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By submitting this application, I confirm that, if selected to receive a Chancellor's Award for Excellence in STEM Education, I will:

- ✓ Attend and be recognized at the annual Symposium on STEM Education (fall 2014).
- ✓ Give a brief introduction (~10-15 min) to my project at DBER in fall 2014.
- ✓ Actively engage in the CU-Boulder STEM education community by attending weekly DBER seminars and Chancellor's Fellow events when possible.
- ✓ Present my work to the STEM education community by giving at least one DBER seminar, OR, if that is an impossibility, I will give a talk that the CU-Boulder STEM education community is invited to attend.
- ✓ Submit a 1000 to 3000-word report detailing the outcomes of the project at the end of the funding period

Framing the Active Learning Classroom:
Materials and research to support STEM instructors in implementing student-centered instruction

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Proposal

I. Summary

The way that instructors "frame" the classroom experience for students can have significant effects on the learning environment. This project will generate a collection of resources that STEM instructors can use to introduce students to active learning. The purpose of such work is to ensure a more productive educational experience for students and instructors and to support more widespread adoption of interactive teaching techniques and increasing learning for students at CU and elsewhere. The results of this grant – particularly the collection of materials -- will be disseminated widely through existing online portals, as well as through in-person professional development experiences. In addition to material compilation, this grant will support initial research, including interviews and survey development, to assess student reactions to instructors' framing approaches. Preliminary findings from this work will provide further insight into this important and understudied issue.

II. Background

A. Statement of Need

The NSF and other agencies have invested hundreds of millions of dollars in research and development in science, technology, engineering and math (STEM) education. Here at CU Boulder, an impressive cadre of discipline-based education research (DBER) efforts and educational programs have generated substantial resources for education research and practice (see http://colorado.edu/csl). My current academic home, the Science Education Initiative, has funded the research, development and implementation of a wide variety of instructional innovations in STEM (see http://colorado.edu/sei). These investments have resulted in a wealth of effective instructional strategies, technologies, and curricula which have been proven to improve student learning across STEM disciplines[1]. Additionally, an extensive body of research has demonstrated the efficacy of student-centered, active-learning strategies for improving student learning of key concepts in science.[2]

However, achieving widespread, sustained, effective implementation of these strategies by faculty has been elusive[3,4,5]. While faculty are aware of these research-based instructional strategies, few faculty use them, don't use them with high fidelity[4], and stop using them after only a semester or two.[3] The STEM education community is increasingly aware of the critical need to develop more

effective methods for achieving widespread, effective use of these instructional innovations – if the full potential impact of these research-based instructional strategies on student learning is to be realized.[1] It has become clear that instructional change must go beyond the "develop and disseminate" model, where developers create an effective teaching strategy and then make it available to the community at large.[6,7] Rather, faculty require support and help in implementation, including strategies to overcome or avoid common challenges or pitfalls.[6,7]

One key area of faculty support that is currently lacking is guidance on how to generate student buy-in to instructional innovations. Faculty members commonly student resistance as a major barrier to the use of interactive techniques.[8,9] Instructors often believe that students do not support the use of research-based methods, do not like to interact with each other, and are not prepared to think independently.[10] There have been a few striking cases of student resistance to such methods, including at the Massachusetts Institute of Technology, where students petitioned against the instructional changes in introductory physics.[11]

Despite this growing awareness of the importance of student buy-in, there has been no known prior work to investigate the methods that instructors have used to communicate to their students about their pedagogy, and what is most effective. Anecdotal evidence suggests that many instructors simply tell students what they will be doing and why (which is likely to have minimal impact, as with other lecture-based forms of education[1]) and that perhaps what works for some instructors actually backfires for others (e.g., women and minorities). Informing instructors about the ways that they might promote student buy-in to their course approaches can help ensure that more instructors feel comfortable using interactive teaching strategies, and that they have more success in their use of these methods – encouraging them and their students to engage in such methods in the future.

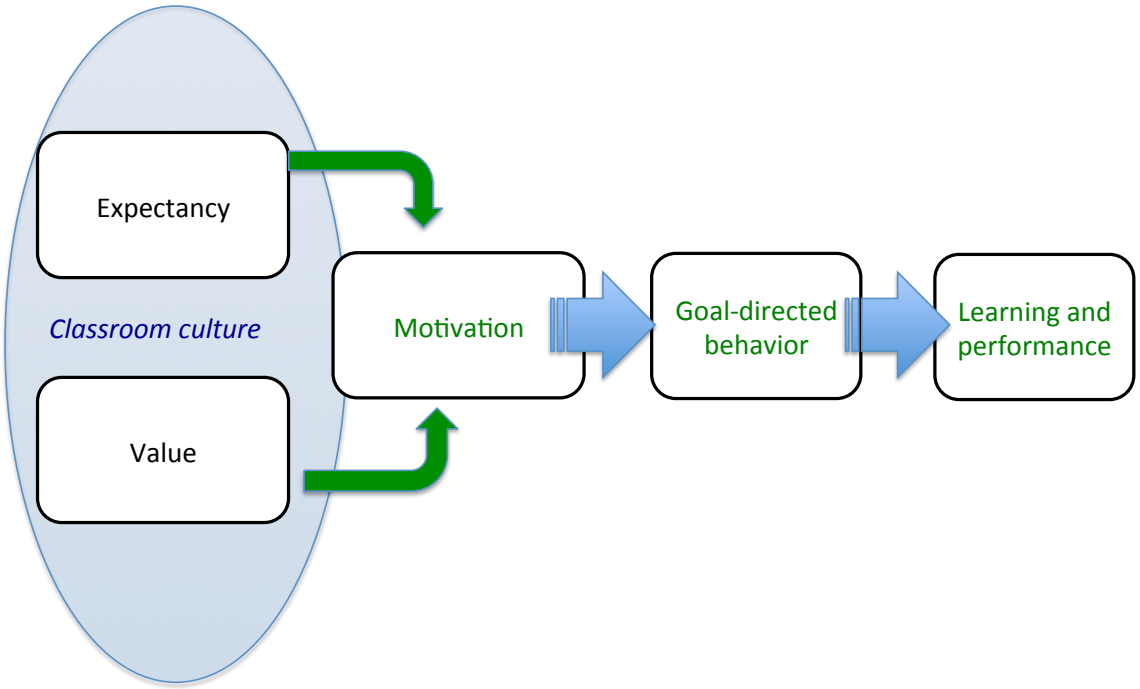
The purpose of this project is to gain a better understanding of the methods that STEM instructors, at CU and nationally, have used in order to "frame" their classroom strategies to create a classroom climate for effective learning – and to provide access to such tested activities to instructors nationwide. This "framing" can include ideas about the purpose of the activities, about what students should do to learn, and about what constitutes understanding in science, engineering, technology, and math (STEM).

B. Theoretical framework: Motivation and buy-in

Because active-learning strategies require students to engage as participants, the success of these methods is contingent upon students accepting, or "buying-in" to, this non-traditional way of teaching and learning. Research on student

attitudes, expectations, and motivation suggests that the way students understand learning activities can strongly influence how they engage and how much they can learn.[12,13]

There is substantial overlap between the idea of "buy-in" and that of student motivation, so I briefly review some of the motivation literature here. Both intrinsic (internally-driven) and extrinsic (reward-driven) motivation play a role in educational outcomes, though I hypothesize that intrinsic motivation is the more important factor due to its' strong link to learning.[13] Two key ideas drive both intrinsic and extrinsic motivation – *"subjective value"* of a particular outcome or goal, and *"expectancies"* of how to best achieve that goal[12]. The figure below (adapted from Reference 12, page 70) outlines how these factors relate to student learning, and operate within a particular classroom environment and culture.



