



Integrating STEM Education

UNIVERSITY OF COLORADO BOULDER

I3: Towards a Center for STEM Education

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1. Project objectives and summary

The NSF I³ project at the University of Colorado Boulder works primarily to integrate three existing lines of work supported by NSF: (1) efforts in course transformation in STEM, particularly at the undergraduate and graduate levels, (2) programs in teacher preparation and professional development, for K12 and college, and (3) discipline-based education research among faculty, students, and post-doctoral scholars. Notably, each of these three lines of inquiry into STEM education supports the other two. One of the distinctive aspects of these multidisciplinary efforts at CU-Boulder is that they are located largely in the disciplinary and education departments, rather than in an external center or department. This NSF I³ effort is working to build a *distributed* center of STEM education research and transformation. This center will: (a) integrate the three lines of inquiry and development described above, (b) retain the status and rigor offered through science and engineering departmental identity, and (c) expand the reach of thriving STEM education community to include more departments and participants. The five year NSF I³ program is designed to establish CU-Boulder as a national hub of STEM education by broadening participation, bridging critical educational junctures, developing a better prepared workforce, and integrating discipline-specific education and research, all in the context of a sustainable model of institutional practice.

To better establish an identity and to define the effort goals of a center more clearly, the NSF I³ supported program has created the working name of iSTEM (Integrating STEM Education) and developed both mission and vision statements. They are:

1.A. Mission

To build an infrastructure of institutional support in order to promote STEM education reform through course transformation, discipline-based education research, and teacher recruitment and professional development.

1.B. Vision

We facilitate change in STEM education by integrating an interdisciplinary community of scholars, promoting and sustaining existing reform efforts, sponsoring new programs, advocating for diversity and access, influencing relevant policy, and fundraising. We are building a center for STEM education at CU-Boulder.

1.C. Intellectual Merit

iSTEM has explicitly supported 25 research projects and programs, and built a community of scholars in STEM education that spans more than 30 programs and departments. In the last year, this community has produced more than 70 publications and an equal number of presentations and workshops on STEM education research and reform. iSTEM has supported the inclusion of a scholarly approach to educational practice that is spreading throughout our campus and institutions that are replicating our educational models.

1.D. Broader Impacts

Funding from the NSF I³ has started to build a cohesive organization among more than 45 different programs on campus that focuses on STEM education. These programs impact roughly 10,000 undergraduates per year and thousands of pre-college children through our community partnerships. The efforts in policy, communication and fundraising are impacting the university's identity and perception of the university's role in the community. We are well on our way to establishing a national scale Center for STEM education research and reform at the University of Colorado Boulder.

iSTEM includes activities at each of the following levels, which are designed to support the mission mentioned above:

- *Programmatic*: programs designed to integrate existing efforts, nucleate new efforts, and build a STEM education community at CU-Boulder.
- *Diversity and Access*: programmatic activities and policy actions to support the inclusion of minorities, women, and students from historically under-represented populations in STEM.
- *Infrastructure development/university policy*: efforts to secure sustainable long-term support for these efforts.
- *Dissemination*: beyond outreach to constituents we externalize our efforts and are building a web portal for sharing of resources.
- *Public Policy and Outreach*: efforts to support STEM education in the region, state, and nation.
- *Evaluation*: both formative (largely internal) and summative evaluation of our effort to achieve our mission.

2. Programmatic activities

2.A. Integrating, supporting, and running programs

iSTEM supports individual programs that span a broad section of campus (such as the Colorado Learning Assistant Program, described below), while simultaneously serving to link, coordinate, and integrate these constituent programs. By creating a network of programs, we strengthen individual programs, leverage resources, gain broader attention, and nucleate new programs.

In the past year we have reached out to more than different 80 programs on the University of Colorado Boulder campus to link with our iSTEM efforts. See list in 7.A. List of affiliated programs.

2.A.i. Annual symposia

A cornerstone of our iSTEM program is an annual symposium celebrating STEM education at the University of Colorado Boulder. Our Second Annual Symposium was held November 15, 2010, and was attended by more than 130 people, including six deans, two members of the Board Regents, the mayor and vice-mayor of the City of Boulder, several state legislators, donors, the vice president of Ball Aerospace, the

engineering director of Google's Boulder campus, and faculty, staff, and students from across five academic colleges/schools.

The program began with a poster session showcasing 27 programs, which provided networking opportunities among our STEM education constituents. An award ceremony honored Professor Albert A. Bartlett (a Boulder icon and early leader in STEM education). As per our tradition, we recognized recipients of the Chancellor's Award for Excellence in STEM Education. The deans of the College of Arts and Sciences, School of Engineering and Applied Science, School of Education, and Graduate school also spoke briefly.

Plans are under way for a third annual STEM education symposium to be held on October 10, 2011. Dr. Joseph Garcia, Colorado's lieutenant governor and executive director of higher education for the state of Colorado, will give a keynote address. We will invite participation from donors, VIPs, and key stakeholders throughout the state and the university, and plan to announce the establishment of a center at the event.

2.A.ii. Mini-symposia/workshops in targeted areas of STEM education

Based on ideas generated at iSTEM's inaugural symposium (2009), iSTEM developed a series of mini-symposia (see 7.B. Mini-symposia for STEM education). These mini-symposia were to bring people from the campus policy, practice, and research communities together to learn from each other's work, to make connections and build community, and to collaborate or coordinate on future work. The mini-symposia participants would decide if and how to move forward. In the last year two mini-symposia series were inaugurated: 1) CU-Boulder teacher professional development, and 2) a LA workshop within/beyond CU-Boulder.

iSTEM plans to organize mini-symposia in the areas of undergraduate research, and informal STEM education, outreach, and community engagement during the 2011-2012 academic year.

2.A.ii.a. Teacher professional development

The first of these mini-symposia series was focused on professional development for CU-Boulder teacher professional developers. The very successful, four-hour event featured a keynote speaker and breakout sessions. Thirty-seven people attended, and follow-up surveys indicate widespread appreciation for the event and virtually unanimous support for continued meeting of the group. Based on ideas generated at the mini-symposium, the community proposed and organized another meeting of CU-Boulder teacher professional developers about the new Colorado K12 science standards. See 7.C. Mini-symposium on teacher professional development for a full write-up of this event.

This second gathering of the teacher professional development community was held on February 15 and featured Barry Cartwright, science content specialist from the Colorado Department of Education. Seventeen people from 13 campus organizations

attend the event. All reported this as a positive experience, and an independent survey of participants detailed successes and challenges. All seven of the online responses reported this as valuable and requested additional activities in the future. See 7.D “Tackling the New Colorado Science Standards” K-12 teacher professional development session for a full write-up of this event.

2.A.ii.b. Colorado Learning Assistant Program (LA Program)

The second series of mini-symposia focused on the use and dissemination of the LA Program (described below).

2.A.ii.b.1. Internal CU-Boulder faculty development LA Program workshops

iSTEM sponsored two workshops aimed at CU-Boulder faculty this year. The first was a three-hour introductory workshop in August. This provided opportunities for new faculty to learn about the program and models for using LAs from experienced faculty users (and LAs) across several departments. About 30 people attended this workshop, including faculty from departments who are now using LAs for the first time in 2011. The second workshop was held in December, and was targeted to faculty committed to using LAs in their Spring 2011 courses. It provided an opportunity to plan weekly prep sessions as well as share ideas among new and experienced LA users. This workshop was attended by 13 of the 29 faculty using LAs in their Spring 2011 courses.

2.A.ii.b.2. 2010 PhysTEC/national LA Program workshop

PhysTEC (the national Physics Teacher Education Coalition) sponsored a national workshop at CU-Boulder in October. In addition to representatives from the American Physical Society and CU-Boulder faculty, this workshop was attended by 37 faculty from 22 universities who were looking to emulate the LA Program. Since this workshop, we have been supporting faculty across the country in adopting and adapting the model for their institutional needs.

2.A.iii. Math Association of America – educational meeting

On April 8-9, 2011, iSTEM co-sponsored the annual meeting of the Rocky Mountain Section of the Mathematical Association of America. Eric Stade, CU-Boulder professor of mathematics and iSTEM co-director, organized the event. Over 125 post-secondary mathematics educators and students attended.

The meeting featured four keynote speakers, a chairs' luncheon and discussion on the Common Core State Standards in mathematics, a workshop on using LAs in college math and science courses, and more than 50 contributed talks, of which nearly a third concerned issues and topics in mathematics education. The LA workshop was facilitated by iSTEM co-directors, Noah Finkelstein and Valerie Otero, and by LA Program co-director, Laurie Langdon. Twenty-six post-secondary math educators from around the Rocky Mountain region registered for the workshop. In this workshop, two and four-year college math faculty were introduced to the LA Program model. Several different approaches to implementation and funding of an LA program were discussed. Materials to assist faculty in developing and initiating such a program were provided.

2.A.iv. Chancellor's Awards for Excellence in STEM Education

A key and innovative component of iSTEM is the Chancellor's Awards for Excellence in STEM Education. These mini-awards provide funding to faculty (up to \$10,000) and graduate students (25% research assistant appointments) who excel in discipline-based education research and/or promoting education within their department through course transformation. These awards have supported and encouraged STEM education research at CU-Boulder.

For faculty, the award money can support course release, summer salary, or research costs associated with STEM education projects. Funds can support projects in the early stages, the coordination of existing projects, and efforts that can continue beyond the funding period. Grants of up to \$10,000 are awarded for up to one year.

In the first two and half years of this project, iSTEM has funded ten faculty awards (see 7.E. Chancellor's Awards for Excellence in STEM Education). The 2010-2011 Chancellor's fellows are currently wrapping up their projects and submitting final reports. The 2009-2010 Chancellor's fellows report that their projects have resulted in at least seven invited presentations, seven peer-reviewed publications, and two new NSF grants (see 7.F. Outcomes of the Chancellor's Awards).

An example of one of the current Chancellor's Award projects is the work of Drs. Falconer and Nicodemous from the School of Engineering and Applied Science. These PIs are developing and teaching with screencasts (5-15 minute mini-lectures that are recorded and posted on our iTunes University website) to allow more time for meaningful engagement in class. Their project, *Biologically-Focused Screencasts and ConcepTests for Chemical and Biological Engineering Courses*, has resulted in more than 30 screencasts. These materials augment the courses that are being taught, allowing students to review lecture components, particular derivations, or processes that are particularly challenging. For more information see:

<http://itunes.apple.com/us/institution/university-colorado-boulder/id381163745>

Fourteen graduate awards have been made over the last two and a half years (see 7.E. Chancellor's Awards for Excellence in STEM Education). These awards promote the development of graduate students in STEM education, and provide resources for to encourage their disciplinary departments to engage in course transformation and disciplinary-based education research. This year four PhDs were awarded to students who had received support from iSTEM for conducting research in STEM education.

An example of the graduate award is that of Dr. Colin Wallace to *Document and Address students' difficulties with cosmology*. The research he conducted with the funding was central in his dissertation, and at his graduation this spring, he became the first University of Colorado Boulder graduate to be awarded a doctorate in astrophysics for research in education. As part of his research he produced three new tutorials on cosmology that are being disseminated nationally via our efforts with the NSF funded Collaboration of Astronomy Teaching Scholars (CATS) from Arizona.

Another example is the support of *Undergraduate Climate Change Curriculum Development and Validation*, by Kimberly Trenbath. She is anticipated to be the first University of Colorado Boulder graduate to be awarded a doctorate in atmospheric studies for research in science education. The materials she has produced have been instrumental in the revision of two courses in introductory atmospheric studies here.

For both faculty and graduate students, the complete text of funded proposals is available at <http://www.colorado.edu/istem/fellows.html>.

The third year of awards is under way, with a July 1 call for proposals. The chancellor has issued the call for proposals, and we anticipate a very popular response.

2.A.v. The LA Program

The LA Program is a flagship program of iSTEM. The LA Program embodies iSTEM's three-part mission of course transformation, educational research, and teacher recruitment and preparation. With the support of iSTEM the LA Program made 86 undergraduate LA appointments in Fall 2010 and 87 appointments for Spring 2011. These appointments spanned nine departments within two colleges (Arts & Sciences and Engineering). The program is expanding into two new departments (including online math courses offered through Independent Learning) so that 107 undergraduates will be hired as LAs in Fall 2011. The LA Program is also poised to expand into additional courses in the School of Engineering and Applied Science.

We continue to collect data, documenting the positive impact of LA-supported courses that feature interactive, research-based practices. We are in the midst of transitioning the LA Program to institutional rather than grant-funded support. Currently, departments, deans, and the provost all contribute to the LA Program. Information about the LA Program is available at: <http://laprogram.colorado.edu/>.

2.A.vi. Discipline Based Education Research

In year three, the Discipline Based Education Research (DBER) seminars built on the success of the first two years, holding 36 seminars since June 2010. These seminars brought together faculty and graduate students from roughly 30 different programs and departments and across four schools/colleges. The average attendance was more than 20 people, and, over the year, spanned more than 80 faculty, graduate students, and staff from the university. These meetings continue to be effective at creating community among STEM education researchers on campus. DBER is also serving as a vehicle to make connections with STEM education experts from other institutions and has already hosted faculty from the American Physical Society, Arizona State Polytechnic, Indiana University, Massachusetts Institute of Technology, Seattle Pacific University, the University of Copenhagen, the University of Nebraska, the University of New Hampshire, the University of North Dakota, the University of Texas at Austin, and the University of Wisconsin–Madison. A complete calendar of DBER meetings, presenters, topics, and video recordings of many past seminars can be found at: <http://colorado.edu/istem/DBER.html>.

2.A.vii. Physics Education Research Group at Colorado

iSTEM also continues to support the Physics Education Research Group at Colorado (PER@C), which is one of the largest PER research programs in the nation. The research group develops and studies: uses of technology in physics education, assessments (conceptual, epistemological, and belief oriented), theoretical models of students learning physics, social and contextual foundations of student learning, examination of successful educational reforms and replication studies of such reforms, and student problem-solving in physics. They sponsor a number of educational reforms in physics, which range from pre-college to post-doctoral. The research group includes faculty, staff, and students from both the Department of Physics and the School of Education. In partnership with iSTEM, the last year's efforts have expanded to include significant funding (e.g., two Phase 2 CCLI/TUES) for: course transformation (upper division physics), computer simulation (PhET), and other efforts such as a Phase 1 TUES grant on upper division laboratory reform. More at: <http://per.colorado.edu/>

2.A.viii. Additional collaborative STEM education projects

Over the last year, iSTEM has supported a variety of interdisciplinary efforts in science, technology, engineering, and math education, including:

2.A.viii.a. CU Teach, new course development

As part of CU-Boulder's new effort in K12 STEM teacher certification, CU Teach (<http://cuteach.colorado.edu/>), faculty teams have been developing new research-methods courses that focus on discipline-specific issues in scientific research for future teachers. The first of these courses ran in Fall 2010, and is supported by iSTEM.

2.A.viii.b. Teaching and learning science courses

Two new courses in disciplinary-specific teaching have run (*Teaching and Learning Physics* and *Teaching and Learning Biology*). Chemistry is assembling a parallel course to offer in the 2011-2012 academic year.

2.A.viii.c. Creating an engineering teacher certification track

Discussions are underway between key faculty/administrators in the College of Engineering and Applied Science, CU Teach, and the School of Education to identify what features a teacher certification program in engineering would include.

2.A.viii.d. Partnerships with other NSF centers and grants at CU-Boulder

iSTEM offers consulting, community, and research-based educational support for a variety of centers at the University of Colorado Boulder, including the JILA Physics Frontier Center, COSI-IGERT, the Renewable and Sustainable Energy Institute, Colorado Initiative in Molecular Biotechnology (CIMB-IQ), the Center for Engineering Educational Research and Assessment, and Colorado's expanded efforts through Science Discovery.

