OVERVIEW OF THE PROGRAM

Our Noyce Phase II project is similar in nature to our Phase I project in that we recruit undergraduate STEM majors through the Learning Assistant program and then from the Learning Assistant program to the Noyce Fellowship program. However, for our Phase II Noyce grant, we are partnering with several school districts and two informal science education programs to expand our current Noyce Fellowship Program to address two growing needs at our institution:

(1) **Expand the Noyce Fellows program through CU-Teach.** CU Boulder recently received funding to replicate the UTeach certification program that includes an aggressive teacher recruitment campaign. Part of this effort is to provide fellowship incentives to STEM majors to become K-12 teachers. Noyce Fellows who become teachers can apply for mini-grants for classroom supplies.

(2) **Increase diversity by partnering with informal science education programs on campus.** We will increase the number of students traditionally underrepresented in mathematics and science at CU Boulder and the number of these students applying to the Noyce Fellowship program. We will do this by engaging Noyce Fellows in local Informal Science Education efforts.

Activity Overview January 2011-December 2011

1. We began funding Noyce fellows from this Phase II grant in Spring 2010. Eleven new Noyce fellows were funded through the Noyce Phase II grant in 2011. Among these were four mathematics majors, three molecular, cellular, and developmental biology majors, two ecology and evolutionary biology majors, one chemistry major, and one engineering major. One of these students is Hispanic; two students were enrolled in a post-BA “masters plus certification” program when recruited. One of the molecular biology students is pursuing her elementary teaching license. Of these new recruits, two students completed their teacher certification program in 2011.

2. We are working to increase the diversity among Noyce Fellows on campus. We have been working with Collinus Hunt, the director of the Education Diversity Scholars program and with Sallye McKee, the Vice Chancellor of Diversity, Equity, and Community Engagement to engage with other programs on campus, such as the McNeill program, Miramontes Arts and Sciences Program, Education Diversity Scholars Program, Multicultural Engineering Program, Chancellor's Leadership Residential Academic Program and Ethnic Living and Learning Community, CU-LEAD Scholars Program, Ronald E. McNair Post Baccalaureate Achievement Program, the Center for Multicultural Affairs, the First Generation Scholars Program, Pre-Collegiate Development Program, and the White Antelope Memorial Scholarship Program. Related activities from 2011 include:

   a. Two Noyce fellows participated as TAs in the Roaring Fork Pre-Collegiate summer program on campus. They worked with a faculty member from Chemistry.

   b. One of our new 2011 Noyce fellows is a McNeill Scholar. He arranged for Anne Scarritt,
Mathematics Program Director of the McNeill Academic Program, to participate in our September Noyce meeting.

c. One PI provided training for undergraduate teaching assistants (UTAs) in the summer Pre-Collegiate Development Program. Most UTAs were Hispanic and had participated in the program in their pre-college days.

In addition, Noyce Fellows are interacting with diverse populations outside CU-Boulder. For example:

d. Four Noyce Fellows participated in two youth career fairs sponsored by Workforce Boulder County. The fellows set up demonstrations to engage middle and high school students in math and science and shared their enthusiasm for becoming STEM teachers with students and their parents. Many of the students attending the fair are from diverse backgrounds and will be first-generation college students.

e. Several of our Noyce fellows are pursuing their own opportunities to gain experience in high-needs settings and to work with diverse students, both at the K-12 level and with undergraduates at the university.

3. The CU Teach program is increasingly recruiting new students to become interested in teaching careers. We find that CU Teach is working synergistically with both the Learning Assistant (LA) and Noyce programs in this effort. In Summer 2010, 10 internships of $2500 each were awarded to freshmen and sophomores to participate in summer teaching experiences, paid by CU Teach. In Summer 2011, the Noyce Phase II grant paid for 7 such internships.

4. Several of our Noyce fellows are engaged in discipline-based education research projects, course and curriculum development, and community partnerships. Projects in which Noyce fellows participated in 2011 include:

a. One Noyce Fellow is conducting research on student ideas related to “order of operations” in mathematics. He has conducted surveys and student interviews and presented his findings at the National Noyce Conference in July. He continues to work with Professor Eric Stade in the Mathematics department and will be presenting at upcoming mathematics conferences as well.

b. Two Noyce fellows have participated in research and materials development for El Pueblo Mágico. This is an after-school program, designed by CU faculty and doctoral students, and modeled on successful programs in the UC-Links system in California, that brings together CU undergraduates, graduate students, and learning science researchers with K-5 students at Alicia Sanchez Elementary School in Lafayette, CO, to play and learn through computer-mediated and health science focused inquiry projects.