Within this framework, buy-in occurs when instructors help students achieve (a) an understanding of the value of the class material, and (b) an expectancy that a particular pedagogical approach is the best way to achieve learning of that material. Additionally, instructors must foster (c) an environment that is seen as supportive of learning. Thus, important instructional factors in generating motivation are the personal relevance of the material, a sense of personal efficacy and ability in the class, feedback which allows students to demonstrate their own success in that class format, an emotionally supportive atmosphere, and positive social dynamics. In some cases, an instructor is faced with the challenge of overcoming existing expectancies – e.g., that reading the textbook is

sufficient to learn the material. Additionally, these instructional outcomes are deeply tied to issues of *communication* – the way that instructors create a safe climate, encourage student ownership in the material, demonstrate respect for students, and humanize themselves and other students in the class, can have a significant impact on student perception of the class, their role, and their motivation to engage.[14]

C. Summary of past work on the Framing Project

Beginning in Summer 2012, three physicists -- Andrew Boudreaux (Western Washington University), Jon Gaffney (Eastern Kentucky University) and myself (Stephanie Chasteen) began an informal collaboration to identify what instructors do at the start of the semester to promote student buy-in. Results from that work include:

"Bank" of materials. Solicitations were sent to several nationwide email lists across disciplines. Submissions were received from 21 instructors, comprising of 22 in-class activities, 19 slide sets, 19 clicker questions, and a variety of handouts. These materials were later organized, based on post-processing and categorization described below, into an online, open-source, Creative-Commons licensed archive, at http://www.colorado.edu/sei/fac-resources/framing.html

Categorization of framing approaches. In order to better understand the range of strategies used by instructors, we iteratively generated a categorization scheme of different "framing approaches." Each submission was identified as primarily addressing one such framing approach, so that the submitted materials could be used as examples of a broader framework of framing approaches. Inter-rater comparisons were used to provide a measure of reliability of these categorizations. These categorizations provide an initial theoretical framework for the project, and overlap substantially with the existing literature on student motivation (e.g., establishing expectancies, generating value, and creating a positive environment). Part of the work of this proposal will be to more clearly link these categories to existing frameworks on motivation.

The current categorization structure is as follows:

1. Instructors **justify** their course approach by:
    a. Reference to how people learn
    b. Asking students to reflect on how they, personally, learn
    c. Clarifying the expectations and roles of students and instructors
2. Instructors **motivate** students to engage in the course by
    a. Discussing the relevant or importance of the course
    b. Establishing classroom norms for behavior and community

c. Addressing student confidence and affect

Additionally, we found that instructors accomplished these results through a few pedagogical means:

1. Didactically, through lecture or presentation of material
2. Through discussion, either instructor-student or student-student
3. Through direct experience of interactive methods

Pilot survey for instructors. We developed an initial survey for instructors (see http://bit.ly/1ilgfe8) to ask them to identify their framing approaches, and perception of student buy-in. Initial results showed that instructors use a variety of framing approaches, and that there are some differences between novice and expert users of an instructional technique. Novice users tend to use fewer different framing strategies, and cluster them towards the beginning of the semester, whereas experts use a wider variety of strategies, spread throughout the semester.

D. Future Questions

While this initial work was interesting and promising, more is needed. We presented these results at the national American Association of Physics Teachers and Physics Education Research conferences in 2013, and DBER in 2014, both of which generated useful questions and guidance for future work. In particular, I would like to gain a deeper understanding of what happens in the classroom during "framing" activities, connect this work to a theoretical framework, develop a richer, more representative database of "framing" strategies, organize them in a way that is accessible to the average instructor, and develop measures of student buy-in for instructors and students that can be used to guide research and instruction.

III. Methodology

This project consists of six main parts:

1. Exploratory research on instructors and students
2. Developing pilot survey for student and instructors
3. Gathering "framing" resources from instructors,
4. Organizing and structuring these resources,
5. Dissemination, and
6. Evaluation.

This is an exploratory project, and will result in guidance for instructors on the variety of methods available for promoting student buy-in, as well as enhance our understanding of student resistance to innovative teaching methods.

A. Advisors and idea partners

A broader community of scholars is interested in this work, and several have offered specific collaboration and advisory roles. These partnerships will significantly enhance this work and extend the resources of the grant. These partnerships also connect me to diverse institutions and a variety of STEM disciplines.

Advisor	Institution	Discipline	Role
Andrew Boudreaux	Western Washington University	Physics	Advisor. Pilot-test surveys in classes.
Jon Gaffney	Eastern Kentucky University	Physics	Advisor. Complementary research will inform project. Knowledge of relevant research base. Pilot-test surveys in classes.
Sam McKagan	American Association of Physics Teachers	Physics	PERUG editor. Advisor on dissemination and faculty needs.
Cathy Manduca	Science Education Resource Center	Geoscience	SERC director. Advisor on dissemination and faculty needs.
Heather Macdonald	College of William & Mary	Geoscience	Early investigation into First Day activities for SERC. Connection to Geoscience community and two-year college community. Interested in collaboration on project, especially re: SERC dissemination.
Chuck Hayward	University of Colorado Boulder	Mathematics	Offered connection to community of inquiry-based mathematics practitioners.
DBER community	CU Boulder	Various	Have offered useful insights and direction on research, will continue to consult.

B. Exploratory research

In order to more fully identify what instructors do in their class, what they think works, and issues that are important from the student perspective, I will conduct a set of observations and interviews with instructors and students. These, and all work with human subjects, will be subject to IRB approval. (Note that IRB approval has been obtained for instructor surveys).

Research questions:

1. What framing activities do instructors use?
2. What are instructors trying to accomplish through framing?
3. What framing approaches do instructors think is effective?
4. What challenges do instructors report in framing their instruction?
5. What are students' perceptions of instructors' framing strategies?
6. What do students think would help them work most productively in an interactive class?
7. What challenges do students face in getting oriented to active learning?

I will work primarily with Jon Gaffney, a physics education researcher currently focusing on how to mitigate the expectation violation that occurs in interactive classrooms: I.e., students have certain expectations regarding the format and structure of a classroom, and of how they learn best, both of which are often violated by an interactive format. I will make use of Dr. Gaffney's framework, as well as consult a broader literature, to generate interview and observation protocols. Due to the limited scope of the proposal, I will interview and observe 5-7 instructors on the first and second days of their classrooms. If possible, videotape of instructors at different institutions will be obtained to provide a broader sample. I will then conduct focus groups of 4-5 students in each of these instructors' classes that are located in Boulder area. Students will be offered refreshments as incentive to participate, and instructors will be given a copy of "How Learning Works," or a gift certificate, based on preference.

The outcomes of this research will help to guide the rest of the project, particularly the survey measures and organization of the resources.

C. Developing pilot surveys for students and instructors

I will create two survey instruments that can be used to assess the impact of framing interventions:

1. Instructor survey, to identify their framing strategies and perception of student buy-in.
2. Student survey, to assess their buy-in, and perceptions of the instructor's framing strategies.

These instruments will be valuable assessment tools for faculty, to guide their teaching, as well as researchers. Due to the limited nature of this project, the outcome measures are likely to be early, pilot measures, with only initial validation and reliability measures.

Research questions:

1. What are students' perceptions of instructors' framing strategies?
2. Do students' and instructors' perceptions match, or conflict?
3. Which framing strategies impact student buy-in, and how?

As part of the earlier work on this topic, we developed a pilot survey for instructors to determine how they accomplished buy-in in their classroom (see http://bit.ly/1ilgfe8). I will significantly simplify this survey, and create a partner student survey. Outcomes from the exploratory research project (see above), as well as feedback from advisors, will greatly inform these pilot measures. The student survey will be pilot-tested by 4-5 students using a think-aloud format in individual interviews, with iterations and improvements occurring simultaneously. Faculty surveys will be given to advisors and other faculty friendly to the project for feedback. The student survey and instructor survey will be then tested as a pair (i.e, given to both the instructor and students) in 2-3 classes to provide pilot data. Andrew Boudreaux and Jon Gaffney have volunteered the use of their classes for this purpose, and Dr. Boudreaux's course includes several sections taught by colleagues, providing possible treatment/control conditions. Additionally, courses here at CU-Boulder are viable candidates for test populations.

The results of these surveys will help to inform the rest of the project, including information on what instructors most need to find in the framing resources.

D. Gathering "framing" resources from instructors

One challenge with the materials collected previously was the lack of information about the instructional context, evidence for effectiveness, and how to deal with narrative responses that didn't fit into a clear "activity". Additionally, a great amount of effort was spent on formatting these resources. To address these issues, I will first create a more streamlined system for material submission, as well as a questionnaire to gather data from instructors (drawn heavily from the instructor survey discussed earlier) – where do they teach, how long have they been teaching, what is their framing philosophy, how effective they feel their framing approach is, and their evidence for that effectiveness. Instructors who have already provided their materials will be asked to complete this short questionnaire. In order to encourage submissions, all instructors responding to

the query will be entered into a drawing for a copy of "How Learning Works," by Ambrose et al.