2.B. Enhanced use of technology

Over the last year, iSTEM has started sharing our resources electronically.

2.B.i. iSTEM Website

An up-to-date website is maintained to coordinate work internally at Colorado and to share information and resources with the public. The website is available at:

<http://www.colorado.edu/istem>.

2.B.ii. Streaming videos

Our weekly DBER and PER meetings are now being captured and streamed online. Roughly three-dozen videos from our weekly meetings are now posted. These videos feature both local researchers and internationally renowned visitors. More info at:

<http://sites.google.com/site/custemeducationalvideos/home>

2.B.iii Robust database of iSTEM participants

In the last year, we have built a system for supporting the iSTEM community, and constituent programs. Our web efforts allow us to track participants, quickly send out surveys, collect information, electronically track applications, and provide for collaborative space. These efforts are on going but have already facilitated the management of our community.

2.B.iv. Communication efforts

As discussed below, the University Communications office is leading an effort to promote STEM Education as a central theme of the University of Colorado. New media (blogs, twitter, and web2.0 tools) are playing an increasing role in this communications effort.

3. Diversity, equity, and access

Below are some of the iSTEM diversity and access efforts, which intersect with and/or supplement existing programs on campus:

3.A. Office of Diversity Equity and Community Engagement (ODECE)

CU-Boulder has established a new vice chancellor-level position focusing on diversity and access. The iSTEM directors are the STEM education consultants to this office. More information is available at <http://www.colorado.edu/odece/>. iSTEM's directors partnered with ODECE directors on an NSF proposal to increase STEM scholarships, and while not successful in obtaining funding, this effort has established models for partnership and internal scholarship opportunities for students

3.B. Colorado Diversity Initiative (CDI)

This program, which works to improve diversity and access in STEM, is a strong collaborator with the iSTEM effort, particularly for undergraduate and graduate scholarships. More information is available at

<http://www.colorado.edu/GraduateSchool/DiversityInitiative/>.

3.C. Partnerships in Informal Science Education in the Community (PISEC)

An out-of-school program that simultaneously supports the development of children and of undergraduate and graduate students at CU-Boulder. More information is available at <http://www.colorado.edu/physics/PISEC/index.html>.

3.D. MESA/Colorado MESA

The PISEC director, who is partially supported by iSTEM, serves on the St. Vrain MESA (Math Engineering Science Achievement) executive board.

3.E. Minority Bridge Program

The CU-Boulder physics department is partnering with the American Physical Society to be one of eight institutions committed to doubling the number of black and Hispanic PhDs in physics in the United States (other institutions include Harvard, Princeton, Stanford, MIT, and the University of California).

3.F. STEMS Seminar

A grassroots student movement to support under-represented minorities in STEM with community and scholarship. Student seminars are run by and for students and are attended by 25-35 students per week.

3.G. National Society of Black Physicists and Hispanic Physicists Conference

Each year CU-Boulder sends a delegation of about ten students to the joint annual meetings of the National Society of Black Physicists and Hispanic. The STEMS seminar grew from this community. While the NSBP/NSHP meeting did not run in 2010-2011, the students at CU-Boulder who've participated in the past created and sent a delegation to the Puerto Rico Interdisciplinary Scientific Meeting (PRISM). This delegation of one-half dozen students raised awareness about CU-Boulder, supported minority students at CU-Boulder, and created strong ties with the Puerto Rican scientific community. Noah Finkelstein has already been invited for to give a follow-up addresses for the PR LSAMP community.

3.H. Noyce

iSTEM partners with the two Noyce programs, the Noyce pre-certification program at CU-Boulder and the Streamline to Mastery program for practicing teachers. Each Noyce community focuses on working in underrepresented/underserved populations. These Noyce scholars are being featured by iSTEM by presenting at DBER and hosting poster presentations at our annual symposia.

3.I. CU Science Discovery

This program is partnering with iSTEM to create opportunities for underserved students in their staple afterschool/summer camp programs. In particular, iSTEM is supporting the integration of Science Discovery into more central practice/role at the university.

3.J. Boulder Area STEM Education Coalition (BASEC)

BASEC (see <http://boulderareastem.org>) focuses on diversity, equity, and access for children in STEM. iSTEM has helped shape and create this effort and links CU-Boulder efforts directly with the community. In partnership with BASEC, iSTEM has supported career fairs for youth, campus visits, and networking among the dozens of community-based programs focusing on STEM.

3.K. Women in engineering

iSTEM has supported a meeting of women in engineering on campus that is serving as the educational cornerstone of one of our faculty, who is applying for an NSF CAREER award. This weekly meeting builds a community and cohort between electrical engineering undergraduate and graduate women. The annual outcomes of this project are available at our website: <http://www.colorado.edu/istem>

3.L. Chancellor's Awards for Excellence in STEM Education

Our i3/iSTEM efforts explicitly call for proposals to directly or indirectly impact diversity and access in STEM. An example of a current award is an effort in the College of Engineering & Applied Sciences' program, *Assessing YOU'RE@CU: A New Program to Promote Diversity in Engineering*. She says of her efforts, "Our educational vision is that merging bioengineering research with teaching and providing a range of research opportunities will enhance new student recruitment, improve retention of engineering lowerclassmen – and particularly target retention of underrepresented minorities and women, encourage undergraduates to seek graduate degrees, and provide mentoring training for graduate students."

4. Dissemination and public policy

Efforts to disseminate findings and support educational policy run throughout each of the three major areas of iSTEM: course transformation, discipline-based education research, and teacher professional development.

Much of our dissemination and networking efforts focus on the programmatic level:

- iSTEM has supported the dissemination of the LA Program model of educational transformation. In the past year, in addition to the three major workshops described above, the iSTEM directors have made over a dozen presentations at state and national venues regarding this effort. Currently 32 different institutions are replicating this successful program that positively impacts student learning, the number and quality of certified teachers, and institutional commitment to education.
- As described above, the DBER seminars are now streaming on the web and have hosted more than 40 participants from outside of CU-Boulder.
- iSTEM has recently partnered with researchers at Western Michigan in the design and population of a website dedicated to collecting research-based models of educational transformation in undergraduate STEM (see <http://www.STEMreform.org>)

- iSTEM has been an instrumental partner in creating a state-supported regional center for STEM education: the Boulder Area STEM Education Coalition (BASEC). This coalition includes over 250 members, has been endorsed by all of the county commissioners, and received support from the University of Colorado Boulder, Google Inc., Ball Aerospace, NCAR/UCAR, and a host of other regionally based efforts. More on BASEC can be found at: <http://www.boulderareastem.org>

Parallel efforts have been made to raise awareness about STEM education and iSTEM efforts at CU-Boulder:

- iSTEM has been featured at national meetings of the Association of Public and Land-grant Universities' (APLU) Science and Mathematics Teacher Imperative (SMTI), the National Mathematics and Science Initiative (NMSI), the American Institute of Physics, the American Association of Physics Teachers, and the American Physical Society's Physics Teacher Education Coalition (PhysTEC).
- The lead principal investigator of this NSF I³ grant, Chancellor DiStefano, will be chairing APLU SMTI beginning Summer 2011.
- iSTEM directors have given a wide variety of addresses on educational policy including presentations to:
 - The University of Colorado Board of Regents (June 2010)
 - COLABS, Colorado state & federal Congressional delegations (Aug 2010)
 - University of Colorado Foundation Officers (Fundraising office for the University of Colorado)
 - At Colorado public legislative briefings (Feb 2010, Aug, 2010, Aug 2011)
- iSTEM initiative has hosted a variety of policy makers:
 - US Congressman Jared Polis
 - Bruce Alberts, American Association for the Advancement of Science
 - The lieutenant governor of Colorado, Joseph Garcia
 - Shirley Malcom, AAAS
 - Colorado State Representative Dickey Lee Hullinghorst
 - Boulder County commissioners, Will Toor and Cindy Domenico
 - Boulder Mayor, Susan Osborne

iSTEM has produced a series of simple materials that describe our efforts. We have produced a brochure and a one-page summary of the project. Additionally, iSTEM has developed one-page summaries of many of the key constituent programs. Currently, there are one-page summaries of eight programs, including: iSTEM, DBER, PER@C, PhET, the LA Program, and SEI (see 7.G. One-page handouts).

The Office of University Communication has offered to produce more of these one-page summaries. We anticipate creating a full suite of 25+ summaries in the coming year.

The university has established a working group around branding, communications, and public relations with respect to STEM education at CU-Boulder. Since June 2010, a

group representing University Communications, Government Relations, Media Relations, News Services, the College of Arts and Sciences, the School of Education, the College of Engineering and Applied Sciences, the CU Foundation, and STEM education program leaders have been engaged in biweekly meetings to establish a communications and branding plan for CU-Boulder STEM education. As a result, there have been roughly a dozen articles about CU-Boulder surrounding STEM education, many of which are posted at <http://www.colorado.edu/news/reports/stemeducation/index.html>. A preliminary communication and branding plan has been established and is awaiting approval from university officials. This joint effort is unique at CU-Boulder, and represents a pilot attempt to coordinate many key areas of inquiry on campus.

In April 2011, University of Colorado president Bruce Benson announced the \$1.5 billion *Creating Futures* capital campaign. One of the four major pillars of this campaign, “Learning and Teaching”, features STEM education as a key area of emphasis. iSTEM was featured at each of the last two CU-Boulder donor receptions.

4.A. Scientific presentations/publications

iSTEM has supported more than 70 publications and 70 workshops and presentations. See 7.H. Partial listing of publications by iSTEM affiliates for a list of publications from the last year. See 7.I. Partial listing of presentations by iSTEM affiliates for a list of presentations given in the past year.

5. University structures: Towards a center for STEM education

Over the past year, the iSTEM directors have been meeting weekly in order to manage the programming in order to accomplish our mission and reach our goals. One of the explicit five-year goals of this NSF I³ grant is to establish a center for STEM education at the University of Colorado Boulder.

We are well on the way to establishing such a center. Over the last year, the iSTEM directors have been meeting to draft mission and vision statements (see 1.A. Mission and 1.B. Vision), establish an organizational structure and write by-laws (see 7.J. Draft of center by-laws).

In addition to establishing a center, the iSTEM directors have made extensive investigations into whether it would be better to establish an institute (higher on the organizational chart, representing a structure akin to a department at CU-Boulder). In consultation with the NSF I³ principal investigators, it was determined that establishing a center is a good stepping stone towards eventually establishing an institute, which may, in the long run, will be the appropriate level of administrative structure for iSTEM.

In addition to weekly meetings of the iSTEM directors, members of the team have been meeting with the key personnel at the university, such as deans, the provost, and the chancellor to lay the groundwork and build community consensus around this center.

Complementing the administrative structures that are underway, iSTEM directors are actively involved in:

- Establishing community culture/public relations around this center:
To this end, this project has promoted CU-Boulder STEM education programs to build community. These programmatic/community building events include the symposia (featuring deans, the provost, the chancellor, and members of the Board of Regents) and the communications and branding efforts described above. Among the results of these efforts, a regular press presence supports the development of community identity around STEM education.
- Establishing long term, sustained funding avenues for STEM education activities at CU-Boulder. In the last year, the university has committed a half-time development officer from the CU Foundation. In addition to coordinating with the CU Foundation, the iSTEM directors are working with senior university administration to identify mechanisms for regular, sustained support for a center and constituent programs.

6. Evaluation

iSTEM at CU-Boulder has been conducting three levels of evaluation:

- Providing measure of positive outcomes of increased educational capacity for constituent programs.
- Measure the integration of constituent programs.
- Assessing the institutional capacity and commitment to establishing a center for STEM education.

These evaluations are being conducted internally (under the direction of the iSTEM directors) and externally (through our external evaluator, Dr. Rachel Scherr).

Just past the halfway mark of this funding cycle, iSTEM is meeting its goals of establishing a center, integrating programs, and promoting and creating opportunities for individual efforts in STEM education.

6.A. Component efforts

Key programs are successful and benefit from iSTEM. For example:

- iSTEM has supported roughly 30 individuals directly through the Chancellor's Awards for Excellence in STEM Education (see 2.A.iv. Chancellor's Awards for Excellence in STEM Education).
- The LA Program has become a key model for teacher preparation, course transformation, and institutional change. As described above, we are now impacting roughly 10,000 students/year, hiring 200+ LAs/year, have dramatically increased the learning gains of students in large-enrollment classes, and have nearly tripled the number of students going into teaching in hard-to-staff subjects (such as chemistry and physics).

- DBER and PER@C groups hold meetings attended by more than 20 faculty and students per week, create a culture of scholarly work around educational transformation, and produced dozens of papers and presentations.
- The College of Engineering and Applied Sciences is establishing a parallel center, the Center for Engineering Education and Research Assessment, and is collaborating with the LA Program and iSTEM.

6.B. Integration efforts

iSTEM has, through concerted programming and communication efforts, created opportunities for integration, and has built a more robust network of programs.

6.B.i. Creating time and space for integration

Much of iSTEM's programming is designed to facilitate cross-program communications. This includes the symposia and mini-symposia, PER@C and DBER group meetings, meetings with University Communications and resultant materials, our website, <http://www.colorado.edu/istem/>, and email communications sent to our collaborators across campus.

In the last year, at least 250 different people have participated in an iSTEM-sponsored event.

In year one of this grant we conducted a "baseline" survey of the network among programs. This cross-campus survey resulted in a dataset identifying which programs were connected, in what ways, and how often interaction occurred (see 7.K. STEM Program Interaction Map for example).

We are currently in the midst of a mid-program follow-up (expanding on the original survey at the advice of our external evaluator) and already have compelling indications that more programs are involved and are more integrated with each other since our initial survey.

6.C. Creating a center structure

As described in Section 5. University structures: Towards a center for STEM education the process for establishing a center is well underway. In the past year, the iSTEM directors have met 19 times and have held an additional half-dozen meetings with NSF I³ principal investigators. These have resulted in a variety of the outcomes described above, established mission and vision statements and preliminary draft of center by-laws, and proposed center structure. We anticipate establishing the center in the fall of 2011 or the winter of 2012.

As per the NSF I³ proposal, iSTEM is shaped by annual visits (and regular consultations) with our external evaluator. In November 2010, Dr. Scherr made an annual site visit to CU-Boulder to conduct an evaluation our efforts. This year's visit focused on:

- Exploring potential for establishing a center
- Coordination of efforts, particularly among the iSTEM directors

Dr. Scherr's evaluation (see 7.L. Report on iSTEM evaluation by R. Scherr, 11 15-16, 2010) outlines the strengths and weaknesses of our efforts. She identifies the following areas of focus:

- Relationships among disciplines and programs
- Rewarding intellectual interactions
- Funding structures
- Participation of high-status individuals
- Branding

In the past year the PMT has attended to these areas, worked to establish common vision, and continue working to establishing a supportive STEM education community. Some of this is captured in Scherr's evaluation. She writes, "The project management team is a major strength of the project..." and of the efforts to establish a center, "Overall, there is a compelling 'buzz' around iSTEM events and programs, suggesting that the elusive yet crucial process of building a STEM education community identity is taking place. In addition, tangible outcomes such as program growth and sustainable funding models mark progress toward center status."

Her report has focused our attention on creating a common vision and mission for our program, prompted the iSTEM directors to schedule a working retreat, and resulted in a more coherent plan for establishing a center.