c. One Noyce fellow is working with a science education doctoral candidate to analyze videos of Learning Assistants (LAs) working in Physics tutorial settings. In addition to analyzing how LAs interact with students, this project will identify quality video clips to be used in the pedagogy course that all new LAs take.

d. One Noyce fellow participated as an intern for the Global Ozone Project.

e. Two Noyce fellows worked with an Applied Math faculty member in analyzing data and developing materials for use in undergraduate calculus workshops.

f. Four Noyce fellows partnered with Streamline to Mastery teachers, as described in more detail below.
g. Two Noyce fellows were instrumental in designing and creating content for our new Colorado Noyce website: http://noyce.colorado.edu/

h. Three Noyce fellows attended the Western Regional Noyce Conference in March. They presented a poster related to their Noyce and Learning Assistant activities.

i. We funded a proposal from one of our former Noyce fellows (now teaching math in Fort Collins, CO) to supply him with a classroom set of iClickers. He plans to share his experiences and data with our current Noyce fellows at a monthly meeting.

5. Some of our Noyce Fellows are working with K-12 teachers who are funded by the Noyce MT/TF strand of Noyce—our program is called “Streamline to Mastery.” As a part of their professional development, these teachers are engaging in classroom research. Noyce Fellows are working directly with these teachers in collecting and analyzing data as well as in working directly with the students in the classroom. Because Noyce Fellows are developing a working relationship with teachers through the classroom research, this experience seems to be more substantive than the typical practicum placement. We have therefore leveraged the Noyce Teaching Fellowship program with the Noyce Master Teacher program so that inservice teachers are meaningfully involved in, and indeed help to staff, programs that certify teachers. At the same time, Noyce Fellows staff needed positions in K-12 schools (for example, if teachers are working within teacher certification programs, they will need assistance covering all of their duties). In this situation, professional development of inservice teachers is embedded within the preparation of future teachers. The preparation of future teachers is embedded within the professional development of veteran teachers. This is all held together by discipline-based educational research with the participation of faculty and graduate students from local universities.

6. Now that other Colorado universities have received NSF Noyce funding, we are working on ways to support and learn from each other, while broadening the network of past and current Noyce fellows across the state. In November of 2011, Dr. Penny Noyce visited CU-Boulder. We used this opportunity to invite PIs and scholars from University of Northern Colorado, Colorado State University, and University of Colorado-Denver to join us (along with Streamline to Mastery teachers). Close to 40 people attended this event, representing four NSF Noyce programs within the state. We hope to continue collaborations in order to strengthen all of our programs.

RESEARCH AND EVALUATION

Ongoing Research

In Fall 2006 the STEM Colorado/PhysTEC team was awarded a DRK-12 grant from the NSF, DUE-0554616, “Learning Assistant Model of Teacher Education in Science and Technology (LA-Test).” This project is designed to test the efficacy of the Learning Assistant (LA) model for recruiting and preparing highly effective STEM K-12 teachers. The LA-Test project consists of three research teams focusing on Content, Pedagogy, and Practice. Among other things, this project consists of a longitudinal study of Noyce Fellows in comparison to other students who have graduated from the same teacher preparation project but did not participate as LAs. The team that focused on practice observed teachers who received Noyce Fellowships (as well as a control group who did not participate as LAs and thus did not receive Noyce Fellowships) during their student teaching and during their first few years of teaching.
The Learning Assistant model for Teacher Education in Science and Technology (LA-TEST) research project was designed to test the effectiveness of the LA model specifically in terms of LAs’ development of content knowledge, pedagogical knowledge, and their practice in K-12 schools. Faculty members from education, mathematics, and science, K-12 teachers, graduate students, and Noyce Fellows comprise three interacting research teams: the Discipline-Based Educational Research (DBER) team, the Conceptions of Teaching and Learning (CTL) team, and the K-12 team. These interacting research teams investigate teacher recruitment rates as well as the research questions shown below and synthesize results on an ongoing basis.

Each research team focused on a specific set of questions (shown below). Answers to these questions have been synthesized in order to make inferences about the impact of the Learning Assistant (LA) Model on teachers’ pedagogical content knowledge.

The DBER team consists of faculty and graduate students from five departments: Physics, Chemistry, Applied Mathematics, Astrophysical and Planetary Sciences, and Molecular, Cellular, and Developmental Biology. The CTL team consists of faculty members from the School of Education in Research and Evaluation Methodology and from the Physics department, and graduate students in Science Education and in Physics Education Research. The K12 team consists of faculty members and graduate students in Science and Mathematics Education.