Then, I will actively solicit materials from instructors in a wider variety of venues, and across disciplines, significantly expanding our set of resources.

E. Organizing and structuring the resources

I will work heavily with my advisors (see above) to generate a framework for how these materials may be organized and aligned with a more general framework. In particular, we have a current organization scheme for the materials (see "prior work") but it is not clear that this organization is the best "portal" to the materials for instructors, and it is not explicitly connected to a theoretical framework. I will work closely with Jon Gaffney in this area; his deep connection to the theoretical literature, as well the insight of my other idea partners connected to faculty development and online resource dissemination (e.g., McKagan and Manduca), will provide valuable resources as I create a meaningful structure and framework for the resources. The end result of this work will be (a) an outline of how the resources connect, broadly, to the literature on motivation and expectancy violation, and (b) an organizational framework for the resources that will serve as a starting-place for online dissemination.

Based on that work, the resources will then be compiled into a consistent format (e.g., easy-to-use handouts, slides, or activity descriptions). I will make use of a student or administrative assistant for this formatting work in order to stretch the impact of the grant dollars.

F. Dissemination

Dissemination forms a main part of this grant, and will be accomplished through four main venues:

Digital libraries. I have approached several digital libraries to obtain commitment to house the materials (see letters of commitment). The final material package will be included on the following sites, as well as other relevant locations that are identified over the course of the grant.

1. The Science Education Initiative websites at the University of Colorado Boulder and the University of British Columbia. Note: I am the Associate Director of the Science Education Initiative at CU-Boulder, which is in its' final months of funding. http://colorado.edu/sei and http://cwsei.ubc.ca
2. The Physics Education Research User's Guide, http://perug.org

3. The Science Education Resource Center, http://serc.carleton.edu
4. Other areas of the National Science Digital Library (http://nsdl.org) as appropriate

Advertisements. Additionally, the materials will be advertised in a variety of venues, such as national email lists and social media. I am well-connected with bloggers and leaders in education reform.

Interactive workshop. Another major outcome of the grant will be the development of a 2-hour interactive workshop for instructors on how to best achieve framing in their classroom. I am a highly capable workshop leader, and have developed a wide variety of professional development workshops (see CV). This workshop will be provided through the Faculty Teaching Excellence Program, as well as at conferences such as the American Association of Physics Teachers. Workshop materials will be archived online for use by other facilitators, at http://colorado.edu/se/fac-resources/workshops.htm. Materials at that site have been used by other facilitators nationally and internationally. As possible, this workshop may also be given online as a webinar, or recorded for offline viewing.

Written article. I plan to write a short two-pager (in the style of the guides at http://www.colorado.edu/sei/fac-resources/guide.html), summarizing this work. While the execution of a full-length article is beyond the scope of this grant, I hope to be able to use this work to write a longer article for a practitioner publication such as the Journal of College Science Teaching.

G. Evaluation

As an experienced external evaluator (see CV), I will apply my deep knowledge of evaluation measures to assess the impact and outcomes of this work. There are two components to the evaluation portion of this study:

1. Research on the use and impact of framing (from the Exploratory study and survey testing)
2. Evaluation of the use of the developed framing resources and online delivery.

1. Research on the use and impact of framing.

The work of this grant will lay an initial foundation for answering how framing impacts student buy-in, from the exploratory research conducted through interviews, and the development of pilot instructor and student surveys. Results from use of those surveys in classrooms will provide initial data on what instructors do to frame their classes, and how students perceive what instructors

do. I will specifically address, and provide relevant evidence pertaining to, each of the research questions listed in this proposal.

2. How are the framing resources used?

A variety of summative measures will allow us to assess the impact of the resources.

- A short survey on the website(s) will ask instructors for feedback
- The number of individual website "hits" will be tracked.
- The number of downloads of specific materials will be tracked.

3. Report. A short report on the study and its' impacts will be compiled as part of this evaluation work, and included in dissemination efforts as appropriate.

IV. Budget and timeframe

A. Budget:

Item	Justification	Total
Student or administrative support	Allowing some work to be completed at a reduced rate. Approx. 20 hours.	**$500**
Transcription	10 hours of interview x $60 per audio hour	**$600**
PER User's Guide web development	To support integration of materials on website. Approx. 8 hours	**$500**
Faculty and student incentives	To encourage participation in studies through refreshments, books, or raffles for gift certificates.	**$300**
Dr. Chasteen salary	The bulk of the work of the grant. $6458.31/mo FTE x ~1.3 months .	**$8100**
Total		**$10,000**

B. Timeline:

The work of this project will be achievable in the time and budget proposed by maintaining a very clear, limited focus. Research and analysis will result in qualitative, generative information to guide the project, and I will not aim for extensive validation and reliability. Pilot survey measures will similarly be developed for guidance, rather than as fully developed instruments. My work as an external evaluator (see CV) has provided ample experience in generating budgets and timelines for such focused work, as well as tracking time spent within a project, and I am confident that this scope of work is manageable within the time allotted. That said, development and testing of the pilot surveys could be reduced in scale if needed, as this is a less critical aspect of the project.

Task	Timeline
Exploratory research: Interviews and observations and analysis.	Fall 2014 (~ 7 person-days)
Pilot survey development and testing, implementation in courses, analysis.	Fall 2014 – Winter 2015 (~7 person-days)
Gathering framing resources	Fall 2014 - Winter 2015 (~ 2 person-days)
Organizing and structuring resources, incorporating into digital libraries	Winter 2015- Spring 2015 (~6 person-days)
Workshop development and implementation plus other dissemination	Summer 2015 (~4 person-days)
Evaluation, final report	Summer 2015 (~1 person-day)

V. Impact

This project will have impacts at multiple levels, supporting my own intellectual development, education reform in multiple STEM and non-STEM departments, and provide resources to the campus as a whole and STEM education professionals around the country and around the world. Through addressing this issue of framing and student buy-in, I aim to address one of the critical issues facing STEM education reform – that of successful faculty adoption of research-tested teaching practices.

Personally, I am very excited about the opportunity to expand this area of research, which I have found compelling enough to pursue in my spare time to date. There is currently no funding to continue this research. Thus, this Chancellor's Award would be a valuable chance to re-engage in education research, which I would find incredibly fulfilling. Additionally, my personal mission is to support faculty in successful use of interactive teaching strategies – this project is aligned with that career goal, and I would be very pleased to be able to contribute the tangible outcomes of this project to the broader community. This project will provide valuable opportunities for collaboration (see Advisors, and Letters of Commitment), which will be personally and professionally fulfilling and may lead to future work. Lastly, while I have substantive experience in project management through my work at CU and running an independent consulting business, this project will further contribute to my professional development in giving me an opportunity to manage a research project and budget as a Principle Investigator.

This project will serve to further the DBER community through research on teaching and learning, as well as support STEM and non-STEM departments as they integrate innovative instructional methods into their classrooms. These impacts will be achieved through (a) increased insight into framing and student buy-in stemming from research, (b) access to resources for promoting effective framing, (c) in-person professional development workshops offered through FTEP and (d) written reports summarizing the outcomes of this work.

Lastly, CU Boulder will enjoy continued prestige as a leader in innovation in teaching and learning, as the results from this project will be highlighted in several online digital libraries providing access to a national and international audience. Instructors around the world may benefit from this project, which will both bring attention to – and provide concrete resources for addressing – the issue of student buy-in and productive engagement in student-centered instruction.

VI. References

[1] S. Singer, N. Nielsen, and A. Schweingruber, Eds., *Discipline-Based Education Research: Understanding and improving learning in undergraduate science and engineering* (National Academies Press, Washington, DC: 2012). http://www.nap.edu/openbook.php?record_id=13362

[2] Bransford, J., A. Brown, and R. Cock- ing, eds. 2000. *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

[3] C. Henderson, M. Dancy, and M. Niewiadomska-Bugaj, "The Use of Research-Based Instructional Strategies in Introductory Physics: Where do Faculty Leave the Innovation-Decision Process?" *Phys. Rev. ST Phys. Educ. Res.* 8 (2), 020104 (2012).