7. Appendices

- 7.A. List of affiliated programs
- 7.B. Mini-symposia for STEM education
- 7.C. Mini-symposium on teacher professional development
- 7.D. "Tackling the New Colorado Science Standards" K-12 teacher professional development session
- 7.E. Chancellor's Awards for Excellence in STEM Education
- 7.F. Outcomes of the Chancellor's Awards
- 7.G. One-page handouts
- 7.H. Partial listing of publications by iSTEM affiliates
- 7.I. Partial listing of presentations by iSTEM affiliates
- 7.J. Draft of center by-laws
- 7.K. STEM Program Interaction Map
- 7.L. Report on iSTEM evaluation by R. Scherr, 11 15-16, 2010

7.A. List of affiliated programs

Short Name	Program	Contact	Position	Phone	Email	Website
CMTL	A Community of Mathematics Teachers and Learners	Eric Stade	Professor	(303) 492-4989	Eric.Stade@colorado.edu	http://outreach.colorado.edu/programs/details/id/78
	Alliance for Technology, Learning, and Society	Jill Van Matre	Assistant Director	(303) 735-1454	Jill.VanMatre@colorado.edu	http://www.colorado.edu/ATLAS/
	Alliance for Technology, Learning, and Society	John Bennett	Director	(303) 735-6153	John.Bennett@colorado.edu	http://www.colorado.edu/ATLAS/
	Alternative Breaks	Anna Domenico	Director	(303) 492-7632	volunteer@colorado.edu	http://www.colorado.edu/vrc/altebreaks/index.html
	Alumni Association of CU-Boulder	Jennifer Cassidy Moxon	Events & Outreach Chair	(303) 492-8484	ucbalumni@colorado.edu	http://www.cualum.org/services/contact-us/
	Assessing the Effects of Natural Gas on Water Quality in Garfield County	Joseph Ryan	Program Contact	(303) 492-0772	joseph.ryan@colorado.edu	http://outreach.colorado.edu/programs/details/id/87
	Astronomy Day at CU	Doug Duncan	Director	(303) 735-6141	dduncan@colorado.edu	http://cosmos.colorado.edu/sbo/public/astroday.html
	AVID Tutoring	Victoria Hand	Program Contact	(303) 492-7738	victoria.hand@colorado.edu	http://outreach.colorado.edu/programs/details/id/179
	BeSocratic	David Nesbitt	Director	(303) 492-5011	djnadmin@jila.colorado.edu	http://www.colorado.edu/physics/Web/wizards/cu/wizards.html
	BeSocratic	Mike Klymkowsky	Director	(303) 492-8508	Michael.Klymkowsky@Colorado.edu	http://www.colorado.edu/physics/Web/wizards/cu/wizards.html
BSI	Biological Sciences Initiative	Lisa Romero de Mendoza	Associate Director	(303) 492-8230	romero@colorado.edu	http://www.colorado.edu/Outreach/BSI/
BSI	Biological Sciences Initiative	Julie Graf	Director	(303) 492-8230	julie.graf@colorado.edu	http://www.colorado.edu/Outreach/BSI/
BOLD Center	Broadening Opportunities through Leadership and Diversity	LaRuth McAfee	Director, Student Engagement & Community Building Programs	(303) 492-8609	laruth.mcafee@colorado.edu	http://engineering.colorado.edu/bold/index.html
	CARLA Lab	Barbara Wise	Contact	(303) 735-5226		http://carla.colorado.edu/
	Center for Energy and Environmental Security	Lakshman Guruswamy, Ph.D.	Director		cees@colorado.edu	http://cees.colorado.edu/

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	Center for Integration of Research, Teaching, and Learning	Laura Border	Network Leader (for CU-Boulder)	(608) 263-0630	info@cirtl.net	http://www.cirtl.net/
CIRTTL	Center for the American West	Patty Limerick	Faculty Director and Chair of the Board	(303) 492-4879	patricia.limerick@colorado.edu	http://centerwest.org/
CIRES	CIRES Education and Outreach	Susan Buhr	Director	(303) 492-1143	sbuhr@cires.colorado.edu	http://cires.colorado.edu/education/outreach/index.html
	Colorado Bioneers	Sarah Dawn Haynes		(303) 492-8308	bioneers@colorado.edu	http://ecenter.colorado.edu/bioneers
	Colorado Center for Biorefining & Biofuels	Frannie Ray-Earle	Center Coordinator	(303) 492-7736	c2b2@colorado.edu	http://www.c2b2web.org/
CDI	Colorado Diversity Initiative	Bob Boswell	Co-Director	(303) 492-8565	Robert.Boswell@colorado.edu	http://www.colorado.edu/GraduateSchool/DiversityInitiative/index.html
CDI	Colorado Diversity Initiative	Mark Hernandez	Co-Director	(303) 492-5991	Mark.Hernandez@colorado.edu	http://www.colorado.edu/GraduateSchool/DiversityInitiative/index.html
CU LA Program	Colorado Learning Assistant Program	Valerie Otero	Director	(303) 492-7403	Valerie.Otero@Colorado.edu	http://stem.colorado.edu/la-program
	Colorado Math Circle	Silvia Chang	Director	(303) 494-1097	mathcircle@coloradomath.org	http://www.coloradomath.org/
	Colorado Momentum	Mary Nelson	PI	(303) 492-4273	Mary.Nelson@Colorado.EDU	http://spacegrant.colorado.edu/index.php/outreach
	Colorado Space Grant Consortium	Bernadette Garcia	Associate Director	(303) 492-3141	bgarcia@colorado.edu	http://spacegrant.colorado.edu/index.php/outreach
	Colorado Space Science Teacher's Summit	Erin Wood	Educational Coordinator	(303) 735-0692	erin.wood@lasp.colorado.edu	http://lasp.colorado.edu/education/teacherssummit/index.html
COSI IGERT	Computational Optical Sensory Imaging Integrative Graduate Education and Research Traineeship	Rafael Priestun	Director	(303) 735-0894	Rafael.Priestun@Colorado.EDU	http://cosi.colorado.edu/index.html
	Conference on World Affairs	Maura Clare	Director of Public Affairs	(303) 492-2525	cwa@colorado.edu	http://www.colorado.edu/cwa/
	Continuing Education- ACCESS Program	Carol Drake	Program Director	(303) 492-3963	carol.drake@colorado.edu	http://conted.colorado.edu/programs/access/
	CU in the Community- Learn about climate	Sophie Roudane	Program Coordinator	(303) 492-4471	sophia.roudane@colorado.edu	http://learnmoreaboutclimate.colorado.edu/
	CU on the Weekend			(303) 492-9881	weekend@colorado.edu	http://conted.colorado.edu/programs/cu-on-the-weekend/

	CU Science and Technology Policy Program	Mark Williams	Professor	(303) 492-8830	Markw@snoobear.colorado.edu	
	CU Science Discovery	Stacey Forsyth	Director	(303) 492-4839	Stacey.Forsyth@colorado.edu	http://www.colorado.edu/ScienceDiscovery/
CUTeach	CUTeach	Mike Klymkowsky	Co-Director	(303) 492-8508	Michael.Klymkowsky@Colorado.edu	http://stem.colorado.edu/cu-teach
CUTeach	CUTeach	Valerie Otero	Co-Director	(303) 492-7403	Valerie.Otero@Colorado.edu	http://stem.colorado.edu/cu-teach
	Digital Currents	Anthea Johnson Rooen	ATLAS Director of Outreach	(303) 735-0797	anthea.johnson@colorado.edu	
	Digital Library for Earth System Education	Tamara Summer	Associate Professor	(303) 735-4469	summer@colorado.edu	http://disciplines.org/
DBER	Discipline Based Education Research	Mike Klymkowsky	Director	(303) 492-8508	Michael.Klymkowsky@Colorado.edu	http://www.colorado.edu/stem/DBER.html
eCSite	eCSite	Clayton Lewis	PI	(303) 492-6657	Clayton.Lewis@Colorado.EDU	
eCSite	eCSite	Jessica Feld	Project Coordinator	(303) 735-6566	Jessica.Feld@Colorado.EDU	
	El Pueblo Magico	Kris Gutierrez	Professor	(303) 492-8450	kris.gutierrez@colorado.edu	
	Energy Certificate Programs	Paul Komor	Energy Education Director	(303) 492-7805	komor@colorado.edu	http://rasei.colorado.edu/index.php?id=122&page=Education
	Energy Justice: Combating Global Warming in Peru	Nicholas Doman	Director	(303) 735-0181	guruswam@colorado.edu	
	Ethnic Astronomy	John Stocke	Professor	(303) 492-1521	stocke@casa.colorado.edu	http://fiske.colorado.edu/
E&ER	Ethnography and Evaluation Research	Anne-Barrie Hunter	Co-Director	(303) 735-0887	Anne-barrie.Hunter@Colorado.EDU	http://www.colorado.edu/eer/
E&ER	Ethnography and Evaluation Research	Sandra Laursen	Co-Director	(303) 735-2942	Sandra.Laursen@Colorado.EDU	http://www.colorado.edu/eer/
FTEP	Faculty Teaching Excellence Program	Mary Ann Shea	Director	(303) 492-1049	maryann.shea@colorado.edu	http://www.colorado.edu/ftep/
Planetarium	Fiske Planetarium and Science Center	Doug Duncan	Director	(303) 735-6141	dduncan@colorado.edu	http://fiske.colorado.edu/
	Friday Night Stargazing at Sommers	Keith Gleason	Manager, Sommers-Bausch Observ.	(303) 492-6732	keithg@cosmos.colorado.edu	http://cosmos.colorado.edu/sbo/public/openhouse.html
	From Top to Bottom	Ryan Vachon	Program Coordinator	(303) 324-0383	ryan.vachon@colorado.edu	
	Front Range Pika Project	Chris Ray	Contact	(303) 489-8863	cray@colorado.edu	http://www.citsci.org/cwis438/Browse/Project/Project_Info.php?ProjectID=275&WebSiteID=7
	Girls at the Museum Exploring Science	Cathy Regan	Education Coordinator	(303) 492-4843	cathy.regan@colorado.edu	

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GTP	Graduate Teacher Program	Laura Border	Director	(303) 492-4902	gtp@colorado.edu	http://www.colorado.edu/gtp/
GTO	Graduate Teacher Program	PJ Bennett	Interim Assistant Director		gtp@colorado.edu	http://www.colorado.edu/gtp/
	High School Success Institute	Janet Yowell	K-12 Engineering Education Coordinator	(303) 492-5230	janet.yowell@colorado.edu	http://itll.colorado.edu/
	Integrated Teaching and Learning Program & Laboratory	Derek Reamon	Co-Director	(303) 735-0484	Derek.Reamon@Colorado.edu	http://itll.colorado.edu/
ITL	Integrated Teaching and Learning Program & Laboratory	Jacquelyn Sullivan	Co-Director	(303) 492-8303	Jacquelyn.Sullivan@Colorado.edu	http://itll.colorado.edu/
IDREAMS	Integrative Design-based Reform-oriented Educational Approach for Motivating Students	Alexander Reppening	PI	(303) 492-1349	Alexander.Reppening@Colorado.EDU	
LASP	LASP Education and Outreach	Dan Baker	Director	(303) 492-0591	Dan.Baker@asp.colorado.edu	http://lasp.colorado.edu/education/community/K-12/
	Making Global Local	Erin Furtak	Assistant Professor of Curriculum and Instruction	(303) 492-4242	erin.furtak@colorado.edu	http://learnmoreaboutclimate.colorado.edu/form-educators
	Materials Science from CU-Boulder	Hester Nadel	Program Director	(303) 492-8640	sfu@colorado.edu	http://cmrc.colorado.edu/outreach/classroomprograms1.html
	Mercury Contamination in Southwest Colorado	Joseph Ryan	Professor	(303) 492-0772	joseph.ryan@colorado.edu	
MASP	Miramontes Arts and Sciences Program	Linnea Avallone	Director	(303) 492-8229	Linnea.Avallone@Colorado.EDU	http://www.colorado.edu/masp/
	Mortenson Center in Engineering for Developing Communities	Angela Bielefeldt	Associate Director	(303) 492-8433	Angela.Bielefeldt@Colorado.EDU	http://ceae.colorado.edu/mc-edc/
	Mortenson Center in Engineering for Developing Communities	Bernard Amadei	Director	(303) 492-7734	Amadei@Colorado.EDU	http://ceae.colorado.edu/mc-edc/
NCWIT	National Center for Women and IT	Lucy Sanders	CEO and Co-Founder			http://www.ncwit.org/

	National Education Policy Center	Bethy Leonardi	Research Assistant	(720) 939-4713	bethyleonardi@gmail.com	http://nepc.colorado.edu/
	Neuroscience Undergraduate Program	Donald Cooper	Director Neuroscience Undergrad Program	(303) 335-0248	dcooper@colorado.edu	http://neurocloud.org/teaching/
NOYCE	NOYCE Foundation	Ron Ottinger	Executive Director	(650) 856-2600	rfo@noycefdn.org	http://www.noycefdn.org/index.php
	Observatory Field Trips for Schools	Keith Gleason	Manager, Sommers-Bausch Observ.	(303) 492-6732	keithng@cosmos.colorado.edu	http://cosmos.colorado.edu/sbo/public/openhouse.html
	Ozone & Snow	Shelly Sommer	Contact	(303) 492-1867	shelly.sommer@colorado.edu	http://instaar.colorado.edu/outreach/ozone-and-snow/
PISEC	Partnerships for Informal Science Education in the Community	Laurel Mayhew	Director	(303) 492-7815	Laurel.Mayhew@colorado.edu	http://spot.colorado.edu/~mayhew/PISEC/index.htm
PER	Physics Education Research @ Colorado	Noah Finkelstein	PI	(303) 735-6082	finkelsn@Colorado.EDU	http://www.colorado.edu/physics/EducationIssues/index.htm
	PHET	Carl Wieman	Chairman	(303) 492-6963	Carl.Wieman@Colorado.EDU	http://phet.colorado.edu/index.php
	PHET	Kathy Perkins	Co-Director	(303) 492-6714	katherine.perkins@colorado.edu	http://phet.colorado.edu/index.php
	PHET	Wendy Adams	Co-Director	(303) 492-6963	Wendy.Adams@Colorado.EDU	http://phet.colorado.edu/index.php
PTLC	President's Teaching and Learning Collaborative	Mary Ann Shea	Director	(303) 492-1049	maryann.shea@colorado.edu	http://www.colorado.edu/ptsp/ptlc/
PTSP	President's Teaching Scholars Program	Mary Ann Shea	Director	(303) 492-1049	maryann.shea@colorado.edu	http://www.colorado.edu/ptsp/index.html
	Problem-Solving Cycle	Jennifer Jacobs	Research Associate	(303) 492-9565	jennifer.jacobs@colorado.edu	http://psc.stanford.edu/
	Professional Learning as Leadership	Erin Furtak	Assistant Professor of Curriculum and Instruction	(303) 492-4242	erin.furtak@colorado.edu	
	Renewable & Sustainable Energy Institute	Margie Bopp	Administrative Assistant	(303) 492-0284	margie.bopp@colorado.edu	http://rasei.colorado.edu/
	Saturday Physics Program	Carole Capsalis	Program Coordinator	(303) 735-5993	carole.capsalis@colorado.edu	http://www.colorado.edu/physics/Web/Saturday/index.html
SEI	Science Education Initiative	Kathy Perkins	Director	(303) 492-6714	katherine.perkins@colorado.edu	http://www.colorado.edu/sei/
	Special Celestial Event Observing	Keith Gleason	Manager, Sommers-Bausch Observ.	(303) 492-6732	keithng@cosmos.colorado.edu	http://cosmos.colorado.edu/sbo/public/openhouse.html

STEMsation	Victoria Hand	Assistant Professor	(303) 492-7738	victoria.hand@colorado.edu	
Sustainable Practices Program	Kelly Simmons	Program Manager	(303) 492-7438	kelly@bouldersustainability.org	http://ecenter.colorado.edu/education/sustainable-practices
Teach Engineering Digital Library Collection	Jacquelyn Sullivan		(303) 492-7222	Jacquelyn.Sullivan@Colorado.edu	http://teachengineering.org/
Teaching NPS Interpretive Staff	Karl Mueller	Professor	(303) 552-7067	karl.mueller@colorado.edu	http://structure.colorado.edu/~structure/teaching_GEOL4712/index.htm
TEAMS Program	Deborah Fink	Planning and Promotions Librarian	(303) 492-8302	deborah.fink@colorado.edu	http://ucblibraries.colorado.edu/news/index.htm
The Herbst Program of Humanities for Engineers	Diane Sieber	Director	(303) 492-6399	Diane.Sieber@colorado.edu	http://engineering.colorado.edu/herbst/
University Libraries	Ami Nacu-Schmidt		(303) 735-3102	ami@cires.colorado.edu	http://sciencepolicy.colorado.edu/stcer/
University of Colorado Museum of Natural History	Patrick Kociolek	Director	(303) 492-6297	cummuseum@colorado.edu	http://cummuseum.colorado.edu/index.html
Water Resources Outreach to the Four-Corners Area	Anna Domenico	Director	(303) 492-7632	volunteer@colorado.edu	http://www.colorado.edu/vrc/altbreaks/index.html

7.B. Mini-symposia for STEM education

A collaboration between Integrating STEM Education and the Faculty Teaching Excellence Program

iSTEM and FTEP plan to collectively offer up to four mini-symposia during 2010-2012. These were proposed at the Inaugural Symposium for STEM Education in fall of 2009. One to two mini-symposia will be offered each year.