**Research Questions:**

**DBER Team:**
- (a) How do LAs compare to other STEM majors in terms of their content understanding, beliefs about the discipline, and beliefs about learning in the discipline?
- (b) What effects can be observed on student achievement in courses that are supported by LAs?

**CTL Team:**
- (a) What is the effect of the LA model on the sophistication of LA pedagogical understanding?
- (b) Does sophistication of pedagogical understanding vary by length of exposure to the LA model?
- (c) How is the pedagogical sophistication of STEM LAs different from the sophistication of STEM non-LAs who become teachers?

**K-12 Team:**
How do teachers and teacher candidates who participated as LAs compare to those who did not in terms of:
- (a) Practicum-based coursework
- (b) Their teaching practices
- (c) K-12 student attitudes and beliefs about mathematics and science
- (d) Retention and attrition rates
Thus far, we have interviewed, observed, and collected artifact packages from 24 1st year teachers who served as Learning Assistants, 17 of whom were formerly Noyce Fellows. We also interviewed and observed a matched sample of twenty-five 1st year teachers who went through the same teacher certification program but who did not serve as LAs or Noyce Fellows. Many of these teachers were observed for up to three years. We have found that there are significant differences in the group of LA/Noyce Fellows (LAs for short) and non-LA/Noyce Fellows (Non-LAs for short) in their teaching practices according to observations made with the Reformed Teaching Observation Protocol (RTOP). For a full report on the results of this research please see: http://laprogram.colorado.edu/sites/default/files/reports/la-program-10-11.pdf

RELATED GRANT ACTIVITIES

Title: I3: Towards a Center for STEM Education (#0833364)
Duration: 08/15/2008–8/14/2013, Amount: $997,000
Program: NSF, Innovation through Institutional Integration

Integrating STEM (iSTEM) at the University of Colorado, Boulder works primarily to integrate three existing lines of work supported by NSF: (1) efforts in undergraduate and graduate course transformation, (2) programs in undergraduate and graduate teacher preparation, 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 multi-disciplinary 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 I3 effort builds on the efforts to integrate programs to build a distributed Center of STEM education research and transformation. This Center for STEM education 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 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 which integrates multiple efforts in STEM education.

The first two years of this project (2008-2010) has been spent building a foundation for this endeavor. On the programmatic side we are primarily focused on building networks of scholars across the Boulder campus to foster STEM education research and reform. These programmatic efforts are supported by a newly instituted, weekly, Discipline Based Education Research (DBER) seminar series, a weekly project management team meeting, faculty mini-grants, and preliminary development of cyber-infrastructure – a website.

A major success of this program has been the establishment of the “Chancellor’s Awards for Excellence in STEM Education. These awards go to STEM faculty and STEM doctoral students who are interested in pursuing research in STEM education in their own university classrooms. This research often involves Noyce Fellows and this program has worked synergistically with the Noyce Fellowship program. More information can be found at: http://www.colorado.edu/ScienceEducation/ .
STREAMLINE TO MASTERY

In 2009 we received approximately $1.5 M with a match of $750K to launch a professional development program which we have named “Streamline to Mastery.” As a part of NSF’s Noyce Program, this grant is intended to focus on the professional development of teachers who have master’s degrees. We have launched the program and four teachers have been selected for the first cohort of the project. Streamline to Mastery (S2M) teachers are currently meeting twice per month to develop a 5-year professional development program with the program PI and 2 graduate students. This planning process is part of the professional development program, yet we will implement the program with the 5 S2M teachers during the second half of the first year of the program. The same teachers will then implement the program with the second cohort of teachers and then all 10 teachers will more broadly implement professional development within their districts and beyond. The idea is that development and implementation is a part of professional development and developing mastery and leadership. These teachers will attend at least one conference per year and will regularly conduct research in their classrooms. One of the S2M teachers is a former Noyce Fellow and another is a former LA.

Streamline to Mastery Teachers have come to call themselves the “Stream Team” or “Streamliners,” which includes two STEM Education doctoral students (both former physics teachers) and 5 Noyce Fellows. Noyce Fellows are working directly with Streamline teachers in their action research in their classrooms. Noyce Fellows are finding this extremely valuable to their own development as teachers and Streamline teachers are finding their work with Noyce Fellows extremely beneficial to their own productivity and toward their own professional development.