[4] M. Dancy and C. Henderson, "Pedagogical practices and instructional change of physics faculty," *American Journal of Physics* 78, 1056-1063 (2010).

[5] President's Council of Advisors on Science and Technology (PCAST), *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering and Math* (2012). http://www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/pcast_edit_dec-2013.pdf

[6] Henderson, C., Finkelstein, N. & Beach A. (2010). Beyond Dissemination in College science teaching: An Introduction to Four Core Change Strategies, *Journal of College Science Teaching*, **39** (5), 18-25.

[7] Henderson, C. and Dancy, M. (2008) Physics Faculty and Educational Researchers: Divergent Expectations as Barriers to the Diffusion of Innovations, *American Journal of Physics (Physics Education Research Section),* **76** (1), 79-91.

[8] Henderson, C., & Dancy, M. "Beyond Instructor Beliefs: Additional Barriers to the Adoption of Student-Centered Instruction in Physics", Contributed Talk, International Society for the Scholarship of Teaching and Learning, Bloomington, IN, October 23, 2004

[9] Ebert-May, D., Derting, T.L., Hodder, J., Momsen, J.L., Long, T.M., and Jardeleza, S. E., "What we say is not what we do: Effective evaluation of faculty professional development programs," Bioscience, 61(7) (2011).

[10] Henderson, C., & Dancy, M. (2011). Increasing the Impact and Diffusion of STEM Education Innovations, A White Paper commissioned for the Characterizing the Impact and Diffusion of Engineering Education Innovations Forum, New Orleans, LA, Feb 7-8, 2011.

[11] http://www.nytimes.com/2009/01/13/us/13physics.html?pagewanted=all&_r=0

[12] S. Ambrose, M. Bridges, M. DiPietro, M. Lovett and M. Normal, *What Factors Motivate Students to Learn?*, chapter in "How Learning Works: Seven Research-Based Principles for Smart Teaching," San Francisco: John Wiley & Sons (2010).

[13] P. Pintrich, "A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts." *Journal of Educational Psychology* 95 (4): 667–686 (2003).

[14] J. Kerssen-Griep, "Teacher communication activities relevant to student motivation: Classroom facework and instructional communication competence," Communication Education, 50(3), 256-273 (2001).

Letters of Commitment

1. **Sarah McKagan, Physics Education Research User's Guide and AAPT**
   Incorporating materials into PER User's Guide, and guidance on organization and faculty needs
2. **Jonathan Gaffney, Eastern Kentucky University**
   Advising, synergistic research, and pilot-testing of surveys
3. **Cathy Manduca, Science Education Resource Center and Carleton College**
   Incorporating materials into SERC, and guidance on organization and faculty needs

DR. SARAH MCKAGAN
Editor, PER User's Guide
American Association of Physics Teachers

March 31, 2014

To Whom it May Concern:

I am writing to express my commitment to provide key dissemination for materials from Dr. Chasteen's project, "Framing the Active Learning Classroom". These materials will be included on the Physics Education Research User's Guide (http://perusersguide.org), where they will be accessible by physics and STEM instructors nationwide, and internationally.

The PER User's Guide is a web resource for physics educators to learn how to teach more effectively by applying the results of physics education research (PER) and teaching methods based on these results. Research in the field of PER has made enormous advances in understanding how students learn physics most effectively and in developing teaching methods that apply this understanding to achieve improved student learning. The goal of this site is to provide a synthesis of decades of physics education research in a format that is easy for busy physics instructors to understand and apply. The PER User's Guide website is provided by the American Association of Physics Teachers. It is supported by the National Science Foundation (DUE 0840853, 1245490, 1256352, and 1347728).

I have followed with interest the outcomes of Dr. Chasteen's work in framing active learning for students for several years. In my research on faculty needs around research-based teaching, I have seen that getting students to buy in to non-traditional instruction is a major area of concern for physics faculty. Dr. Chasteen's resources will fill a major need I have identified by providing a broad array of methods for achieving more productive student engagement in their student-centered courses. For this reason, I am eager to incorporate Dr. Chasteen's work into the PER User's Guide. Dr. Chasteen will write a short "expert recommendation" to summarize her work, which will then link to a database of the resources.

The PER User's Guide team will, as possible, leverage existing design structures on the website to house the materials from the Framing Project. However, some supplemental funds will allow us to provide a design that is best suited to providing instructors with an easy-to-use structure and access to materials. To this end, we are requesting a $500 honorarium for web design work. Resulting web structures will be made available for use in other relevant locations, such as the Science Education Initiative website, and the Science Education Resource Center.

Best,

Sarah McKagan

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To Whom It May Concern:

During the past year I have been working intermittently with Dr. Stephanie Chasteen to understand how faculty members frame their active learning physics classes. Like her, I have a vested interest in both having an organized, annotated collection of activities that STEM instructors use to frame their classrooms and in performing research to understand better how those activities are used to generate student buy-in to such courses. Faculty members in my department look to me as an expert in pedagogical theory, and I am frequently asked for my advice and thoughts about how to approach aspects of class. Regarding first day activities, I often point them to the website that Dr. Chasteen has already assembled. I consider it to be a valuable resource, although performing continued research regarding how the activities are used is still necessary. My own approach to such research is complementary to Dr. Chasteen's, and I stand to benefit greatly both as a researcher and a teacher from her continuing her line of research. Therefore, I am pleased and excited to be listed as an external collaborator with her on this grant.

Specifically, during Dr. Chasteen's work on this grant, I will provide direct feedback about her research, including commenting and validating survey measures that she develops, pilot test those surveys, and share with her the results of my own research. I expect to have periodic discussions with her to compare research notes and exchange feedback on various items that we have been investigating. Such conversations have been very productive in the past, and I expect that by continuing our collaboration, our different but related investigations will generate mutually useful results that will benefit each of us.

I do not seek or require any funding from this grant as a collaborator. Because my research is independent from Dr. Chasteen's, any work that I do in helping her directly benefits me in my own investigations.

Sincerely,

Dr. Jon Gaffney
Assistant Professor
Department of Physics and Astronomy

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April 1, 2014

To Whom it May Concern:

I am writing to express my commitment to provide key dissemination for materials from Dr. Chasteen's project, "Framing the Active Learning Classroom". These materials will be included in the Pedagogies in Action Collection on the SERC website (http://serc.carleton.edu). We find Dr. Chasteen's project very compelling, and are eager to use her materials to provide critical guidance to instructors on how they may more productively generate student engagement in their classes.

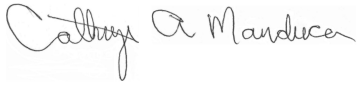
The format of SERC online modules is particularly well-suited to this work, as our online structure provides both general information and recommendations, as well as opportunity to share examples and multimedia resources. A fully-functional digital library, all information within SERC is readily accessible, searchable, and cross-linked. We will work with Dr. Chasteen to develop a module for SERC which incorporates her findings.

Our office has special expertise in effective pedagogies, geoscience education, community organization, workshop leadership, digital libraries, website development and program and website evaluation. We will be pleased to provide information and feedback for Dr. Chasteen based on this expertise to help direct the Framing Project.

The site websites contains over 19,000 pages of original content, including community contribution of more than 3900 teaching activities. In aggregate more than 5 million unique users from around the world visited these sites in 2013.

We are pleased to partner with Dr. Chasteen to incorporate her important work on framing activities. We have worked with Dr. Chasteen in this regard previously, and were very pleased with our collaboration: Dr. Chasteen authored our module on Learning Assistants, at http://serc.carleton.edu/sp/library/learning_assistants/.

Sincerely,



Cathryn A. Manduca

Stephanie V. Chasteen

• Stephanie@sciencegeekgirl.com Web: http://sciencegeekgirl.com • Blog: http://blog.sciencegeekgirl.com

BACKGROUND SUMMARY

Ph.D. Physicist creating college educational reform through effective communication and support of research-based instructional techniques. Possess 9 years experience in communication and education, plus persistence, organization and creative passion.