The goal is to bring people from policy, practice, and research communities in each area together to learn about each other's work, make connections and build community, and hopefully collaborate or coordinate on future projects and proposals. Each mini-symposia will be a platform to bring people together, but it will be up to the participants as to how they choose to move forward. The Annual iSTEM Symposium in August will feature outcomes from the mini-symposia.

Topics will include:

- Teacher professional development
- LA Program workshops
- Graduate education and professional development
- Undergraduate research
- Outreach and community engagement

Division of Responsibilities:

FTEP will lend its expertise and experience and help publicize and disseminate the symposia. iSTEM will handle framing and logistics and will contribute all financial resources necessary.

Budget:

Up to \$2000 each to support food, advertising, and materials and payment for a facilitator/ organizer (Something like \$500 for organizer: 10 hrs \$50/hr?). iSTEM will provide organizational support for each Symposia (web dissemination, scheduling, materials preparation, invitations, etc).

7.C. Mini-symposium on teacher professional development

Based on ideas generated at iSTEM's Inaugural Annual Symposium on STEM Education (August 31, 2009), a series of mini-symposia were proposed (see 7.B. Mini-symposia for STEM education). These mini-symposia were to bring people from the campus policy, practice and research communities together to learn from each other's work, to make connections and build community and to collaborate or coordinate on future work. The mini-symposia participants would decide if and how to move forward.

The first of these mini-symposia was focused on Teacher Professional Development. In February 2010, Barry Kluger-Bell was selected to coordinate this mini-symposium. The goals for the mini-symposium were determined to be:

- Make a time and space for people to talk and make connections
- Begin to develop new connections between administrators, researchers and practitioners in the area of K-12 professional development
- Determine if continuing meeting of this group is considered useful. If so, gather information on what sorts of continued efforts would be useful, what support may be needed, and what the barriers to this might be.
- Make sure attendees feel valued
- Offer attendees something of immediate value (e.g. PD for Peers)

The program included lunch, an invited poster session, three parallel professional development sessions, an address by Anne Heinz on the CU perspective on outreach and discussions on the continuation of the group.

The formal program started with a brief talk by Noah describing iSTEM efforts, progress and how this event fit with the iSTEM agenda. Barry followed by talking about the goals of the mini-symposium and the schedule for the rest of the afternoon. This was followed directly by people going to their professional development breakout sessions. After these sessions, and a short break, people reassembled to hear Anne Heinz talk about the institutional perspective on outreach. This was followed by table group discussion on the future of the iSTEM teacher professional development group and whole group follow-up of these discussions.

Mini-symposium Evaluative Comments:

As a whole, this mini-symposium was a success. We had 37 people attend the event. There was a widespread expression of appreciation for the event and virtually unanimous support for continued meeting of the group. Some of the individual elements of the event, however, could have used some improvement.

Schedule for iSTEM Mini-Symposium on Teacher Professional Development Thursday, September 2, 2010

- 12:00 Mount Poster's and Pick-up Lunch
- 12:30 Lunch and STEM Teacher Professional Development Poster Session
- 1:05 Formal Introduction to the Symposium
- Noah introduces chancellor or Barry
 - Barry frames and outlines the mini-symposium
 - Goals and vision
 - Describe the rest of the afternoon
 - Transition to professional development breakout sessions
- 1:15 Professional Development Sessions for Professional Developers
1. Evaluating teacher professional development: Why it's hard and what you can do anyway
Sandra Laursen, Ethnography & Evaluation Research, and Susan Lynds, CIRES Outreach
We will offer a framework for thinking about evaluating professional development for science teachers, discuss opportunities and constraints in evaluating university-based TPD programs, and share examples of evaluating TPD programs.
 2. Inquiry Science Teaching and Learning
Barry Kluger-Bell, Inquiry Science Education Consultant
The group will experience the first part of a hands on inquiry lesson, walk through the rest of the lesson and discuss the structure for inquiry learning developed by the Exploratorium Institute for Inquiry, on which the lesson is based.
 3. The connection of DBER at the college level and K-12 classrooms
Trish Loeblein and Stephanie Chasteen
- 2:15 BREAK and reconvene
- 2:25 Presentation by Anne Heinz "The Institutional Perspective on Outreach"
- 2:55 Frame table group discussions (Barry)
- 3:00 Table Group Discussion (Barry)
- Each group will designate a recorder/reporter
 - Each group will discuss a set of questions (TBD). They will include
 - What might this group do if it continued to meet?
 - Should this group continue to meet?
 - What should we try to do in the short run?
 - What should we try to do in the long run?
 - What are the barriers to collaboration?
- 4:00 Table groups report (Barry)
- Each group gets a couple of minutes to report main ideas
 - Reports are recorded on charts
 - Ideas will be transcribed and emailed to participants
- 4:20 Wrap-up (Barry)
- Individual participants will have the opportunity to write their ideas, questions or obstacles about ongoing work together to be included in our report on the meeting
 - Thank group for coming
- 4:30 END

Name	Organization	Email Address
Alexander Repenning	IDREAMS	Alexander.Repenning@Colorado.EDU
Anne Gold	CLEAN	Anne.U.Gold@colorado.edu
Anne Heinz	Continuing Education	Anne.Heinz@colorado.edu
Barbara Monday	Science Discovery	barbara.monday@colorado.edu
Barry Kluger-Bell	iSTEM	klugerbell@yahoo.com
Bruce McMullen	University of New EnglandNSW Australia	bmcmulle@une.edu.au
Clare Tisher	University Outreach	
Doug Duncan	Fiske Planetarium	dduncan@Colorado.EDU
Ed Johnsen	iSTEM	Edmond.Johnsen@colorado.edu
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Stephanie Chasteen	PhET	stephanie.chasteen@colorado.edu
Stephanie Renfrow	LASP	stephanie.renfrow@Colorado.EDU
Stephanie Rivale	BOLD Center	Stephanie.Rivale@Colorado.EDU
Susan Lynds	CIRES	susan.lynds@Colorado.EDU
Trish Lobeline	PhET	ploeblei@jeffco.k12.co.us
Valerie Otero	CU Teach	valerie.otero@colorado.edu

7.D “Tackling the New Colorado Science Standards” K-12 teacher professional development session

Based on ideas generated at iSTEM’s mini-symposium on teacher professional development (September 2, 2010), Barry Kluger-Bell proposed and organized another meeting of the iSTEM K-12 Teacher Professional Development Group. The topic proposed was the new Colorado Science Standards. These standards have some significant differences from the previous standards and the deadline for district adoption is December, 2011. Given this, there is some urgency for university-based professional development groups to better understand these changes in order to address the needs of Colorado school districts and teachers. Barry Cartwright, Science Content Specialist from the Colorado Department of Education was invited to come as a guest speaker.

Evaluative Comments:

As a whole, this mini-symposium was a success. We had 17 people attend the event from 13 campus organizations. There was a widespread expression of appreciation for the event by attendees. Additional evaluative information is being solicited by online survey.

Attendees

Name	Affiliation	Email
Stephanie Rivale	BOLD Center	stephanie.rivale@colorado.edu
Julie Graf	BSI	Julie.Graf@colorado.edu
Tammy Maldonado	BSI	tammy.maldonado@colorado.edu
Kristin Swihart	BSI	kristin.swihart@colorado.edu
Jessica Feld	CIRES	jessica.feld@colorado.edu
Clayton Lewis	CS	clayton.lewis@colorado.edu
Jim Hakala	CU Museum	james.hakala@colorado.edu
Matt Benjamin	Fiske	matthew.benjamin@colorado.edu
Matt Oetting	IEEE	matt_oetting@hotmail.com
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Melinda Zarske	ITL	melinda.zarske@colorado.edu
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Trish Loeblein	PhET	ploeblei@jeffco.k12.co.us
Kathy Perkins	PhET	katherine.perkins@colorado.edu
Emily Moore	Phet	emily.moore@colorado.edu
Lorrie Shepard	School of ED	lorrie.shepard@colorado.edu
Stacey Forsyth	Science Discovery	stacey.forsyth@colorado.edu
Barry Cartwright	CO DOE	Cartwright_B@cde.state.co.us

7.E. Chancellor's Awards for Excellence in STEM Education

Current Faculty Fellows:

John Basey, College of Arts & Sciences - Ecology & Evolutionary Biology

Variation in Working Memory and the Optimal Design of STEM Labs Our ultimate goal is to research how cognitive load imposed on students in the form of different designs of inquiry-oriented labs interacts with individual variations in working memory among students to influence learning. As a beginning step, I am re-designing the traditional and guided, diversity-survey-labs in biology (i.e. teacher-centered with guided procedures and a guided write-up) to mirror constructs advocated by science education reform (i.e. student-centered without guided procedures and an open-ended write-up). In addition, the new survey labs begin with “the learning cycle” and are more inquiry-oriented (hypothesis-driven). I will develop and finalize a working model of this new survey lab during summer 2010 and do a test-run in the classroom with an assessment in spring 2011.

John Falconer and Garrett Nicodemus, College of Engineering & Applied Science - Chemical and Biological Engineering

Biologically-Focused Screencasts and ConcepTests for Chemical and Biological Engineering Courses The goal of this proposal is to increase the use of biological engineering topics in three core courses in the Chemical and Biological Engineering Department: Material and Energy Balances, Chemical Engineering Thermodynamics, and Fluid Mechanics. We propose to prepare teaching materials that can be readily used by faculty who do not have backgrounds in biological topics. We propose to develop two types of teaching materials that incorporate biological concepts: 1) ConcepTests, which are multiple choice conceptual questions, used in class with clickers to empathize the important concepts in the course, 2) Screencasts, which are short screen captures of writing and narration on a tablet PC, can be used to solve example problems and provide further explanations. Creating these teaching materials will allow students in these three courses to be exposed to biological concepts earlier in their majors. These courses are taken by both Chemical Engineering majors and Chemical and Biological Engineering majors, and were originally developed for Chemical Engineering majors and thus did not incorporate biological concepts or examples.

Virginia Ferguson, College of Engineering & Applied Sciences – Mechanical Engineering

Assessing YOU'RE@CU: A New Program to Promote Diversity in Engineering This proposal seeks to improve training and academic preparation of engineering students, who are interested in the combined study of engineering and biology. The PI, along with the BOLD Center, will achieve this by developing a new program that targets women and minority students at the undergraduate and graduate levels: “Your Own Undergraduate Research Experience at the University of Colorado: YOU'RE@CU”. We seek to establish a vibrant and diverse research community that increases the accessibility of studying biological materials and medicine from an engineering perspective. Our educational vision is that merging bioengineering research with teaching and providing a range of research opportunities will enhance new student recruitment, improve retention of engineering lower classmen – and particularly target retention of underrepresented minorities and women, encourage undergraduates to seek graduate degrees, and provide mentoring training for graduate students.

Kris Gutierrez, School of Education

When Scientific and Everyday Knowledge Grow into One Another: Designing for Robust Science Learning for Students from Non-dominant Communities This project joins CU professors, PhD and undergraduate students, and a local school in an interdisciplinary effort to create and study an innovative technology-based after-school program called El Pueblo Mágico (EPM). Joining students from CU and Alicia Sanchez Elementary, a school with low-income and Emerging Bilingual student populations, EPM engages students collaboratively in computer, science, and health science based activities to engage students in multi modal forms of learning about science. In fall of 2010, we launched EPM, piloting new technology and science-oriented activities, supported by our CU collaborators in Computer Science: design software by Alex Repenning & Andri Ioannidou (AgentSheets); and a computer-mediated fabrication curriculum by Michael Eisenberg & Jane Meyers (Craftopolis). We aim to examine how multi-age groups learn together in technology-mediated activity as designers who will also gain valuable forms of multi modal expertise within a vibrant, technology-rich learning community. An overarching goal of this design experiment is to introduce undergraduates and children to high status knowledge about digital design, energy-use, science, and health in ways that helps them leverage their everyday understandings to develop robust science concepts, practices, and dispositions.

Jenny Knight, College of Arts & Sciences – Molecular, Cellular, & Developmental Biology

Development of a Capstone Concept Assessment to measure integrated content retention in biology The intent of this proposal is to begin developing a Capstone Molecular Biology Concept Assessment (Capstone MBCA) to evaluate how well graduating seniors in Molecular Cell and Developmental Biology (MCDB) can integrate and apply concepts from all their coursework. Such an assessment tool will have widespread impact in supporting the transformation of undergraduate education and providing a resource to evaluate meaningful student learning. Some of the expected uses of this tool are: 1. To measure the level of conceptual learning in graduating biology majors, 2. To measure conceptual learning gains between beginning and end of final year of coursework, 3. To measure the level of content retention after graduation, 4. To help determine which different models of pedagogy can help to promote long-term content retention and integrative abilities. The Capstone MBCA can be used not only at CU, but at any college or university department that teaches genetics, molecular biology, and cell biology, across the nation and internationally. It may also be valuable to science educators in other disciplines, as well as to science teachers at the secondary school level.

Heather Lewandowski and Charles Rogers, College of Arts & Sciences – Physics

Learning Goals and Course Materials for Advanced Undergraduate Physics Laboratories In Physics, we recognize and teach that experiment is an extraordinarily powerful method for judging and differentiating competing ideas. Although most physics majors are required to take an upper-level laboratory course, these courses are seldom effective at teaching students the necessary skills to carry out independent research beyond the classroom setting. We are requesting support for the development of learning goals, coordinated course materials, and a preliminary online evaluation survey for the upper-level “advanced laboratory” courses, PHYS3340, PHYS4430, and PHYS5430.

Past Faculty Fellows:

Clayton H. Lewis, College of Engineering & Applied Sciences – Computer Science

Video Resources for Lower Division Computer Science Curriculum This project aims to improve the effectiveness of Computer Science pedagogy by developing, evaluating, and sharing the practice of providing short video modules that students can view before class and review after class. This two-year study will develop and evaluate materials for four lower division courses, and assess the costs of creating and using these materials. In the longer term, the project aims to extend this approach to the remaining curriculum, while at the same time providing a model for creating and sharing such materials that can be widely adopted elsewhere.

