days or weeks in large-enrollment classes. She developed the tasks used in the RAWR system.

Robert Hilborn (co-PI) will coordinate the work of this project with professional society efforts in faculty professional development and instructional reform, and will assist with advertising the online modules to the AAPT community. Hilborn is Associate Executive Officer of AAPT. He is the leader of the Physics and Astronomy New Faculty Workshops that have introduced over 1400 new physics and astronomy faculty members to the latest science pedagogy and the research that supports that pedagogy. He has also served as staff organizer for the Physics Department Chairs Conference hosted jointly by the APS and AAPT. He led the National Task Force on Undergraduate Physics and its SPIN-UP study of thriving undergraduate physics programs.

D. J. Wagner will lead the development of the assessment results database, supervising an undergraduate student and working closely with the PER User's Guide editor (McKagan) and ComPADRE technical staff to integrate the database into the PER User's Guide. Wagner is a physics professor at Grove City College. As a physics education researcher, her current work includes developing a conceptual inventory on fluid statics and developing a national database of assessment instrument results. Wagner and a student have developed a prototype of the assessment results database and determined what information needs to be collected and how to organize the information in the database. She is leading a roundtable discussion scheduled at the PER Conference in Philadelphia to solicit feedback from the PER community on the database development.

Mathew "Sandy" Martinuk will serve as a user interface design consultant, working with the PIs on the design of online resources to ensure that they incorporate best-practice design principles, and overseeing user testing of these resources. Martinuk is a User Experience Designer with Theresa Neil Interface Design, a prominent design firm whose recent clients include PayPal, Forbes, and Pearson. His specialty is leveraging his background as a physics education researcher to create educational software user

experiences that speak naturally to the needs of educators and students.

Charles Henderson will serve as an external evaluator, periodically reviewing the progress of work and offering suggestions for improvements to both research and resources based on the results of his research and his evaluation of our work. Henderson is a professor at Western Michigan University. His research focuses on understanding and improving the slow incorporation of research-based instructional reforms into college-level STEM courses. Research projects have attacked this problem from several directions: in-depth studies of faculty attempting to change their instruction[24], surveys and interviews with faculty related to their interaction with research-based instructional strategies[25], and an interdisciplinary literature review of change strategies in higher education[2]. His work has generated substantial interest; it was cited prominently in a major initiative recently announced by the Association of American Universities (AAU) to improve the quality of undergraduate teaching and learning at its member institutions[26], and has resulted in invited presentations at national panels and related commissioned white papers[27].

Steven Pollock will serve on the advisory board, offering his expertise and experience as a leader in departmental reform and systematic assessment at the University of Colorado (CU). Pollock is a physics education researcher investigating student learning in large and small scale physics classes, and the constraints and opportunities involved in replicating "proven" curricular practice[1,28]. He leads the assessment and evaluation of transformations in introductory-level physics classes throughout the department, including the role of Learning Assistants[29], impacts of the use of established research-based curricular materials, and investigation of measurable student outcomes across large populations and over time. He has collected, analyzed, and used an extensive database of scores for students on conceptual measures for a variety of purposes, including research, faculty development, informing CU departmental and administrative level decision making, and informing faculty beyond CU.

Dean Zollman will serve on the advisory board, offering his expertise and experience as a former chair of a large physics department at Kansas State University. Zollman has over 40 years experience in physics education research and curriculum development. He has received international repute for his pioneering contributions particularly in the use of technology to help students learn complex physics concepts. More recently, his has focused on problem solving, conceptual learning and transfer. From 2001-11 he served as head of the KSU physics department, which has 27 permanent faculty, approximately 60 graduate students, more than 20 postdoctoral fellows, and over 40 undergraduate physics majors. The members of this department conduct research and purse degrees in atomic, molecular and optical physics; condensed, soft and biological matter physics; cosmology and high-energy physics; and physics education. During his tenure as head, he received the KSU Outstanding Department Head Award.

Laura McCullough will serve on the advisory board, offering her expertise and experience as a current chair of a small physics department at the University of Wisconsin-Stout. McCullough is a physics education researcher whose work focuses on gender and context in assessment. Her past research includes studying how gender differences in responses to questions on the Force Concept Inventory change when the context of the question is shifted from male-oriented to female-oriented.[30] She has served as physics department chair for 4 years, and runs a mentoring/best practices group for all chairs on her campus. She has experience with different types of evaluation, including program accreditation, program assessment for a physics department, and project evaluation for NSF grants. As department chair, she led a department assessment of curricular needs based on input from stakeholders. In the classroom, she has used many forms of assessment, including PER-based conceptual tests, points-based grading, standards-based grading, project-based assessments, and essay responses.

We will hire a **postdoctoral researcher** who will conduct synthesis research including updating and expanding the 1998 Hake study to compare the impact of many PER-based teaching methods in a variety of environments, and reinterpreting existing data sets to answer chairs' authentic assessment questions. The postdoc will also assist with the development of the assessment workshop and online resources.

References

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