- communication
- research-based educational approaches
- research & evaluation
- faculty change
- teacher professional development
- institutional transformation

PROVEN SKILLS

Project management

- Broad experience facilitating and collaborating with diverse groups of people.
- Vision and clarity in creating and managing innovative projects.
- Initiate and follow through on long-term projects.

Technical and creative skills

- Data collection and analysis, including program evaluation, educational assessment, assessment and pre/post content survey design, and interviews.
- Excellent written and verbal skills, for both public and professional audiences.
- Digital audio and video writing, direction, and production.
- Workshop creation and facilitation.

FORMAL EDUCATION

University of California – Santa Cruz. Ph.D., Condensed Matter Physics, 2005.
Bard College. B.A., Social Psychology, 1995.

EXPERIENCE

… *STAFF POSITIONS*

SCIENCE EDUCATION CONSULTANT **2002-present**
sciencegeekgirl enterprises, LLC • self employed
Support research-based educational reform: Create materials (workshops, videos, written material) for faculty on instructional techniques, produce and review curricular materials, conduct external evaluation, and work as a freelance science journalist.

ASSOCIATE DIRECTOR **2012-Fall 2014**
OUTREACH DIRECTOR **2010-2012**
SCIENCE TEACHING FELLOW **2007-2010**
Science Education Initiative, CU-Boulder • Dr. Kathy Perkins (15% FTE)
Collaborated with faculty to research and reform upper-division physics courses to increase student comprehension through active engagement. Initiated outreach program to inform educators about how science education research can inform their teaching.

MULTIMEDIA DIRECTOR **2013-present**
PhET Interactive Simulations, CU Boulder • Dr. Kathy Perkins (35% FTE)
Produce and direct a video series aimed at K-12 and college instructors, to communicate about effective ways to use PhET simulations in the classroom.

POSTDOCTORAL FELLOW **Mar. 2006-Aug. 2007**
Exploratorium Teacher Institute, San Francisco • Dr. Paul Doherty
- Created and taught hands-on inquiry-based professional development workshops for secondary school educators, including online workshops.
- Co-wrote and produced or hosted several audio podcasts and live webcasts
- Acted as a scientific advisor for the museum.

AAAS MASS MEDIA NPR INTERN **Summer 2003**
National Public Radio Science Desk, Washington DC • Alison Richards
Reported, wrote, voiced, and produced several nationally-aired radio shorts on breaking science news. Learned to communicate science briefly and clearly.

… CONSULTING CLIENTS

WORKSHOP & WEBINAR FACILITATOR **2010-present**
Facilitated pedagogical workshops for faculty and K12 teachers on effective pedagogy, including use of personal response systems ("clickers"), backwards-design, assessment, and education research for a variety of clients, including:
University of California at Berkeley • i>clicker / MacMillan • Oregon State University • University of Oregon • Oregon Association of Physics Teachers • Sheridan County School District • CU-Boulder GK12 Programs.

VIDEO PRODUCER AND DIRECTOR **2011-present**
Directed the filming and production of several pedagogical videos for instructors.
- **PhET Interactive Simulations**, Boulder CO • Dr. Katherine Perkins
- **Physics Education Research User's Guide**, Seattle, WA • Dr. Sarah McKagan

EXTERNAL EVALUATOR **2009-present**
- **NSF_TUES, Video Resource for Professional Development of University Physics Educators**, Seattle Pacific University, Dr. Rachel Scherr, 2013-present.
- **NSF-IGERT, IQ-Biology Graduate Training Program** in quantitative biology, CU-Boulder, Dr. Thomas Cech, 2011-present.
- **NSF-TUES, Introductory Physics for Life Sciences Conference**, American Association of Physics Teachers, Dr. Robert Hilborn, 2014-present.
- **NSF-AISL, Teen Science Café Network,** Science Discovery, CU-Boulder Dr. Stacey Forsyth, 2013-present.
- **NSF-TUES, LearnCheMe Screencasts and ConcepTests**, CU-Boulder, Dr. John Falconer, 2013-present.
- **DoE-GAANN Graduate Assistance Program** in Electrical, Computer, and Energy Engineering, CU-Boulder, Dr. Robert McLeod, and Renewable and Sustainable Energy, CU-Boulder, Dr. Alan Weimer, 2013-present.
- **NSF-IGERT, COSI Graduate Training Program** in Computational Optics, CU-Boulder, Dr. Rafael Piestun, 2009-2013.
- **Teaching Excellence Workshops, Center for Astronomy Education,** U. of Arizona, Dr. Edward Prather, 2011
- **NSF-DRK12, Expanding PhET Simulations to Grades 4-8,** CU-Boulder, Dr. Katherine Perkins, 2010-2013.

SCIENCE CONTENT REVIEWER **2011-present**
National Geographic TV • Dr. Paul Durbin
Lawrence Hall of Science SEPUP • Dr. Chris Keller
Reviewed instructional and media materials for scientific accuracy.

SCIENCE & SCIENCE EDUCATION WRITER **2012-present**
i>clicker / MacMillan • James McNamee (2011-present)
Science Education Resource Center (SERC) • Dr. Cathy Manduca (2012)
JILA Communications Office, CU-Boulder • Julie Phillips (2011)
Harvard-Smithsonian Center for Astrophysics • Alex Griswold (2009-2010)
Wrote blog articles and a detailed module on instructional techniques. Created a teacher's guide to accompany an online course. Wrote short articles about physics for the public.

K12 COORDINATOR **2011**
Learn More About Climate, CU-Boulder • Linda Molner-Kelley
Created K-12 outreach programs and initiatives for the Office of University Outreach, focused on university resources related to localized impacts of climate change.

DISCUSSION FACILITATOR **2011**
Dep't of Astronomy & Planetary Sciences, CU-Boulder • Dr. Douglas Duncan.
Facilitated faculty conversations about course transformations and learning goals.

PODCAST PRODUCER **2009-2010**
National Science Digital Library • Susan Van Gundy
Produced a monthly podcast on polar research for elementary teachers as part of the Beyond Polar Bears and Penguins project for the International Polar Year.

PROFESSIONAL AFFILIATIONS
National Association of Science Writers (2001-present) • American Association of Physics Teachers (2006-present) • National Science Teachers Association (2007-present) • American Physical Society (2001-present) • Colorado Science Education Network (2009-present).

LEADERSHIP & VOLUNTEER EXPERIENCE

SCIENCEGEEKGIRL BLOG **2008-present**
Blog regularly as part of a community dedicated to science and physics education at http://blog.sciencegeekgirl.com

ADOPT A PHYSICIST **2009, 2010, 2011**
Interacted with high school physics classes and students in national AIP program.

APPENDIX

PEER-REVIEWED PUBLICATIONS

Full articles at http://sciencegeekgirl.com/publications.html

Change from Within: The Science Education Initiative," **S. V. Chasteen** and K.P. Perkins. Book Chapter, "Center for Integrative Research on Cognition, Learning and Education Conference (in press).

The Colorado Upper-Division Electrostatics (CUE) Diagnostic: A conceptual assessment for the junior level, **S. V. Chasteen**, R. E. Pepper, M. D. Caballero, S. J. Pollock and K. K. Perkins, *Phys. Rev. S.T.: Phys. Educ. Res.*, 8, 020108 (2012).

Thinking Like a Physicist: A Case Study in Transforming Upper-Division Electricity and Magnetism **S. V. Chasteen,** R.E. Pepper, S. J. Pollock, and K. K. Perkins, *Am. J. Phys.*, 80, 923 (2012).

Observations on Student Difficulties with Mathematics in Upper-Division Electricity & Magnetism, R. E. Pepper**, S. V Chasteen**, S. J. Pollock and K. K. Perkins, *Phys. Rev. Spec. Top.: Phys Ed. Rsrch*, 8, 010111 (2012).

Transforming the Junior Level: Outcomes from research and instruction in E&M, **S. V. Chasteen,** R.E. Pepper, S. J. Pollock, and K. K. Perkins, *Phys. Rev. Spec. Top.: Phys Ed. Rsrch*, 8, 020107 (2012).

Teasing Out the Effects of Tutorials via Multiple Regression*,* **S. V. Chasteen,** PERC Proceedings 2011, AIP Press, 2012.