Eric Frew, College of Engineering & Applied Sciences – Aerospace Engineering

The Sky's the Limit: An Unmanned Aircraft Laboratory Model The goal of the Sky's the Limit project is to create, evaluate, and then disseminate new learning material that reflects advances both in unmanned aerospace systems and in what is known about the impact of active learning on engineering education. The centerpiece of the proposed effort is the creation of a complete unmanned aircraft laboratory module. This module will reflect the current state of the art in embedded systems, wireless communication, automatic control, and unmanned systems.

Erin Furtak, School of Education

Teaching and Learning Biology at CU: Course Evaluation and Revision Project The proposed research supports a collaboration between two CU STEM faculty members; fosters research into the design and evaluation of instructional strategies and novel course design, and promises to promote a uniquely effective type of course/instruction with great potential to positively impact STEM education, both at CU and nationally. The proposed research will support: a) the completion of the evaluation of the TALB course, its effectiveness as a teacher education and educational research recruitment tool; b) suggest revisions of the course to be implemented when it is offered again in the fall of 2010.

Steven Pollock, College of Arts & Sciences – Physics

Development of Pre-Post Tests for Upper Division Electricity and Magnetism Tutorials This research study is part of a broader effort to move beyond research and development of curricular reforms at the introductory level, in order to better address the specialized needs of students in upper-division physics courses.

Current Graduate Fellows:

Lindsay Anderson, College of Arts & Sciences - Psychology

Advisor: Alice Healy

Understanding the Components of the iClicker System that Promote Learning, Retention, and Generalization of Classroom Knowledge

Heidi Iverson, School of Education

Adviser: Erin Furtak

What Works in Undergraduate Physics Education? A Research Synthesis

Michael Ross, School of Education

Advisor: Valerie Otero

Transforming the Classroom Power Structure to Impact Physics Learning

Seyitriza Tigrek, College of Engineering & Applied Science - Electrical Engineering

Advisor: Frank Barnes and Melinda Piket-May

Developing an Adaptive Method for Teaching Mobile (Phones) Programming to Freshman Engineering Students

Kim Trenbath, College of Arts & Sciences – Atmospheric & Oceanic Sciences

Advisor: Linnea Avallone

Undergraduate Students' Climate Change Conceptions

Ben Van Dusen, School of Education

Advisor: Valerie Otero

Empowering Students through the Use of iPad Technology

Colin Wallace, College of Arts & Sciences – Astrophysical & Planetary Sciences

Advisor: Doug Duncan

Understanding Students' Difficulties with Cosmology

Past Graduate Fellows:

David Cheeseman, College of Engineering & Applied Science - Computer Science

Advisor: Michael Main

Tablet Teaching Pilot Program

Ryan Grover and **Louisa Harris**, School of Education

Advisers: David Webb and Victoria Hand

A Longitudinal Study of the Implementation and Impact of LAs on Teaching in Undergraduate Mathematics

Lauren Kost-Smith, College of Arts & Sciences – Physics
Adviser: Steven Pollock
Investigating the Gender Gap in Undergraduate Physics Courses

Sarah Roberts, School of Education
Adviser: Erin Furtak
Reforming Undergraduate Biology Teaching Through Formative Assessment

Benjamin Spike, College of Arts & Sciences – Physics
Adviser: Noah Finkelstein
An Examination of Conceptions of Teaching and Learning Physics in Graduate TAs and Undergraduate LAs

Kim Trenbath, College of Arts & Sciences – Atmospheric & Oceanic Sciences
Adviser: Linnea Avallone
Undergraduate Students' Climate Change Conceptions

Colin Wallace, College of Arts & Sciences – Astrophysical & Planetary Sciences
Adviser: Doug Duncan
Understanding Students' Difficulties with Cosmology

7.F. Outcomes of the Chancellor's Awards

Name	Affiliation	Dept.	Title	Fund Period	Final Report	# of Papers	# of Presentations	# of New Funding
David Webb	Advisor	EDUC	AY appointments to support a longitudinal study of the implementation and impact of Las on teaching in undergraduate mathematics	2009-2010	yes	n/a	n/a	n/a
Doug Duncan	Advisor		AY Year appointment to support student's difficulties with cosmology	2009-2010	yes	5	5	n/a
Erin Furtak	Advisor	EDUC	Summer appointment to support reforming undergraduate biology teaching through formative assessment	2009-2010	yes	n/a	n/a	n/a
Linnea Avallone	Advisor	ATOC	AY Appointment to Support Undergraduate Climate Change Curriculum Development and Validation	2009-2010	yes	n/a	n/a	n/a
Michael Main	Advisor	CSCI	AY Year appointment to support a tablet teaching pilot program	2009-2010	yes	n/a	n/a	n/a
Noah Finkelstein	Advisor	PHYS	AY Appointment to support an Examination of Conceptions of Teaching and Learning Physics in Graduate Tas and Undergraduate Las	2009-2010	no	n/a	n/a	n/a
Steven Pollock	Advisor	PHYS	AY Year appointment to support investigating the gender gap in undergraduate physics tutorials	2009-2010	yes	n/a	n/a	n/a
Victoria Hand	Advisor	EDUC	AY appointments to support a longitudinal study of the implementation and impact of Las on teaching in undergraduate mathematics	2009-2010	yes	n/a	n/a	n/a
Clayton Lewis	Faculty	CSCI	Video Resources for Lower Division Computer Science Curriculum	2009-2010	yes	n/a	n/a	n/a
Dirk Grunwald	Faculty	CSCI	Video Resources for Lower Division Computer Science Curriculum	2009-2010	yes	n/a	n/a	n/a
Eric Frew	Faculty	ASEN	The Sky's the Limit: An Unmanned Aircraft Laboratory Model	2009-2010	yes	n/a	n/a	n/a
Erin Furtak	Faculty	EDUC	Teaching and Learning Biology at CU: Course Evaluation and Revision Project	2009-2010	yes	1	1	2
Ken Anderson	Faculty	CSCI	Video Resources for Lower Division Computer Science Curriculum	2009-2010	yes	n/a	n/a	n/a
Steven Pollock	Faculty	PHYS	Development of Pre-Post Tests for Upper Division Electricity and Magnetism Tutorials	2009-2010	yes	1	1	n/a

Benjamin Spike	Student	PHYS	AY Appointment to support an Examination of Conceptions of Teaching and Learning Physics in Graduate Tas and Undergraduate Las	2009-2010	no	n/a	n/a	n/a	n/a
Colin Wallace	Student	APS	AY Year appointment to support student's difficulties with cosmology	2009-2010	yes	5	5	n/a	n/a
David Cheeseman	Student	CSCI	AY Year appointment to support a tablet teaching pilot program	2009-2010	yes	n/a	n/a	n/a	n/a
Kim Trenbath	Student	ATOC	AY Appointment to Support Undergraduate Climate Change Curriculum Development and Validation	2009-2010	yes	n/a	n/a	n/a	n/a
Lauren Kost-Smith	Student	PHYS	AY Year appointment to support investigating the gender gap in undergraduate physics tutorials	2009-2010	yes	n/a	n/a	n/a	n/a
Louisa Harris	Student	EDUC	AY appointments to support a longitudinal study of the implementation and impact of Las on teaching in undergraduate mathematics	2009-2010	yes	n/a	n/a	n/a	n/a
Ryan Grover	Student	EDUC	AY appointments to support a longitudinal study of the implementation and impact of Las on teaching in undergraduate mathematics	2009-2010	yes	n/a	n/a	n/a	n/a
Sarah Roberts	Student	EDUC	Summer appointment to support reforming undergraduate biology teaching through formative assessment	2009-2010	yes	n/a	n/a	n/a	n/a
Alice Healy	Advisor	PSYC	Understanding the Components of the iClicker System that Promote Learning, Retention, and Generalization of Classroom Knowledge	2010-Present	no	n/a	n/a	n/a	n/a
Doug Duncan	Advisor	APS	Understanding Students' Difficulties with Cosmology	2010-Present	no	n/a	n/a	n/a	n/a
Erin Furtak	Advisor	EDUC	What Works in Undergraduate Physics Education? A Research Synthesis	2010-Present	no	n/a	n/a	n/a	n/a
Frank Barnes	Advisor	ECEE	Developing an Adaptive Method for Teaching Mobile (Phones) Programming to Freshman Engineering Students	2010-Present	no	n/a	n/a	n/a	n/a
Linnea Avallone	Advisor	ATOC	Undergraduate Students' Climate Change Conceptions	2010-Present	no	n/a	n/a	n/a	n/a
Melinda Piket-May	Advisor	ECEE	Developing an Adaptive Method for Teaching Mobile (Phones) Programming to Freshman Engineering Students	2010-Present	no	n/a	n/a	n/a	n/a
Valerie Otero	Advisor	EDUC	Empowering Students through the Use of iPad Technology	2010-Present	no	n/a	n/a	n/a	n/a
Charles Rogers	Faculty	PHYS	Learning Goals and Course Materials for Advanced Undergraduate Physics Laboratories	2010-Present	no	n/a	n/a	n/a	n/a

Garrett Nicodemus	Faculty	CHEN	Biologically-Focused Screencasts and Concept Tests for Chemical and Biological Engineering Courses	2010-Present	no	n/a	n/a	n/a
Heather Lewandowski	Faculty	PHYS	Learning Goals and Course Materials for Advanced Undergraduate Physics Laboratories	2010-Present	no	n/a	n/a	n/a
Jenny Knight	Faculty	MCDB	Development of a Capstone Concept Assessment to measure integrated content retention in biology	2010-Present	no	n/a	n/a	n/a
John Basey	Faculty	EBIO	Variation in Working Memory and the Optimal Design of STEM Labs	2010-Present	no	n/a	n/a	n/a
John Falconer	Faculty	CHEN	Biologically-Focused Screencasts and Concept Tests for Chemical and Biological Engineering Courses	2010-Present	no	n/a	n/a	n/a
Kris Gutierrez	Faculty	EDUC	When Scientific and Everyday Knowledge Grow into One Another: Designing for Robust Science Learning for Students from Non-Dominant Communities	2010-Present	no	n/a	n/a	n/a
Virginia Ferguson	Faculty	MCEN	Assessing YOU'RE@CU: A New Program to Promote Diversity in Engineering	2010-Present	no	n/a	n/a	n/a
Ben Van Dusen	Student	EDUC	Empowering Students through the Use of iPad Technology	2010-Present	no	n/a	n/a	n/a
Colin Wallae	Student	APS	Understanding Students' Difficulties with Cosmology	2010-Present	no	n/a	n/a	n/a
Heidi Iverson	Student	EDUC	What Works in Undergraduate Physics Education? A Research Synthesis	2010-Present	no	n/a	n/a	n/a
Kim Trenbath	Student	ATOC	Undergraduate Students' Climate Change Conceptions	2010-Present	no	n/a	n/a	n/a
Lindsay Anderson	Student	PSYC	Understanding the Components of the iClicker System that Promote Learning, Retention, and Generalization of Classroom Knowledge	2010-Present	no	n/a	n/a	n/a
Seythiza Tigrek	Student	ECEE	Developing an Adaptive Method for Teaching Mobile (Phones) Programming to Freshman Engineering Students	2010-Present	no	n/a	n/a	n/a

7.G. One-page handouts



International Leader in STEM Education

Integrating STEM Education (iSTEM) at CU Boulder works to improve STEM education through course transformation, discipline-based education research, and teacher recruitment and professional development.

We are establishing a **Center for STEM Education** at CU-Boulder to integrate an interdisciplinary community of scholars, promote and sustain existing efforts, sponsor new programs, advocate for diversity and access, influence policy, and raise needed funds.

More than 40 Programs Involved

iSTEM integrates over 40 programs in STEM education representing over \$15 million in grants at CU Boulder, including:

- CU Teach – a nationally leading program bringing STEM students to teaching, offering a specialized secondary science and math teacher certification program for STEM majors.
- Learning Assistant / Noyce Programs – couples the transformation of undergraduate courses with the recruitment and preparation of future teachers in STEM.
- The Science Education Initiative - led by Nobel Laureate Carl Wieman, this initiative seeks to transform undergraduate education in 5 different departments on campus.
- NSF Grants in Physics, Chemistry, Biology, Math & Engineering to transform classes. These have been used to introduce student-centered research-based approaches in these classes.
- Physics & Discipline-Based Education Research Groups (PER & DBER) - One of the largest and best recognized PER research groups in the nation. DBER spans more than 10 departments, meets weekly to support faculty, staff & students in educational research.
- Integrated Teaching and Learning Program & Lab - a nationally-recognized, hands-on, engineering program for CU Students and Faculty and K12 students and teachers.

Increasing National Recognition

- President Obama cites programs like CU Teach as national models for teacher preparation to address the challenges in teacher and workforce preparation.
- PI/ Chancellor Philip DiStefano was invited to the White House in honor of the university's commitment to STEM education.
- Bruce Alberts, editor-in-chief of *Science*, says, "I view the University of Colorado at Boulder as the national leader in driving improvements in STEM education..."

PI: Chancellor Phil DiStefano

Co-PIs: Provost Moore, Dean Gleeson, Dean Shepard, Assoc. Dean Argrow, Professor Finkelstein

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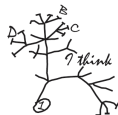
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Committed to Educational Excellence for Colorado!

Integrating STEM Education is supported by the University of Colorado and the National Science Foundation through I³

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Discipline-Based Education Research Group (DBER)



The Discipline-based Education Research (DBER) group began in 2004 as a forum through which faculty in science, technology, engineering and mathematics (STEM) departments could engage in conversations about effective education. It is based on the premise that the various STEM disciplines face both common and distinct pedagogical challenges. These issues are critical to effective university teaching, but no mechanism existed for sharing successes and challenges across departments.

Through a weekly seminar series, faculty and research students present their ideas, observations, and conclusions relating to particular problems and issues associated with promoting effective learning in STEM disciplines. Typically the group consists of faculty and students from a wide range of departments, including applied mathematics, astrophysics, chemistry & biochemistry, computer science, cognitive science, engineering, geology, mathematics, molecular, cellular & developmental biology, physics, and the school of education.

The DBER group meetings also serve as a forum within which iSTEM grant recipients describe the design of their projects, their observations and conclusions. DBER has also taken on broader challenges, such as: examining the proposed Colorado State Science Standards for coherence and “teachability”; working with CU Teach in the design of Functions and Modeling and Research Methods courses (part of the STEM teacher certification program), as well as considering the conceptual coherence of foundation courses in various disciplines.



Recent DBER seminar topics:

- Transforming upper division physics
- Learning through computer modeling
- Faculty attitudes to pedagogical techniques
- Learning through design in engineering
- Identification of conceptually difficult topics in specific STEM disciplines
- Approaches to integrating math and modeling into biology education
- An approach to improving the scientific thinking of students in an introductory class for non-science majors
- Course transformation through the use of learning assistants and pedagogically-based instruction

For current topics and information visit:
www.colorado.edu/istem/DBER

Committed to Excellence in STEM Education for Colorado | www.colorado.edu/istem

Integrating STEM Education is supported by the University of Colorado and the National Science Foundation through I3

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References & Resources: Powell, K. 2003. Science Education: Spare me the lecture. *Nature* 425: 234-236
Klymkowky, M.W. & E.M. Furtak. 2009. Incoherent Science and Mathematics Education Undermines Biological Literacy.
<http://coloradohigherednews.com/Pages/Archive.php?id=1460>



Physics Education Research Group @ Colorado

INTEGRATING STEM
Science, Technology, Engineering, and Math Education at Colorado



What is PER@C?

The Physics Education Research Group at Colorado (PER@C) is one of the newest and largest research programs in PER in the nation. Our research group develops and studies: uses of technology in physics education, assessments (conceptual, epistemological, and belief oriented), theoretical models of students learning physics, social and contextual foundations of student learning, examination of successful educational reforms and replication studies of such reforms, and student problem-solving in physics. We sponsor a number of educational reforms in physics, which range from pre-college to post-doctoral. The research group includes faculty, staff, and students from both the Department of Physics and the School of Education.