Multiple Roles of Assesment in Upper-Division Physics Course Reforms. S. J. Pollock, R. E. Pepper, **S. V. Chasteen,** K. K. Perkins, PERC Proceedings 2011, AIP Press, 2012.

Facilitating Faculty Conversations: Development of Consensus Learning Goals. R. E. Pepper, **S. V. Chasteen,** S. J. Pollock, K. K. Perkins, PERC Proceedings 2011, AIP Press, 2012.

But Does It Last? Sustaining a Research-Based Curriculum in Upper-Division Electricity & Magnetism. **S. V. Chasteen,** R. E. Pepper, S. J. Pollock, K. K. Perkins. PERC Proceedings 2011, AIP Press, 2012.

Teaching with Learning Assistants, **S. V. Chasteen** and V. Otero, online module for *Science Education Resource Center* (2010). http://bit.ly/atzeHU

Upper-Division Students' Difficulties with Ampere's Law. C. Wallace and **S. V. Chasteen**, *Phys. Rev. Spec. Top.: Phys Ed. Rsrch* 6, 020115.

A Thoughtful Approach to Instruction: Course Transformation for the Rest of Us. **S.V. Chasteen**, K. K. Perkins, S. J. Pollock, C.E. Wieman. *J. Coll. Sci. Teach*. March/April 2011.

Our Best Juniors Still Struggle with Gauss' Law. R. E. Pepper, **S. V. Chasteen**, S. J. Pollock, and K. K. Perkins, *PERC Proceedings 2010,* AIP Press, 2010.

The Use of Concept Tests and Peer Instruction in Upper-Division Physics. S. J. Pollock, **S.**

V. Chasteen, K. K. Perkins, M. Dubson, *PERC Proceedings 2010,* AIP Press, 2010.

Tapping into Juniors' Understanding of E&M: The Colorado Upper-Division Electrostatics (CUE) Diagnostic, **S. V. Chasteen** and S. J. Pollock, *PERC Proceedings 2009,* AIP Press (2009).

A Research-Based Approach to Assessing Student Learning Issues in Upper-Division Electricity & Magnetism, **S. V. Chasteen** and S. J. Pollock*, PERC Proceedings 2009*, AIP Press, 2009.

Longer term impacts of transformed courses on student conceptual understanding of E&M, S. J. Pollock and **S. V. Chasteen**, *PERC Proceedings 2009*, AIP Press, 2009.

Transforming Upper-Division Electricity & Magnetism**, S.V. Chasteen** & S.J. Pollock, *PERC Proceedings 2008*, AIP Press, 2008.

The Salty Science of the Aluminum-Air Battery, **S.V. Chasteen**, N.D. Chasteen, P. Doherty, *The Physics Teacher*, December 2008.

Toward optimization of device performance in conjugated polymer photovoltaics: Charge generation, transfer and transport in poly(*p*-phenylene-vinylene) polymer heterojunctions. **S.V. Chasteen,** V. Sholin, S. A. Carter, G. Rumbles. *Sol. Energy Mat. & Sol. Cells* (92), 651-659, 2008.

The effect of broken conjugation on the excited state due to ether-linkage in a cyano-substituted poly(p-phenylene vinylene) conjugated polymer: CN-PPV vs. CN-ether-PPV, **S. V. Chasteen,** G. Rumbles, S. A. Carter, J. *Chem. Phys.* (24), 214704, 2006.

Blended versus Layered Structures in Polymer Photovoltaics. **S. V. Chasteen**, J. O. Haerter, G. Rumbles, C. Scott, S. A. Carter. *J. Appl. Phys*. (99), 033709, 2006.

Numerical Simulations of Layered and Blended Organic Photovoltaic Cells, J. O. Haerter, **S.V. Chasteen,** S. A. Carter, J. C. Scott, *Applied Physics Letters* (86), 164101, 2005.

Exciton Dynamics in Conjugated Polymer Photovoltaics: Steady-State and Time-Resolved Optical Spectroscopy, *Ph.D. Dissertation,* December 2005.

Exciton Dynamics and Device Performance in Polythiophene Heterojunctions for Photovoltaics. S. V. Chasteen, S. A. Carter, G. Rumbles, *Proc. of SPIE* (5938), 59380J-1, 2005.

DIGITAL MEDIA PRODUCTIONS

PhET Simulation Videos http://youtube.com/PhETInteractiveSims
Wrote and directed series of high-quality videos for teachers on the PhET Simulations:

- What is PhET?
- A Brief Introduction to PhET
- Carl Wieman: Why I Donated to PhET
- PhET: Research & Development
- The Founding of PhET
- Using PhET in Lecture

STEM education videos http://stemvideos.colorado.edu
Wrote and directed series of high-quality videos for faculty on educational techniques:

- Clickers: Students and Teachers Speak
- Anatomy of a Clicker Question
- Explain Clickers to Your Students
- Group Work in the College Classroom
- How To Use Clickers Effectively
- Do Clickers Help Students Learn?
- Clickers in Upper Division Courses

Learning about Teaching Physics http://perusersguide.org/podcasts
Awarded mini-grant to produce podcast communicating physics education research to practicing physics teachers. In progress.

Sciencegeekgirl blog http://blog.sciencegeekgirl.com
Science education blog, well-read and often-cited within the science blogosphere.

i>clicker blog http://www1.iclicker.com/blogs
Blog regularly on clickers and educational technology for MacMillan, Inc.

Beyond Penguins Podcast http://beyondpenguins.nsdl.org/podcast
Dec. 2008-May 2010. Co-host, writer, & producer of podcast series for K-5 educators.

Science at the Poles: Video Production. http://bit.ly/9SeROw
Beyond Penguins and Polar Bears. May 2010. Edited video for website for K-5 teachers.

SmallTalk http://www.nisenet.org/podcasts
January 2007 – August 2008. Creator, host, co-writer, producer.
Monthly 25 minute podcast on nanotechnology, Featured in *Science* (Mar. 2, 2007).

Science Teaching Tips http://exploratorium.edu/ti/podcasts
May 2006-present. Creator, host and producer.
Year-long series of 5-10 minute podcast series for science teachers.

OTHER PUBLICATIONS

Full articles at http://sciencegeekgirl.com/publications.html

Evaluation reports for a variety of evaluation clients (confidential information).

Variation on an Infinity of Triangles. *JILA Research Highlights*, February, 2012.

No Free Lunch for Entangled Particles. *JILA Research Highlights*, January 2012.

Schrodinger Cats Light the Way. *JILA Research Highlights,* January 2012.

Simulating a Starquake, *JILA Research Highlights*, December 2012.

Professional Development Guide: Physics for the 21st Century. *Harvard-Smithsonian Center for Astrophysics and Annenberg Media.* August, 2010.

Cracking the Story of Fracture. *Physical Review Focus*, January 29, 2010.

Speaking of Physics: The Art of Science Communication. American Physical Society *Forum on Education newsletter*, Spring 2010.

How a Scientist Becomes a Freelance Science Writer, *National Association of Science Writers website*, January 2010.

Cool Facts about Heat. *Beyond Penguins and Polar Bears webzine*, December, 2009.

Physicists' Guide for *Adopt a Physicist* program. *American Institute of Physics*. December, 2009.

Nuclear Waste Management after Yucca Mountain, *Science Magazine Podcast*, July 17, 2009.

Tiger Moths Jam Bat Sonar, *Science Magazine Podcast*, July 10, 2009.

Response to Classroom Clickers and the Cost of Technology, Letter to the Editor, *The Chronicle of Higher Education,* January 2009.

Why Physics Teachers Should Read Blogs, Websights column, *The Physics Teacher,* December 2008.

Podcasts in the Mathematics Classroom,*The California Mathematics Council Communicator*, December 2008.

Inside Mother of Pearl, *Physical Review Focus* (an APS publication), July 2007.

Inside a Solar Cell, co-author on companion web interactive for *PBS NOVA* program "Saved by the Sun," http://www.pbs.org/wgbh/nova/solar/inside.html. April 10, 2007.

Causal Relations: HIV in Guinea, *Science & Spirit* (bimonthly magazine), May/June 2005.

You're Not as Great as You Think You Are, *Science & Spirit*, May/June 2004.

Light Wave Outlasts Itself, *Physical Review Focus*, May 12, 2004.

Life Beyond Bars, *Science & Spirit,* March/April 2004.

Electronic Voting Unreliable Without Receipt, *Stanford Report*, Feb. 18, 2004.

Who Owns the Wind? *Science & Spirit,* January/February 2003.

City Buildings Rely on Renewable Power Sources, *Santa Cruz Sentinel,* May 16, 2003.

Bait & Switch, *Science & Spirit,* May/June 2003.

Sex and Gender Scientists Explore a Revolution in Evolution, *Stanford Report,* Feb. 16 2003. Reprinted widely, and earned mention from a writer for National Geographic.

Future Farmers, *Santa Cruz Sentinel*, February 1, 2003.

Cosmos "Big Bubble" Theorist Alan Guth to Lecture, *The Stanford Report*, Jan. 22, 2003.

Down on the (Research) Farm, *Science's Next Wave* (AAAS), Nov. 21, 2002.

Solar Power Still Too Expensive, *Santa Cruz Sentinel,* November 10, 2002.

Solar Energy Research Heats Up, *Santa Cruz Sentinel,* Page 1, Nov. 10, 2002.

INTERVIEWS, AWARDS & MENTIONS

Seeking the Warm Spot: A nonlinear career in writing and education, Agora blog from L'Oreal Foundation. http://bit.ly/GLLbe9

STEMinist Profile, Blog about women in science, http://bit.ly/GKtx4G

How a scientist became a freelance science writer, National Association of Science Writers, members-only site

Spotlight on Hidden Physicists: Stephanie Chasteen. *Radiations* magazine of Sigma Pi Sigma (The Physics Honors Society), Fall, 2009.

SPORE Award, American Association for the Advancement of Science. Awarded to Beyond Penguins and Polar Bears webzine, for which I produced the podcast. http://bit.ly/eXuJsK

Members in the News, *American Association of Physics Teachers eNNOUNCER,* September 2010. Mention and link to sciencegeekgirl blog.

Educators that Rock series for *findingEducation*, March 2010. http://bit.ly/bL3Gka

Forum on Graduate Student Affairs, *American Physical Society,* 2007. http://bit.ly/bTTLdo

NetWatch: The NanoBeat. *Science Magazine: Random Samples.* SmallTalk podcast featured, March 2007. http://bit.ly/bjrKYW

Best Professional Development Podcast, awarded to *Science Teaching Tips* podcast by the Podcast for Teachers. July 2, 2007. http://www.podcastforteachers.org/TechpodArchives.html

Blog and posts mentioned in a variety of places throughout the blogosphere and twitterverse.

PRESENTATIONS

Annual meetings designated as follows: AAPT = American Physics Teacher Association; APS = American Physical Society; CSC = Colorado Science Conference; NSTA = National Science Teachers Association; PERC = Physics Education Research Conference.

PROFESSIONAL WORKSHOPS & CLASSES

What Do You Want Them To Learn Tomorrow? Learning Goals and Formative Assessment. *Oregon AAPT,* Portland, OR (October 15, 2011); *North Carolina A&T University,* Greensboro, NC (April 4, 2011); *Faculty Teaching Excellence Program (FTEP),* University of Colorado at Boulder (October, 2011; March 2011; October, 2010; April, 2010; October 2011; February 2012; August 2012; February 2013; May 2013; August 2013, November 2013); *CIRTL-TIGER program,* CU-Boulder (February 2012); *Mathematics Department,* CU-Boulder (November 2013); *Computer Science Department,* CU-Boulder (March 2014).

Writing Great Clicker Questions. *Physics Teacher Education Coalition,* Ontario CA (Feb 3, 2012), *University of California at Berkeley*, Berkeley, CA (February 1, 2012); *Center for the Integration of Research, Teaching, and Learning*, Madison WI (November 10, 2011), *Oregon State University*, Eugene, OR (November 11, 2011); *Sheridan County School District,* Sheridan WA (August 25-26, 2011), *i>clicker webinar* (November 9th 2010), *CSC*, Denver CO (November, 2009); *Faculty Teaching Excellence Program, CU*-Boulder (August 2013).

Make Clickers Work for You: About Peer Instruction & Facilitation, *University of Colorado at Denver* (November, 2013), *College of Engineering, CU-Boulder* (February 2013); *University of California at Berkeley*, Berkeley, CA (January 25, 2012); *Oregon State University*, Eugene, OR (November 11, 2011); *Oregon AAPT*, Portland, OR (October 15, 2011), *Sheridan County School District*, Sheridan WA (August 25-26, 2011),*Technology in Education Conference,* Copper Mountain, CO (June 22, 2011), *North Carolina A&T University,* Greensboro, NC (April 4, 2011); *National Science Teachers Association*, San Francisco (March, 2011), *i>clicker webinar*, (February 16, 2011; January 5, 2012; February 5, 2012; March 18, 2012), *Resource Area for Teachers (RAFT)*, Denver CO (October, 2010), *International Society for Technology in Education*, Denver CO (June, 2010); *Faculty Teaching Excellence Program*, University of Colorado, Boulder (April, 2010, February 2012, August 2012, February 2012, August 2012, August 2013, February 2014); *i>clicker webinar*, (September 5, 2010), *University of Colorado at Denver: Anschutz Campus* (February, 2010), *Graland Country Day School,* Thornton CO (February, 2010), *NSTA,* Phoenix, AZ (December, 2009); *Colorado Science Conference,* Denver CO (November, 2009); *Bollman Technical High School,* Thornton CO (October, 2009); *New England AAPT*, Durham NH (October, 2009), *Technology in Education Conference*, Copper Mountain, CO (July, 2009); *Adams 12 School District,* Thornton, CO (May, 2009).

What Every Teacher Should Know About Cognitive Research. *University of Oregon Science Literacy Group*, Eugene, OR (April, 2012); Computer *Science GK12 Fellows meeting,* University of Colorado at Boulder (February, 2010); *Project EXTREMES GK12 Fellows meeting,* University of Colorado at Boulder (November, 2011); *CSC,* Denver, CO (November, 2009 and November, 2011).

Teaching Faculty about Effective Clicker Use, *i>clicker webinar*, (October 4, 2011; January 18, 2011; August 9, 2012)

Light & Color, *Non-majors summer course in optics, University of Colorado at Boulder.* June 2011, 2012, 2013.

Making the Global Local: Evidence for Climate Change in Colorado. *Science Hubs,* Colorado Springs, CO (March 6, 2012); *CSC,* Denver CO (November 11, 2011); *Teaching Outside the Box*, Boulder, CO (April 30, 2011).

Using Clickers in Museum Environments. *Pacific Science Center*, Seattle, WA (January 10, 2011).

Inquiry Structure for Learning Science Content (with Barry Kluger-Bell). *Colorado Science Conference*, Denver CO (November, 2010; *Resource Area for Teachers (RAFT)*, Denver CO (August, 2010).

Using PhET in the Classroom, *NSTA,* Minneapolis, MN (October, 2009); *NSTA,* Phoenix, AZ (December, 2009); *Technology in Education Conference,* Copper Mountain, CO (July, 2009).

Solid Ways to Teach Fluids, *CSC*, Denver, CO (November, 2007).

Demonstrations and Ideas from the Exploratorium, *CO-AAPT,* Wheat Ridge, CO (October, 2008)

Using and Making Audio Podcasts in the Mathematics Classroom, *California Mathematics Council,* Asilomar CA (June, 2007)

Attack of the Podpeople: Creating and using podcasts in the classroom, *Exploratorium*, San Francisco (May, 2007).

Sparking Excitement for Electricity: Electrostatic activities that work. *CMSESMC Math/Science Conference*, Redwood City (June, 2007).

TALKS

A scholarly approach to science education: A research-validated approach to transforming junior E&M, *Colloquium, Duke University* (September 24, 2013).

Clickers in context: How is peer instruction used in the classroom (and what works?) *Special seminar, University of California at Santa Cruz* (January 23, 2012).

The Quasi-Linear Dynamics of a Career in Science Education. Plenary Speaker, *University of Oregon Women in Science Group*, Portland, OR (April 28, 2012); Invited speaker, *University of Oregon Women in Science Group*, Portland, OR (November 11, 2011); Invited Speaker, *Duke University Graduate Group*, Durham, NC (September 27, 2013).