PER@C Successes:

- Six faculty, including Nobel Laureate Carl Wieman, and six researchers and post-docs make PER@C the largest PER group in the nation
- With over \$12 million in external funding, PER@C is one of the best-funded programs of its kind in the nation.
- PER@C is one of the most published PER groups in the nation with papers appearing in *Science*, *Nature: Physics*, *Physics Today*, *American Journal of Physics*, and *Physical Review*.
- PER@C faculty lead corner-stone efforts in science education at CU, including nationally recognized programs

PER@C: Leading the way in understanding how science is learned and transforming the teaching of science.

per.colorado.edu
www.colorado.edu/istem

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PER@C Highlights

The PhET Interactive Simulations Project: Developing, testing, and researching online simulations in physics, and now, chemistry, biology, geology and math.

Lower Division Course Transformation: Developing materials, implementing, evaluating and conducting research on transformation in Physics 1, 2 and 3.

Upper Division Course Transformation: Transforming junior Electricity and Magnetism & Quantum Mechanics, and use of PER-based tools in courses as advanced as the graduate level.

Assessments: The development of research-based instruments for evaluation of student learning including: attitudes and beliefs, quantum mechanics, and upper division E/M.

Theoretical Work: Developing theories of student learning in physics, including student use of representations, analogies, simulations; student development of epistemic and ontological commitments in physics; the development of future teachers, graduate students and faculty.

Areas of focus include **Institutional change** in physics and science, **gender studies**, and **informal science education**.

The Learning Assistant Program: Research on the nationally recognized effort that couples course transformation with teacher recruitment and preparation.



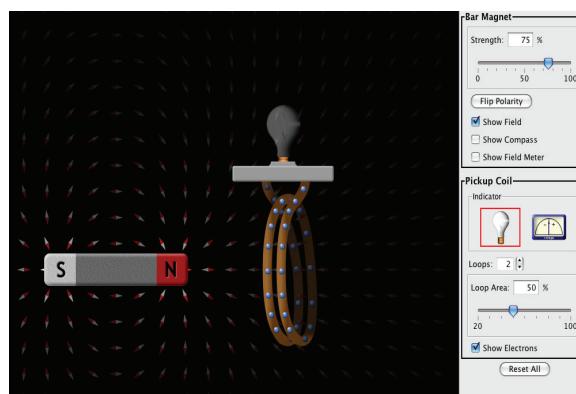
PhET Interactive Simulations



PhET Interactive Simulations are a suite of free, research-based tools that improve the way that physics, chemistry, biology, earth science and math are taught and learned. These interactive tools enable students to make connections between real life phenomena and the underlying science which explains such phenomena. Our team of scientists, software engineers and science educators use a research-based approach to create simulations that support student engagement with and understanding of scientific concepts. All simulations are free and easily down-loadable or can be run live from the web.

Interactive & Engaging: PhET simulations animate what is invisible to the eye through the use of graphics and intuitive controls such as click-and-drag manipulation, sliders and radio buttons. In order to further encourage quantitative exploration, the simulations also offer measurement instruments including rulers, stop-watches, voltmeters and thermometers. As the user manipulates these interactive tools, responses are immediately animated thus effectively illustrating cause-and-effects relationships as well as multiple linked representations (motion of the objects, graphs, number readouts, etc...).

Research Based: To ensure educational effectiveness and usability, all of the simulations are extensively tested and evaluated. These tests include student interviews in addition to actual utilization of the simulations in a variety of settings, including lectures, group work, homework and lab work. Our rating system indicates what level of testing has been completed on each simulation.



PhET Sims: Reaching the World

- **84 total sims** available
- **Over 400 activities** for teachers using sims
- Available in **44 languages** and counting
- **8.4 million:** Number of sims run online in 2009

How do I get PhET Sims?

All simulations are completely free and can be accessed from the PhET website in three ways:

- Download individual sims
- Download the entire website
- Run them live from the web

For more information or to use PhET Sims, visit:
www.phet.colorado.edu

PhET is generously supported by:



Committed to Excellence in STEM Education for Colorado | www.colorado.edu/istem

PhET is affiliated with Integrating STEM Education (iSTEM) ©2011 Regents of the University of Colorado



The Learning Assistant (LA) Model



The **LA Model** is an experiential learning program of the University of Colorado at Boulder

Courses Transformed



Undergraduate students are hired as Learning Assistants to help transform courses to be responsive to research on how students learn.

Over 35 math and science courses have been transformed using Learning Assistants.



Teachers Recruited



Over 40 talented mathematics, science, and engineering majors have been recruited to become K-12 teachers through the Learning Assistant program. Just under 20 are currently teaching in high needs school districts in subject such as physics and chemistry

Multi-disciplinary – High Impact

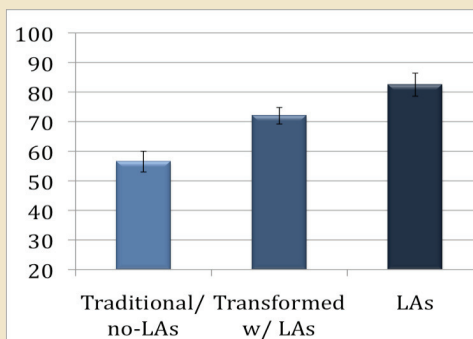
- Aligned with several institutional priorities outlined in the University's strategic plan, Flagship 2030
- Approximately 160 mathematics, science, and engineering majors hired each year to serve as Learning Assistants in 8 departments
- Over 9000 students are impacted each year at a cost of under \$50 per student

National Model



- Universities throughout the nation received significant funding to replicate the Colorado Learning Assistant model
- Addresses our Nation's critical shortage of highly qualified math and science teachers
- 21st century educational program, a signature program at CU Boulder

Students Learn More



Students in courses transformed with Learning Assistants outperform those in traditional courses. Learning Assistants outperform all of their peers.



CU's Science Education Initiative
Departments and Faculty Take Action to Improve Science Learning



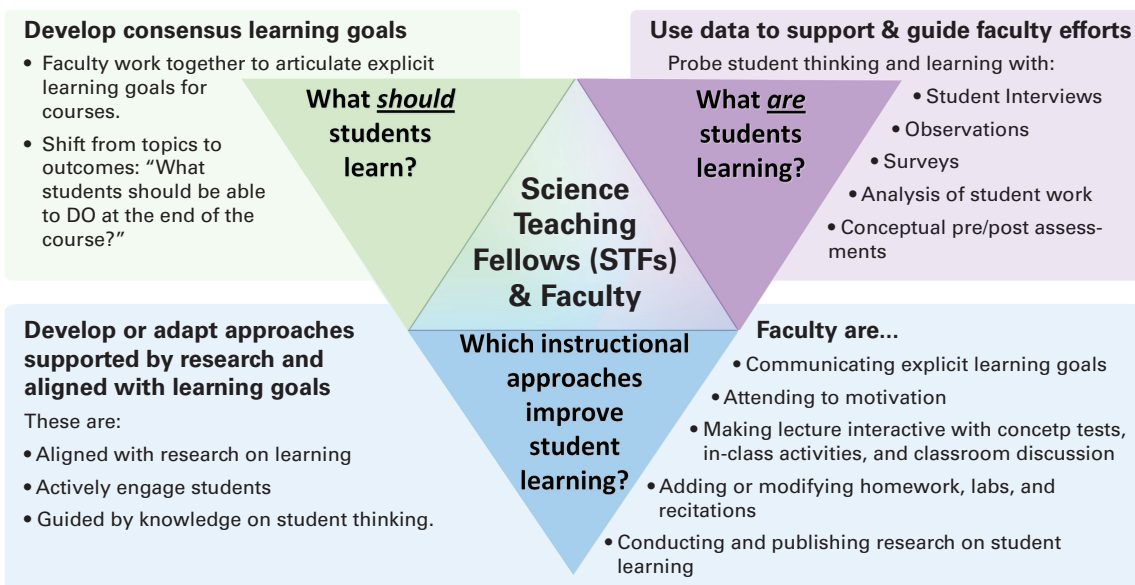
CU's Science Education Initiative (SEI) is a 5-year, \$5M investment by President Benson and Chancellor DiStefano to catalyze and support significant, sustainable improvements in undergraduate science education. Directed by Nobel Laureate Carl Wieman and Kathy Perkins, the SEI funds departments to take a four-step, scientific approach to undergraduate education:

- 1) Establish what students should learn;
- 2) Scientifically measure what students are actually learning;
- 3) Use instructional approaches guided by research on learning and data on student thinking and learning;
- 4) Disseminate and adopt what works.

SEI Supports

<p>Departments 5 funded: IPHY, PHYS, MDCB, GEOL, CHEM</p>	<p>Faculty >100 faculty use SEI-funded resources <75 faculty modified thier teaching</p>	<p>Students Changes in >50 courses Impacts >10,000 students/yr</p>
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Faculty partner with Science Teaching Fellows to Transform Courses



Reference:
Transforming Science Education at Large Research Universities: A Case Study in Progress.
By Carl Wieman, Katherine Perkins, and Sarah Gilbert, Change Magazine, 2010.

For more information visit:
www.colorado.edu/sei

7.H. Partial listing of publications by iSTEM affiliates

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- Bair, A.R. (in press). How 'clicker' technology affects students' voting behavior and attitudes. *Journal of Computers in Mathematics and Science Teaching*
- Brown, N. J. S., Furtak, E. M., Timms, M., Nagashima, S. O., & Wilson, M. (2010). The Evidence-Based Reasoning Framework: Assessing Scientific Reasoning. *Educational Assessment*, 15(3-4), 142-174
- C. Baily and N. Finkelstein, "Refined characterization of student perspectives on quantum physics," *Phys. Rev. ST Physics Ed. Research*, 6, 020113 (2010).
- C. Henderson, N. Finkelstein, & A. Beach A. "Beyond Dissemination in College science teaching: An Introduction to Four Core Change Strategies." *Journal of College Science Teaching*. 39(5), 18-26, (2010).
- C. Turpen and N.D. Finkelstein, "The construction of different classroom norms during Peer Instruction: Students perceive differences," *Phys. Rev. ST Physics Ed. Research* 6, 020123 (2010).
- C. Wallace and S. Chasteen (2010), "Upper-division students' difficulties with Ampere's law", *Physical Review ST PER*, 6, 020115.
- C. Wieman, K. Perkins, and S. Gilbert, "Transforming Science Education at Large Research Universities: A Case Study In Progress." *Change*, (2010).
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- Francoise Benay & Katharine Semsar (in press). "How Not To Lose Your Students in Concept Maps." *Journal of College Science Teaching*.
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- S.J. Pollock, S.V. Chasteen, M. Dubson, K.K. Perkins, "The use of concept tests and peer instruction in upper-division physics", 2010 PERC Proceedings, AIP Press. Melville NY, CP1289 (2010).
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- S.V. Chasteen, R.E. Pepper, S.J. Pollock, K.K. Perkins (submitted-only published online right now), "But Does It Last? Sustaining a Research-Based Curriculum in Upper-Division Electricity & Magnetism", PERC Proceedings

- Semsar, K., Knight, J.K., Birol, G., and Smith, M.K (submitted). The Colorado Learning Attitudes about Science Survey (CLASS) for use in Biology. *CBE Life Sci Educ*
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- Shi, J., W.B. Wood, J. M. Martin, N.A. Guild, Q. Vicens, and J. K. Knight (2010). A diagnostic assessment for Introductory Molecular and Cell Biology. *CBE-Life Sci. Educ.* 9, 453-461.
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- Stephanie V. Chasteen, Rachel E. Pepper, Steven J. Pollock, Katherine K. Perkins (2010), "But Does It Last? Sustaining a Research-Based Curriculum in Upper-Division Electricity & Magnetism", *PERC Proceedings*, AIP Press.
- Steven J. Pollock, Stephanie V. Chasteen, Michael Dubson, Katherine K. Perkins (2010), "The use of concept tests and peer instruction in upper-division physics", 2010 *PERC Proceedings*, AIP Press.
- T.T. Perkins, C. Malley, M. Dubson, K.K. Perkins, "An interactive optical tweezers simulation for science education", *Conference on Optical Trapping and Optical Micromanipulation VII*, *Proceedings of SPIE Volume: 7762*, (2010)
- Thiry, H. (2010). Evaluation of the Atmospheric Science Collaborations and Enriching NeTworks (ASCENT) conference, July 14-16, 2010: Annual report, year 2. (Report to ASCENT). Boulder, CO: University of Colorado at Boulder, Ethnography & Evaluation Research.
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- Trujillo, C. & M.W. Klymkowsky. Using graph-based assessments within Socratic tutorials to reveal and refine students' analytical thinking about molecular networks. *BAMBED* submitted.

- V Otero, S Pollock, and N Finkelstein, "A physics department's role in preparing physics teachers: The Colorado Learning Assistant model," *American Journal of Physics*, 78 (11), pp. 1218-1224, (2010).
- W.K. Adams, H. Alhadlaq, C. Malley, K.K. Perkins, J. Olson, F. Alshaya, F. Alabdulkareem and C.E. Wieman (2009, 2010), "Making on-line science course materials easily translatable and accessible worldwide: Challenges and Solutions." *Multimedia in Physics Teaching and Learning Proceedings* (2009) and *Il Nuovo Cimento C*, Issue 03 - May/June (2010).
- W.K. Adams, H. Alhadlaq, C. Malley, K.K. Perkins, J.B. Olson, F. Alshaya, S. Alabdulkareem, C.E. Wieman, "Making Science Simulations and Websites Easily Translatable and Available Worldwide: Challenges and Solutions", *Journal of Science Education and Technology*, (2010).

7.I. Partial listing of presentations by iSTEM affiliates

- Baily, C. and N.D. Finkelstein, "Interpretation in Quantum Physics as Hidden Curriculum," Physics Education Research Conference, Portland Or, July 2010
- Baily, C., N.D. Finkelstein, The Critical, but Often Overlooked, Teaching of Interpretation in Modern Physics Courses, American Association of Physics Teachers National Meeting, Portland, Or, July 2010
- Bartley, J., L M. Mayhew, N D. Finkelstein, Developing and Assessing University Students' Communication Skills Through Teaching Physics, Am Assoc. of Physics Teachers National Meeting, Portland, Or, July 2010
- Bartley, J., L. Mayhew and N.D. Finkelstein, "Supporting Scientists Ability to Communicate About Science in Everyday Language," Physics Education Research Conference, Portland Or, July 2010
- Beach, A., C. Henderson, N. Finkelstein, and Y. Lin, "Improving Undergraduate Science Instruction: Results of Multidisciplinary Synthesis of the Literature", Am Ed. Research Assoc, Denver, CO, April 30, 2010.
- Cole, M., N. Finkelstein and 10 members of LCHC, "Sylvia Scribner Award Address," Am. Educational Research Association Annual Meeting, Denver, CO, May 2, 2010 [invited award address]
- Finkelstein, N. content specialist/advisor, Professional Development Course: Physics for the 21st Century, Harvard-Smithsonian Center for Astrophysics, Science Media Group, 2010.
- Finkelstein, N., moderator/commenter, War on Science, 62nd Conference on World Affairs, Apr 2010.
- Finkelstein, N.D., "Achieving Excellence in Undergraduate Education: the Colorado Learning Assistant Model," Boston University, Provost and Dean's Council Meetings, Boston, MA, April 15, 2010.
- Finkelstein, N.D., "Answering the Nation's Call: the role of physicists in transforming education," PR-LSAMP, Annual Best Practices Conference, Ponce, Puerto Rico, Oct 29, 2010 [plenary]
- Finkelstein, N.D., "Assessment and Evaluation in College Physics," AAPT, AAS, APS New Faculty Workshop, College Park MD, Jun 29, 2010.
- Finkelstein, N.D., "Making a Science out of Science Education: Transforming physics classes using research in physics education," Department of Physics, Colloquium, University of Cincinnati, OH, Oct 7, 2010
- Finkelstein, N.D., "Scholarly Approaches to Education: the Role of Physicists in Education," SPIE Optics and Photonics national meeting, San Diego, CA July 31, 2010 [keynote]
- Finkelstein, N.D., "Strengthening Undergraduate and Graduate STEM Education," U.S House of Representatives, Committee on Science and Technology, Research and Science Education Subcommittee Hearings, Washington, DC, Feb 4, 2010.
- Finkelstein, N.D., "Studying Change," Science and Mathematics Teacher Imperative Leadership Collaborative, Association of Public and Land-grant Universities Provosts' Meeting, Miami, FL Jan 6-8, 2010.
- Finkelstein, N.D., "Teaching and Learning Physics: coordinating physics, education, university and community," National Association for Research on Science Teaching Annual Conference, Philadelphia, PA, Mar 23, 2010.
- Finkelstein, N.D., "The Role of New Technologies in Science and Mathematics Education," South African Association for Research in Mathematics, Science and Technology Education Annual Conference, Durban, South Africa, Jan 18-22, 2010 [invited plenary]

- Finkelstein, N.D., "Towards a Scholarship of Teaching and Learning in Science and Engineering," Computational Optical Sensing and Imaging center, University of Colorado, Boulder, Apr 12, 2010.
- Finkelstein, N.D., "Understanding When and Why Education Works: the Roles of New Tools and Practices in Physics Education," Schools of Arts and Sciences and Education Coalition on STEM Education, University of Cincinnati, OH, Oct 7, 2010
- Finkelstein, N.D., and V. Otero, "Colorado STEM Education: Investing in Colorado's Future" Board of Regents Meeting, University of Colorado, Jun 24, 2010.
- Finkelstein, N.D., M. Dubson, and K. Perkins, "Seeding and Sustaining Educational Transformation in a Physics Department," AAPT National SPIN-UP Workshop, New Brunswick, NJ, June 5, 2010.
- Finkelstein, N.D., "STEM Education at the University of Colorado," CO-LABS, Briefing of State and National Legislative Delegations, Boulder CO, Aug 12, 2010.
- Hug, S., Thiry, H., Villa, E., & Kephart, K. (2010). Situated learning theory as a framework for apprenticing Hispanics into computer science research in the CAHSI community. Presented at Understanding Complex Ecologies in a Changing World, 2010 Annual Meeting of the American Educational Research Association, Denver, CO, April 30-May 4, 2010.
- Hunter, A.-B., Weston, T. J., Laursen, S., & Thiry, H. L. (2010). URSSA: An online survey measuring student gains from undergraduate research experiences in the sciences. Presented at Understanding Complex Ecologies in a Changing World, 2010 Annual Meeting of the American Educational Research Association, Denver, CO, April 30-May 4, 2010.
- Kogan, M., & Laursen, S. (2010, October). Collaborative research: Research, dissemination, and faculty development of inquiry-based learning (IBL) methods in the teaching and learning of mathematics. Evaluation report: University of Texas, Austin workshop (May 2010). (Report to NSF). Boulder, CO: University of Colorado at Boulder, Ethnography & Evaluation Research.
- Kost, L., S. Pollock and N.Finkelstein, JACKSONVILLE – V. Otero, S. Pollock and N. Finkelstein JACKSONVILLE
- Kost, L., S.J.Pollock and N.D. Finkelstein, A.Miyake, G. Cohen, and T. Ito "Gender Differences in Physics 1: The Impact of a Self-Affirmation Intervention," Physics Education Research Conf, Portland Or, July 2010
- Kost, L.E., S J. Pollock, N D. Finkelstein, Studies of the Gender Gap Across the Introductory Physics Year, American Association of Physics Teachers National Meeting, Portland, Or, July 2010
- Kost, L.E., S J. Pollock, N D. Finkelstein, The Impact of Self-Efficacy in The Introductory Physics Year, American Association of Physics Teachers National Meeting, Portland, Or, July 2010
- Laursen, S., Hunter, A.-B., Seymour, E., Thiry, H. & Melton, G. (2010). Undergraduate research in the sciences: Engaging students in real science. San Francisco: Jossey Bass.
- Loshbaugh, H., Thiry, H., & Laursen, S. (2010). Doing chemistry in changing times: Mapping trends and tensions in U.S. chemistry graduate education. Presented at Understanding Complex Ecologies in a Changing World, 2010 Annual Meeting of the American Educational Research Association, Denver, CO, April 30-May 4, 2010.
- Mayhew, L., and N.D. Finkelstein, "Sustainability of K-12 Afterschool Programs," Physics Education Research Conference, Portland Or, July 2010
- Mayhew, L.M., N D. Finkelstein Impacts of Informal Science Education University: Community Partnerships American Association of Physics Teachers National Meeting, Portland, Or, July 2010
- Otero, V. (2010, August). Transforming Astronomy Education, Presented at the Cosmos in the Classroom Conference, August 2-4, Boulder CO.

- Otero, V. (2010, February). Preserving Excellence in Undergraduate Education at a Relatively Low Cost. Presented at Auburn University, sponsored by the Association of Public and Land Grant Universities, February 22, 2010. Auburn, AL.
- Otero, V. (2010, February). Reconceptualizing Undergraduate Education: LA Programs as Experiential Learning Models, presented at the biannual meeting of the American Association of Physics Teachers, February 16, Washington, D.C.
- Otero, V. (2010, February). Reconceptualizing Undergraduate Education: LA Programs as Experiential Learning Models, Presented at the biannual meeting of the American Association of Physics Teachers, February 18, Washington, D.C.
- Otero, V. (2010, July). Physics Learning as the Objectification of Discourse, Presented at the bi-annual conference of the Am. Association of Physics Teachers, July 17-July 21, 2010, Portland, OR.
- Otero, V. (2010, June). Science Learning as the Objectification of Discourse, presented at the semi-annual International Conference of the Learning Sciences, Chicago, IL, June 28-July 2, 2010.
- Otero, V. (2010, March). Improving Physics Instruction Using Learning Assistants, Presented at the Colorado School of Mines, Physics Colloquium, March 9, 2010.
- Otero, V. (2010, March). Task Force on Teacher Education in Physics: Findings and Recommendations, Presented at the American Physical Society March Meeting, March 15, Portland, OR.
- Otero, V. (2010, May). Experiential Learning Model for STEM Education, Faculty Development, and Teacher Preparation. Presented at the Science Education Colloquium at University of Michigan, May 10-12, 2010.
- Otero, V. (2011, February). Transforming Classrooms So they Align with How Students Learn, Scientia, Rice University, February 11-12, 2011, Houston, TX.
- Otero, V. (2011, January). Taking Action: Physics Departments Can Contribute Significantly to National Problems, Presented at the bi-annual conference of the American Association of Physics Teachers, January 8-12, Jacksonville, FL.
- Otero, V. (2011, January). Transforming Teaching and Learning in Mathematics and Science, The First Annual Conference on Teaching and Learning in Higher Education as a Tool for Progress, January 13-18, 2011, Riyadh, Saudi Arabia.
- Otero, V. & Finkelstein, N. (2010, January). Experiential Learning Model for STEM Education, Faculty Development, and Teacher Preparation, Annual Meeting of the The Leadership Council of the Science and Mathematics Teacher Imperative, Association of Public and Land Grant Universities, January 6-8, Miami, FL.
- Otero, V. & Pollock, S. (2010, February). Introduction to the Colorado Learning Assistant Program. Presented at the annual meeting of the Physics Teachers Education Coalition, February 12, Washington, D.C.
- Otero, V. and N.D. Finkelstein, "Starting a Colorado Learning Assistant Program," Assoc. of Public and Landgrant University, Science and Math Teacher Imperative annual meeting, Cincinnati, OH, Jun 9, 2010.
- Otero, V., Ananda, V., & Stachurski, S. (2010, February). Bringing it all together: NSF Funding to support the continuum for science teacher preparation. Keynote presented at the annual meeting of the Physics Teachers Education Coalition, February 11, Washington D.C.
- Pollock, S. & Otero, V. (2010, July). Colorado Learning Assistant Model: Impacts and Outcomes, Presented at the bi-annual conference of the American Association of Physics Teachers, July 17-July 21, 2010, Portland, OR.
- R P. Wulf, M. Mayhew, N D. Finkelstein, Impact of Informal Science Education on Children's Attitudes about Science, American Association of Physics Teachers National Meeting, Portland, Or, July

2010

- R. Wulf, L. Mayhew and N.D. Finkelstein, "Children's Attitudes about Science as a Result of Informal Science Education," Physics Education Research Conference, Portland Or, July 2010
- Seymour, E., De Welde, K., & Fry, C. (2010). Determining progress in improving undergraduate STEM education: The reformers' tale. White paper commissioned for the National Academy of Engineering Forum, Characterizing the Impact and Diffusion of Engineering Education Innovations, New Orleans, February 7-8, 2011.
- Spike, B., and N.D. Finkelstein, "Examining the Beliefs and Practice of Teaching Assistants: Two Case Studies," Physics Education Research Conference, Portland Or, July 2010
- Spike, B., N D. Finkelstein , Eliciting Beliefs of Recitation Instructors Through Video Commentary, American Association of Physics Teachers National Meeting, Portland, Or, July 2010
- Stade, E. (2010). "Preparing Future K12 Math (and Science) Teachers: The Colorado Learning Assistant (LA) Model," presentation delivered at the Mathematical Sciences Research Institute (MSRI), Berkeley, CA, March 5, 2010.
- Stade, E. (2010). "STEM Education Initiatives at CU," presentation delivered to CU Program Review external reviewers, April 27, 2010.
- Stade, E. (2010). "Preparing Future K12 Math Teachers – the Role of University Math Departments," held at the Mathematical Sciences Research Institute (MSRI), Berkeley, CA, March 5, 2010.
- Thiry, H. L., Laursen, S., & Hunter, A.-B. (2010). The role of student-advisor interactions in apprenticing undergraduate researchers into a scientific community of practice. Presented at Understanding Complex Ecologies in a Changing World, 2010 Annual Meeting of the American Educational Research Association, Denver, CO, April 30-May 4, 2010.

7.J. Draft of center by-laws

Statement of purpose:

Summary statement of purpose:

The Purpose of the CU STEM Education Center (CUSEC) is:

1. To build and maintain an infrastructure of institutional support to promote education reform in science, technology, engineering, and mathematics (STEM) education at the University of Colorado at Boulder and to serve as a national and international resource for such efforts. The center will focus on STEM education transformation, education research within STEM fields and departments, and K20 teacher recruitment, preparation, and professional development.
2. To facilitate change in STEM education by integrating an interdisciplinary community of scholars, promoting, sustaining, and evaluating existing reform efforts, sponsoring new programs, advocating for diversity and access, influencing relevant policy, fundraising, and communicating with the public.

Summary statement of purpose:

We promote STEM education through three integrated lines of inquiry:

1. Course transformation: We work to improve student understanding of content, to develop student understanding of the nature of science and of learning science, and to increase student interest in the sciences through the implementation of research-based curricula that emphasize student-engagement and the use of validated measures of student learning. We emphasize that establishing and assessing learning goals is key to transforming educational practices. We work to transform both large-enrollment undergraduate courses and graduate education, as well as K12 and informal science educational communities.
2. STEM Education Research: Our efforts in STEM education research focus on undergraduate-level learning and are aimed at improving the quality, efficacy, and inclusiveness of STEM education. We foster collaboration between researchers housed in the disciplinary departments, researchers in the School of Education, and researchers in other arenas that focus on STEM learning. We conduct research in order to create new materials, resources, and models for STEM education.
3. K20 teacher recruitment, preparation, and professional development: Our programs promote content mastery by recruiting and preparing K12 teachers from within the STEM departments. Our methods and education courses build on student understanding of teaching in the sciences. Additionally, we augment traditional graduate student teaching preparation through seminars, individualized observations, mentoring, and workshops.

Membership procedures, rights, privileges and responsibilities:

Fellows

The election of new fellows will be from those research scientists who show a strong interest and a long-term commitment to active participation in the CUSEC. Both faculty and CU research staff are eligible to become fellows. Potential new fellows will normally be nominated by a CUSEC fellow. Election will be by at least a 2/3 majority vote by written ballot of all fellows. The initial appointment will be for 2 years and will be renewable in 4-year terms. Termination of appointment by CU will automatically result in termination of the appointment as fellow. A fellow may also be terminated by 2/3 majority vote of all active fellows. In such cases, the reason will be conveyed to the fellow in a letter from the executive director.

The fellows of the CUSEC are responsible for addressing the goals of the center. Where appropriate, they will make recommendations to the university administration on the acquisition and use of facilities, and the faculty and supporting staff needed for the effective cooperation of the center.

Fellows will normally be expected to filter related grant proposals through the center and receive services and benefits from the center in return.

Meetings of the fellows will normally be held at least quarterly at the call of the executive director. Meetings may also be called by written request of three or more fellows to the executive director at a time and place specified in the request. All fellows must be notified at least one day in advance of a fellows meeting. Half of all fellows will constitute a quorum. Except where specified elsewhere in the by-laws, a simple majority of all active fellows present will decide a question. At the request of three fellows present at a meeting, any resolution may be submitted without amendment to a written poll of the fellows.

Center activities will be announced and policy issues discussed via e-mail, to the greatest extent possible, in order to minimize the number of meetings. A Fellow off-campus for more than six months will be expected to remain in contact with the center via electronic mail, or will be declared inactive, and ineligible for voting. An inactive fellow will return to active status upon (semi-permanent) return to the Boulder campus.

Senior Members

Senior membership in the CUSEC is open to all employees of the University of Colorado who participate in the center's activities and have made a long-term commitment to the CUSEC. Senior members will be elected by a majority vote of the fellows. It is ordinarily expected that senior members will hold a doctorate, and that they will have been a member in the CUSEC for two years after receiving their doctorate. The title of senior member is conferred for fixed periods of time, not to exceed 3 years, and is renewable. Senior members may submit center proposals on their own, without a sponsoring fellow.

Members

Membership in the CUSEC is automatically conferred upon those employees who occupy CUSEC space and/or are supported as CU employees by grants administered by the CUSEC. Additional members may be elected by a majority of the fellows. Members are authorized to use the resources of the CUSEC, subject to the approval of the fellows, and are encourage to submit scientific papers with the CUSEC by-line.

Affiliates

The CUSEC may extend temporary membership privileges to persons under the title of CUSEC Affiliate. An affiliate must be nominated by one or more sponsoring fellow of the CUSEC. Appointment is subject to the approval of a majority of CUSEC fellows. Appointment as a CUSEC affiliate does not construe employment by the University of Colorado, and, of itself, will not result in remuneration to the affiliate.

Appointment as an affiliate is subject to renewal every three years, upon nomination by the sponsoring fellow. The sponsor will present evidence that the affiliate is actively engaged in quality research. Reappointments must be approved by a majority vote of the fellows of the CUSEC. Affiliates can be terminated at any time by a 2/3 vote of the Fellows of the CUSEC.

The sponsoring fellow will act as principal investigator for funding proposals submitted through the CUSEC, involving the affiliate as co-investigator. An affiliate is accorded all the privileged of the general membership of the CUSEC, including the use of all facilities. As available, a limited amount of office space will be set aside especially for the shared use of affiliates in order to encourage their presence on campus.

Governance

Advisory Board

With their consent, the university provost, dean of the School of Education, dean of the College of Arts and Sciences, and dean of the College of Engineering and Applied Sciences will sit on the Advisory Board. Should these individuals not wish to serve, they would be encouraged to provide a proxy/recommendation to represent their interests.

Project Management Team (PMT)

The PMT will consist of four to six managing directors, the associate director, and the executive director of the CUSEC, who will serve as chair.

The PMT will develop an annual budget for the center, which must then be approved by a majority of the fellows. The PMT will be responsible for conducting center elections and will act as the nominating committee. Except on matters of appointments, elections and other issues that the fellows specifically choose to retain to themselves, the fellows will automatically delegate authority to the managing directors.

Meetings of the PMT will normally be held at least once every month at the call of the

executive director. Meetings may also be called by written request of two or more PMT members to the executive director at a time and place specified in the request. All PMT members must be notified at least one day in advance of a meeting. Half of all PMT members will constitute a quorum. Except where specified elsewhere in the by-laws, a simple majority of all active fellows present will decide a question.

Executive Director

The executive director will be elected by the fellows from among their number. The regular term of office for the executive director is three years, starting August 1, 2011. The election of the executive director will normally occur between April 15 and May 15. The PMT will be responsible for conducting the election and will act as the nominating committee. Nominations will also be accepted from the fellows at large at least one week before the election. The vote will be by secret ballot of all active fellows. Election will require a majority of all votes cast. If no candidate wins a majority, a new election will be held between the two (or more in the case of a tie) receiving the largest number of votes. The executive director may be removed from office by a petition signed by two-thirds of all active fellows.

The executive director will serve as fiscal officer, oversee the overall operations, and supervise the associate director and administrative and research staff. The executive director, along with the associate director, will be responsible for carrying out policies established by the fellows. The executive director will sign off all proposals routed through the center. The executive director will be a voting member and will serve as chair of the PMT.

Associate Director

The associate director will be chosen by the executive director from among CUSEC members, senior members, and fellows.

The associate director will become acting director if the executive director is to be absent from the center for more than one week.

The associate director will work closely with the executive director and managing directors to oversee daily operations of the center and coordinate with the advisory board.

Acting Director

If the associate director is absent simultaneously with the executive director for more than one week, the executive director will designate an acting director. If the acting director is to serve for a period of time of one month or more, the designation of acting director must receive the approval of the fellows, who may choose to hold an election to select an acting director.

Managing Directors

Managing directors will be elected by the fellows and will serve for overlapping two-year terms, beginning August 1, and are eligible for re-election. The executive director will nominate CUSEC members or fellows to be managing directors and will

announce the nominees at least one week before the election. Election of the managing directors will be by majority vote of the active fellows. If a majority vote is not achieved, alternate slates will be nominated by the fellows until a majority vote is attained. There must be at least one managing director from each the College of Arts and Sciences, the College of Engineering and Applied Sciences, and the School of Education.

The executive director will appoint active CUSEC members or fellows to be managing directors to replace members who are absent from Boulder for more than one month. Such appointments automatically end upon the return of the regularly elected member. A managing director may name his or her own temporary replacement by written notice to the executive director.

Managing directors will advise and assist the executive director. They will serve liaisons to each of the affiliated schools and colleges.

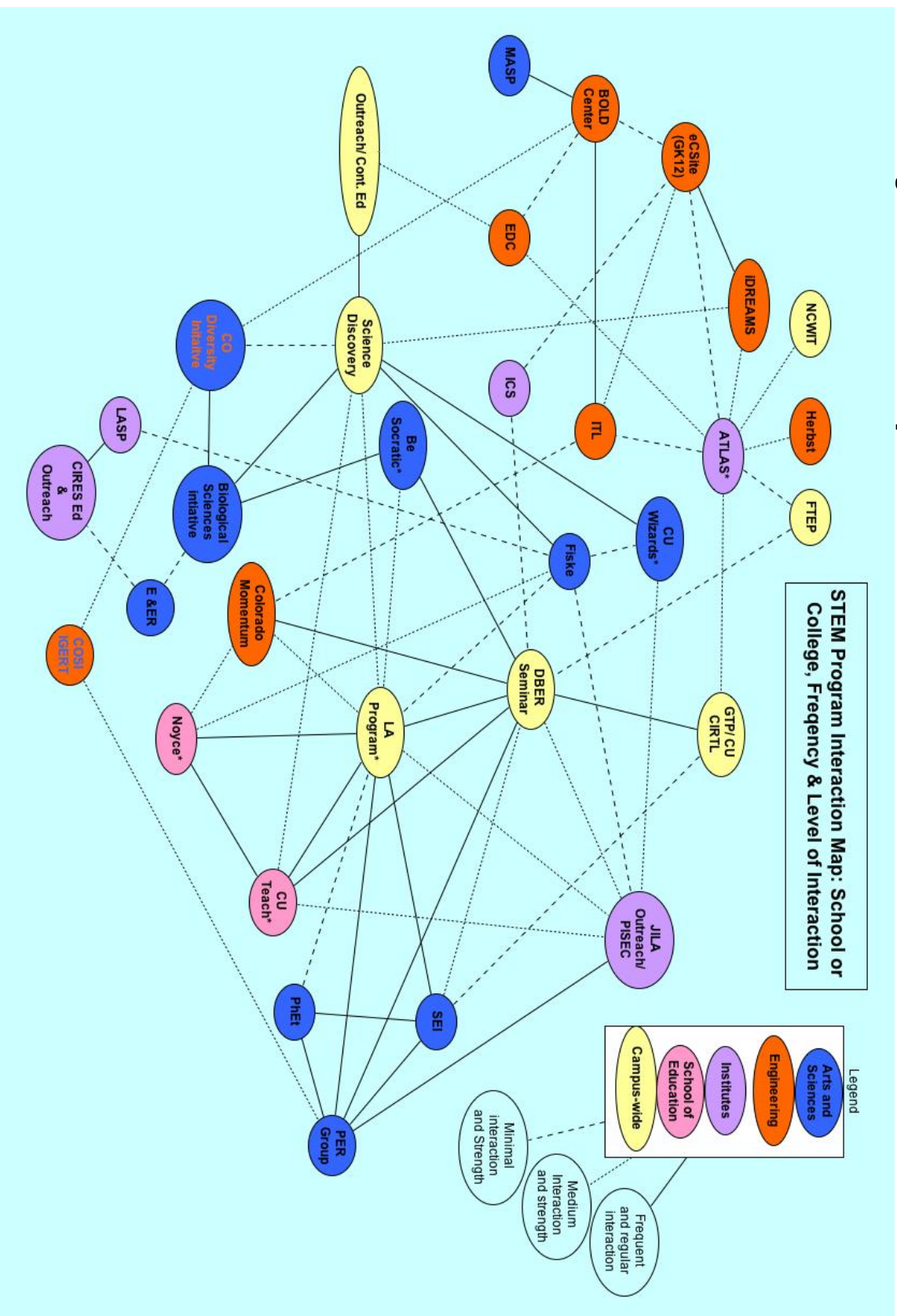
Committees

Ad hoc and standing committees may be established from among the fellows, senior members, and members. All appointments to CUSEC committees will be made by the executive director, subject to the advice and majority vote of the fellows, for terms not to exceed one year. Appointments to committees may be renewed with the consent of the fellows.

Provisions for changing by-laws

The by-laws of the CU STEM Education Center may be amended by a 2/3rds majority vote of all fellows, provided that a written copy of the amendment is provided to all fellows at least one month prior to the vote.

7.K. STEM Program Interaction Map



7.L. Report on iSTEM evaluation by R. Scherr, 11 15-16, 2010

1. Goals of evaluation

This is the second evaluation for this project. The main goals of the evaluation for this year are:

- a. To explore the potential for establishing of a future Center for STEM Education by observing the departmental and university cultures and practices that may support or constrain the establishment of a future Center.
- b. To help the Project Management Team (PMT) continue to articulate and develop its common vision for the project.

In-depth interviews to determine the extent to which stakeholders share the PMT's vision and feel a value added by the project are planned for alternate years (i.e., 2009 and 2011). This year's evaluation includes updates on the PMT's responses to issues raised by stakeholders in 2010.

2. Potential for establishing a future Center for STEM Education

The project is creating and documenting significant growth in departmental and university cultures and practices supporting STEM education, and is well on track toward establishment of a Center for STEM Education. To the extent that these cultures and practices are externalized and have well-defined products and outcomes, they are straightforwardly documentable. The project conducts its own such documentation in consultation with the Evaluator, whose role is to advise the team in data collection and analysis. Some of the evidence of growth is summarized in this section.

Changing cultures and practices, however, are not solely a matter of observable outcomes. One of the goals of this project is to create a shared sense of purpose among CU's many STEM education programs – a feeling that the programs are not isolated constituencies, but are part of a community whose combined efforts have meaning at campus, regional, and national levels. This construction of a shared STEM education identity is a core aim of the project. Though measurement of identity production is not well established methodologically, some indicators of the project's progress toward this goal are summarized below.

a. Relationships among disciplines and programs

The PMT itself is a means by which formerly isolated university communities are now in contact with one another and understand themselves to be participants in a team effort. These relationships now represent well-established lines of communication around the university and have had tangible benefits. For example, faculty leaders in Engineering, which has historically placed a high value on its autonomy

within the university, are now in contact with the LA program director, CU-Teach leaders, and multiple DBER participants in weekly PMT meetings. Partly as a result of this contact, Engineering is beginning to participate in the LA program, a major change for a disciplinary area that (as noted in last year's report) formerly perceived no need for collaboration. Though the LA program in Engineering is struggling to get a foothold, the PMT is actively assisting in resolving the difficulties. A thriving LA program would provide the basis for future collaborations, possibly including advocacy for teacher certification in Computer Science (a matter raised in last year's evaluation). Overall, there is a sense that Engineering is beginning to see itself as part of a larger STEM education community, and beginning to recognize potential benefit in collaborating with other members of that community.

The PMT is considering the possibility of expanding the team by one or two members to create stronger relationships with other departments and programs.

b. Rewarding intellectual interactions

A recommendation from last year was for the project to more clearly identify sites of rewarding intellectual interactions for the faculty and students that are involved with iSTEM. The "Chancellor's Awards for Excellence in STEM Education" support and celebrate valuable STEM education projects as well as increasing the visibility and prestige of those projects at the departmental and university level. Special events such as the 2nd Annual Symposium on STEM Education, held during the Evaluator's visit, showcase the established intellectual benefit of constituent programs and transport that benefit into new venues. Graduate student awardees expressed to the Evaluator last year that the award was crucial to their participation in STEM education research and even to their continuing enrollment in graduate school. These same student awardees presented their maturing research alongside faculty awardees at the iSTEM Symposium, thus sharing the intellectual value of their work with the wider STEM education community. The Chancellor's Awards are an example of how iSTEM provides direct benefit to the faculty and graduate students who get the awards, as well as indirect benefit to their departments and intellectual communities.

c. Funding structures

A critical marker of progress is the development of funding structures to sustain constituent programs, especially pillar programs, now that they have outlived the grant funding that established them. The LA program, for example, has received a commitment of \$250,000 from the Provost to sustain the program for the coming year, and has submitted a scaling model under which the LA program could serve the whole campus. The ultimate goal is for the program to be funded from the university's

operational budget, an arrangement that would require the support of all Deans. The confidence of the Deans is critical as iSTEM moves toward the establishment of a Center, not only because of the Deans' role in program funding, but also because Deans have in the past perceived a potential risk in possibly being challenged to contribute faculty lines to a future Center. The iSTEM Symposium was attended by six Deans, a remarkable show of support and interest from a constituency that had formerly not felt that iSTEM offered clear benefit to them.

d. Participation of high-status individuals

The project has continued to increase participation from high-status individuals in the university community and beyond, including not only the Deans but also the new Provost and local and state elected officials. At the Symposium, the mayor of Boulder declared November 15 to be Al Bartlett Day, in honor of one of CU's most celebrated senior contributors to physics education. Contact between PI diStefano and President Barack Obama suggests the congruence of iSTEM goals and national STEM education efforts.

e. Branding

The visible markers of project identity that were being designed last year are now fully evident in the form of banners, brochures, business cards, and marketing items such as mugs and pens. The project's web presence (<http://www.colorado.edu/istem>) effectively showcases its achievements and provides points of entry for faculty and departments wanting to participate in its constituent programs.

Overall, there is a compelling "buzz" around iSTEM events and programs, suggesting that the elusive yet crucial process of building a STEM Education community identity is in taking place. In addition, tangible outcomes such as program growth and sustainable funding models mark progress toward Center status.

3. Project Management Team's development of common vision for the project

The project management team (PMT) holds weekly meetings to engage in the collective design of activities, selection of Chancellor's Awardees, planning of public relations, and creation of reports and project materials. The PMT has an excellent consensus mission, which is "to transform institutional culture so that STEM education is valued." There is good evidence that this transformation is taking place, as documented above. This section documents the PMT's progress in developing an equally strong and explicit consensus on its specific goals for the middle years of the project.

a. Areas of consensus

All of the publicly-visible achievements enumerated in the first section of this report are shared accomplishments of the PMT as a whole, and are indicators of the team's strength and effective advocacy.

Among the recommendations ensuing from last year's evaluation was for the PMT to consciously limit its integration work to the three pillar programs (the LA program, DBER, and CU-Teach), and to scale back its effort to integrate the many other STEM-relevant programs on campus (which are highly varied in purpose, size, audience, and so on). The project appears to be appropriately maintaining its strong commitment to the pillar programs. The PMT is also productively involved with programs beyond the pillar programs: for example, iSTEM hosted a mini-symposium for constituent programs conducting inservice teacher professional development. The PMT appears to be in agreement that activities such as the mini-symposia are a site of substantive intellectual discourse and do not dilute their efforts in support of the pillar programs.

The PMT is in close contact with the PIs, especially the Provost and the Dean of the School of Education. Each of the PMT members is in frequent informal contact with the Dean or Associate Dean for his or her own area. All PIs receive quarterly or semi-annual updates in writing, as well as presentations at Deans Council and Regents meetings. A future goal is to arrange forums in which Deans and other PIs communicate with one another about iSTEM efforts.

b. Areas for further development

The PMT continues to negotiate the translation of its mission into specific goals for the project. Possible objectives for iSTEM may include:

- Raising awareness of and esteem for STEM education efforts at the departmental, university, regional, state, and national levels.
- Helping raise the quality of STEM education efforts on campus by coordinating assessments and setting expectations for program effectiveness.
- Advocating for specific STEM education efforts on campus; problem-solving for struggling programs.
- Creating a sense of identity for STEM education efforts, in which constituent programs understand themselves to be part of a community of programs with a shared sense of purpose.

All of these possible objectives were articulated to the Evaluator by members of the PMT. All are potentially within the purview of iSTEM; there are likely to be synergies among overlapping objectives, and in any case there is room for diversity of priorities on the PMT. However, to the extent that these different objectives reflect different mindsets as to the core purpose of the project, there may be difficulty for individual

members of the PMT in feeling clear on the worth of specific activities or having a sense of ownership in the outcomes of the project.

The project management team is a major strength of the project. Composed of directors of the pillar programs and representatives of several STEM disciplines, the team engages in very active collaboration to do the substantial daily work that keeps iSTEM moving forward. The mutual trust and collaborative spirit that characterizes the PMT is crucial to the continued strength of the project. To protect and deepen the valuable relationships that make the PMT so productive, I recommend that the team engage in concerted activity to build understanding among its members, such as a facilitated retreat.

4. Future evaluation

Two forms of continuing evaluation are proposed.

- a. Another evaluation visit, consisting primarily of a week of stakeholder interviews, will be scheduled for late spring of 2011.
- b. The Evaluator will advise the survey team in data collection and analysis.