Clickers in context: How is peer instruction used in the classroom (and what works?) Invited speaker, *Department Colloquium, Oregon State University Physics Dept.* (October 17, 2011).

Adopt, Adapt, or Abandon? Instructors' Decisions to use Research-Based Materials, *AAPT,* Omaha, NE (August, 2011).

Speaking of Physics: The Art of Science Communication. *University of West Virginia Colloquium*, Morgantown, WV (March 2, 2012); Invited panelist, *AAPT*, Omaha NE (August, 2011); , Department Colloquium, *Physics Dept., San Jose State University*, San Jose CA (October, 2006).

Getting the Word Out: Effective Communication of the Results of Our Work in Physics Education Research. Plenary Speaker, *Foundations and Frontiers of Physics Education Research, Puget Sound,* Seattle, WA (March 2011); Invited speaker, *Global Physics Department*, online (November 2, 2011); *AAPT*, Ontario, CA (February 6, 2012).

Learning Goals and Bloom's Taxonomy. *Guest lecturer, "Teaching and Learning of Biology" course, CU-Boulder biology department* (Feb. 11, 2011).

Alternative Careers in Media. *Beyond Boulder student career panel.* Invited panel speaker (Feb. 25, 2011).

Communicating DBER outside of DBER. *DBER Group*, Boulder, CO (December, 2010).

Translating Discipline-Based Education Research to K12 Teachers, S. Chasteen and T. Loeblein. *iSTEM Teacher Professional Development Mini-Symposium.* Invited Presentation, Boulder CO (Sept 2, 2010).

Facing Facebook: Using Social Media In and Out of the Classroom. Invited panelist and speaker, *AAPT*, Portland OR (July, 2010).

An Inside Look: Practical strategies for personal response systems ("clickers"). *AAPT*, Portland OR, (July, 2010);

What (most) Physicists (don't) Do: Alternative Careers in Science. Invited speaker for course *What Physicists Do,* Carleton College, MN (April 2010).

Flirt Harder, I'm a Physicist. Invited talk on alternative careers and a career as a woman scientist, *Women in JILA group*, CU Boulder (October, 2009).

Thinking Like a Physicist: Transforming Upper-Division Electricity and Magnetism, *Carleton College Colloquium,* MN (April 2010); *New England AAPT*, Durham NH (October, 2009).

A Research-Based Transformation of Junior Electricity and Magnetism. *APS*, Denver CO (March, 2009).

Clicker Use in Upper-Division Courses, Invited talk, *AAPT*, Chicago, IL (February, 2009); *Colorado Learning and Teaching with Technology Conference*, Boulder CO (August, 2009).

Transforming Upper-Division Electricity & Magnetism, *APS*, Denver, CO (March, 2007).

Transforming Upper-Division E&M, *AAPT,* Edmonton, AB (July, 2008).

Get the Word Out: My Life as a Scientist Communicator, Invited talk, *Ecological Society of America*, San Jose, CA (March, 2007)

Hear Me Out: Communicating Nanotechnology through Podcasts .
Communicating Science to Broader Audiences, Lincoln, NE (December, 2007)

SmallTalk: Conversations about Nanotechnology through Podcasts, *AAPT*, Seattle WA (July, 2007).

POSTERS

Teasing Out the Effect of Tutorials, S. V. Chasteen, *PERC,* Omaha, NE (August 2011).

Learning About Teaching Physics: A new audio podcast on physics education research for teachers. S. V. Chasteen and M. Fuchs, *AAPT*, Omaha, NE (August, 2011) and Ontario, CA (February, 2012).

But Does it Last? Sustaining Upper-Division Transformations in Electricity and Magnetism. S. V. Chasteen, R. E. Pepper, S. J. Pollock, K. Perkins. Center for Integration of Research, Teaching and Learning, Madison, WI (October, 2011); *Foundations and Frontiers of Physics Education Research, Puget Sound,* Seattle, WA (March 2011).

Translating Discipline-Based Education Research to K12 Teachers, S. Chasteen, K. Perkins, C. Wieman. *iSTEM Teacher Professional Development Mini-Symposium,* Boulder CO (Sept 2, 2010).

New Ways of Teaching Junior E&M – Descriptions and Results. S. V. Chasteen, S. J. Pollock, M. Dubson, E. Kinney, P. Beale and K. K. Perkins. *AAPT,* Portland OR (July 2010).

An Inside Look: Practical strategies for personal response systems ("clickers"). S.V. Chasteen. *AAPT*, Portland OR (July 2010); *AAPT*, Omaha, NE (August, 2011); *AAPT*, Ontario, CA (February, 2012).

But Does it Last? Sustaining Upper-Division Transformations in Electricity and Magnetism. S. V. Chasteen, R. E. Pepper, S. J. Pollock, K. Perkins. *PERC*, Portland OR (July, 2010).

Upper Division Transformations in Physics. S.V. Chasteen, S. Goldhaber, M. Dubson, E. Kinney, O. DeWolfe, P. Beale, K. Perkins, *STEM Education Symposium*, Boulder CO (August, 2009)

Thinking Like a Physicist: Transforming Upper Division Electricity & Magnetism, S. V. Chasteen, S. J. Pollock, M. Dubson, E. Kinney, P. Beale and K. Perkins, *PERC*, Ann Arbor, MI (July 2009);

Tapping into Juniors' Understanding of E&M: Development of the CUE Assessment, S. V. Chasteen and S.J. Pollock, *PERC*, Ann Arbor, MI (July 2009).

Cognitive Issues in Upper Division E&M, S.J. Pollock and S.V. Chasteen, invited poster, *PERC*, Ann Arbor, MI (July 2009)

Transforming Upper Division E&M, S.V. Chasteen, S. Pollock, W. Handley, D. Tarshis, P. Beale, *AAPT*, Edmonton AB (July 2008)

Assessing Student Understanding in Upper Division E&M, S. V. Chasteen and S. J. Pollock, *PERC*, Edmonton AB (July 2008).

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Stephanie Chasteen**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Conference on Introductory Physics for the Life Sciences

Source of Support: NSF

Total Award Amount: $97,513 Total Award Period Covered: 7/1/2013-6/30/2014

Location of Project: American Association of Physics Teachers, College Park, MD

Person-Months Per Year Committed to the Project. Cal: 0.15 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Interdisciplinary Quantitative Biology Program

Source of Support: NSF IGERT

Total Award Amount: $3,499,319 Total Award Period Covered: 8/1/2012-8/1/2017

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal: 0.3 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount:

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Graduate Program in Renewable and Sustainable Energy

Source of Support: NSF GAANN

Total Award Amount: $399,798 Total Award Period Covered: 1/1/2013-1/1/2016

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal: 0.2 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Creating a Community of Practice around a Proven Teen Science Café Model

Source of Support: NSF

Total Award Amount: $2,697,291 Total Award Period Covered: 10/1/2012-9/30/2017

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal: 0.2 Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Stephanie Chasteen**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Scalable Transformation: Developing a Model of Effective Faculty Development through Online Multimedia Resources

Source of Support: NSF DUE IUSE

Total Award Amount: $676,361 Total Award Period Covered: 09/1/2014-08/31/2017

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal: 3 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Physics Education Research User's Guide: A Web Resource for Physics Educators

Source of Support: NSF TUES Type 1

Total Award Amount: $200,000 Total Award Period Covered: 1/1/2013-12/31/2014

Location of Project: American Association of Physics Teachers, College Park, MD

Person-Months Per Year Committed to the Project. Cal: 0.43 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Resources to Implement Flipped Chemical Engineering Classrooms

Source of Support: NSF TUES

Total Award Amount: $200,000 Total Award Period Covered: 2/1/2013-1/31/2015

Location of Project: University of Colorado Boulder

Person-Months Per Year Committed to the Project. Cal:0.2 Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Video Resource for Professional Development of University Physics Educators

Source of Support: NSF TUES

Total Award Amount: $234,077 Total Award Period Covered: 7/1/2013-6/30/2016

Location of Project: Seattle Pacific University

Person-Months Per Year Committed to the Project. Cal: 0.4 Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY