Promoting Diversity and Mentorship in Computing and Engineering through Graduate - K-12 Partnerships

PI: Margaret Burnett (Professor, School of EECS, COE)
CO-PI: Carlos Jensen (Associate Professor, School of EECS, COE), Ellen Momsen (Director of Women in Engineering Program, COE), Maggie Niess (Professor Emeritus, Science and Mathematics Education, COS).

Faculty advisors and departments involved: School of EECS, College of Engineering

Number of graduate Fellows per year: 8 Fellows per year, 40 over course of grant
Number of K-12 classes anticipated to be served each year: 4 per year, 20 over course of grant
Number of K-12 teachers working with Fellows: 4 teachers per year, 20 over course of grant

School district partners: Corvallis, Albany, Lincoln (Siletz Charter & Early College High School), Alsea, Salem, Lebanon, Sweet Home

Target audience of the project: Middle & high school

Setting: Urban, suburban, and rural

NSF supported disciplines or themes involved: Technology, Engineering

History: This is the same as last year’s successful letter of intent. The proposal we submitted last year to NSF did reasonably well: 1 Excellent, 2 Very Goods, 3 Good reviews, earning a panel rating of “Recommended,” but ultimately unfunded. The reviewers’ issues point to a need for tuning our presentation, but no substantive flaws. We are confident a revised submission will succeed based on this and our new complimentary NSF CPATH grant which we can leverage.

1. Goals and Objectives

The two primary goals of this program are to provide graduate students in computing and engineering unique opportunities to develop and train as mentors and educators, and to promote diversity in computing and engineering by giving students additional learning opportunities and positive role models. Specifically, these are our objectives for the following stakeholder groups:

For Graduate Fellows

- **Teaching, mentorship, and communication skills**: Many of our graduate students aiming at academic careers have neither formal training in mentorship or pedagogy, nor structured opportunities for gaining hands-on experience. Without training in these important aspects, moving into a faculty position upon graduation becomes a process fraught with risks and pitfalls for these early professionals. This program will enable OSU to be one of the few universities to give students hands-on opportunities to develop these critical skills.

- **Interdisciplinary opportunities**: Employers and funding agencies are increasingly emphasizing the importance of interdisciplinary research and the skills to work effectively as a team. Fellows will gain valuable experience in relating their work to non-experts (pre-college students and teachers), working in an interdisciplinary team (engineering and education), and will help develop interdisciplinary teamwork skills.

- **Real-world focus**: By working with schools, teachers and pre-college students, developing and presenting curriculum, our graduate students will gain valuable experience working with real users, and solving real-world problems as presented by the students and teachers needs. This in turn will help them not only communicate more effectively about their research, but also motivate them to pick more socially relevant projects.

For the School of EECS and College of Engineering

- **Diversity of graduate students**: This program is an opportunity to recruit and support diversity, especially in the School of EECS, which has a severely skewed student population. By providing
direct mentorship opportunities, we hope to attract a more diverse graduate student population, perhaps more interested in working with outreach, human-centric computing, and teaching. We also hope to attract a more diverse undergraduate student population by giving them positive role-models a better understanding of Computing and Engineering as disciplines.

**Schools & Teachers**

- **Enriched opportunities for pre-college students, diversity of future undergraduate students:**
  By showing how technology and computers are part of every aspect of STEM, and through interaction with the graduate students, we will show pre-college students and teachers that computing, science, and engineering are dynamic and interesting, and change stereotypes about these fields. By targeting middle and high-schools we seek to intervene when research shows students start to shun science and technology education.

### 2. Project Plan

Two Fellows are assigned as a team to a class for the academic year. The teams will collaborate to develop and implement hands-on, inquiry-based, problem-based learning activities centered on the NETS (http://cnets.iste.org/students). The NETS are a benchmark for many school districts to evaluate students’ technological readiness. Fellows will be integrated into the classes in support of the Technological Pedagogical Content Knowledge (TPCK) model [14]. This model argues the need for bringing content knowledge, technical knowledge as well as pedagogical knowledge together in order to create more powerful learning experiences. The Fellows will provide added content and technical knowledge to complement the teachers’ pedagogical and content knowledge, and the two groups will learn from each other.

<table>
<thead>
<tr>
<th>Table 1: International Society for technology in education (ISTE) National Educational Technology Standards for Students (NETS*S)</th>
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</table>
| **1. Basic operations and concepts**
  a. Students demonstrate a sound understanding of the nature and operation of technology systems
  b. Students are proficient in the use of technology
| **2. Social, ethical, and human issues**
  a. Students understand the ethical, cultural, and societal issues related to technology
  b. Students practice responsible use of technology systems, information, and software
  c. Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity
| **3. Technology production tools**
  a. Students use technology tools to enhance learning, increase productivity, and promote creativity
  b. Students use productivity tools to collaborate in constructing technology-enhancing models, prepare publications, and produce other creative works
| **4. Technology communication tools**
  a. Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences
  b. Students use a variety of media and formats to communicate information and ideas to multiple audiences
| **5. Technology research tools**
  a. Students use technology to locate, evaluate, and collect information from a variety of sources
  b. Students use technology tools to process data and report results
  c. Students evaluate and select new information resources and technological innovations based on the appropriateness for the tasks
| **6. Technology problem-solving and decision-making tools**
  a. Students use technology resources for solving problems and making informed decisions

Each Fellow must take a 6 credit summer workshop (directed by the SMED faculty and graduate assistant, with the support of the K-12 teachers) in order to prepare for their experience. This workshop will cover:

- **Team-building activities among the teams and teachers**
- Learning basic pedagogic and mentorship skills and techniques
• Experiences in hands-on, inquiry-based, problem-based learning
• Experience and instruction in the scientific and engineering processes
• Exploring process learning skills, constructivism, cooperative learning, inquiry, and effective questioning strategies effective in problem-based learning
• NETS standards and development of course materials and strategies
• Exploring lessons that integrate technology instruction in other fields and disciplines (as required in Oregon)

During the school year, each Fellow will spend a minimum of 10 teaching hours per week at the school and five hours per week in preparation. Niess and the SMED RA will observe in-class activities and provide feedback on performance and effectiveness.

3. Recruitment and Selection

At least 50% of the Fellows will be selected from the area of computing, an area that is struggling more than most engineering and science disciplines in terms of a lack of diversity, and declining interest, especially among women, as described in the Oregonian article entitled “Computing Losing Luster for Women” published on 4/17/07. The remaining fellowships will be competitively awarded to qualified students from other engineering disciplines. We will make every effort to recruit and promote women and underrepresented groups, as these provide important role-models for the school children they interact with.

Students in their second and third years of graduate school (M.S. and Ph.D. candidates) will be targeted for this program. First year graduate students will not be recruited because they typically take heavy course loads, and often lack experience in their subject area and as mentors. In January of each year, a call for applications will be sent by email to all eligible students in the COE. Faculty will be invited to nominate candidates. Also, all graduate students with disabilities or who are underrepresented in their programs (including African American, Hispanic, Native Americans, and women) will receive a personal invitation to apply. An information session will be held each year to further promote the program and recruit students.

Applications will go to a selection committee. The selection committee will consist of the PI’s and two teachers. Interviews will be conducted with top candidates to make the final selection. Primary criteria for selection of Fellows includes: 1) expressed and demonstrated interest in outreach and interdisciplinary work, 2) expressed or demonstrated interest in teaching and mentorship, 3) ability and subject matter knowledge, as indicated by curriculum vitae, letters and other information, and 4) contribution of the applicant to the diversity of the cadre of Fellows.

Identification of K-12 Teachers will be based on recommendations of school principals, and ongoing working relationships with OSU faculty and COE outreach programs such as the Ambassador program and the precollege program. Momsen and Niess, through their ongoing interactions with the school districts, will be primarily responsible for selecting suitable schools and teachers based on 1) fit with the selected Fellows, 2) track record and previous experience, 3) potential for mentoring Fellows, 4) potential benefit to the teacher and school. Particular attention will be paid to schools that either have high diversity, low socio-economic indices, or classes with large female participation.

4. Organization, Management and Institutional Commitment

The PIs will have primary responsibility for the oversight and day to day administration of the program. Burnett will serve as Project Director, and will be responsible for coordinating and supervising the program. She has significant experience with project direction: she is the founding Project Director of the EUSES Consortium (including researchers from CMU, Penn. State, Cambridge University, Drexel, University of Nebraska, and IBM). She also has a 15-year history of mentoring undergraduates, a large number of which have been members of underrepresented groups (usually fe-
male), through the NSF REU program and through CRA-W’s Distributed Mentor Program. Almost all of these students have gone on to graduate school at Carnegie I graduate schools. Burnett’s interest in gender issues in technology led her to develop a mentorship model for female Ph.D. students, used successfully in collaboration with HP Laboratories [9]. As part of her research, she investigates gender issues that arise in end-user problem solving software [2, 3, 4, 5].

Niess will be responsible for training of the Fellows, as well as coordinating the evaluation team and data-collection. Her research centers on curriculum and instruction to guide students in strategic thinking with information technologies. She has worked with teachers in Oregon school districts for more than 25 years. Her recent research focuses on knowledge teachers need for integrating technology in teaching, with specific consideration of methods for engaging girls [15, 16, 17, 18, 19]. Prior to her return to academia, she was a mathematics teacher for 17 years.

Momsen leads the very successful COE Ambassador program which sends undergraduate students to high schools throughout Oregon. The Ambassador program is at the heart of the COE’s diversity and outreach strategy. Thanks to her efforts, the College of Engineering has had a 20% increase in incoming students fall 2006 as compared to fall 2005, and a 40% increase in the number of incoming freshman female engineers and 50% increase for other minorities. She also brings her 20 years of experience as a high-school physics teacher. Ellen will serve as liaison with the schools, identifying schools and classes for placement, and mentoring Fellows.

Jensen received a Ph.D. in computer science in 2005, with a minor in psychology. His research lies at the intersection of software engineering and usability. His interests include privacy and security aspects of software engineering and their interactions with user behaviors [1, 11, 13], online trust and collaboration [7, 10, 12], and gender issues in programming and in self-directed learning [6, 8]. He is currently the PI of the departments’ NSF CPATH grant looking at ways of reenergizing CS education nationally, a program which we can leverage in this proposal. He will lead efforts to identify novel and effective educational tools and strategies for addressing the NETS requirements.

This program is designed to fit seamlessly into the already existing and highly successful outreach activities existing at the college of engineering such as the COE Ambassador and precollege programs. We will work with EECS and the College of Engineering to develop a plan for the long-term sustainability, and to obtain institutional commitments to accompany this proposal.

5. Evaluation
The Northwest Regional Educational Laboratory (NWREL) will provide the external evaluation services for this project through the Research and Evaluation unit of the Center for Teaching and Learning. NWREL staff will determine the evaluation components needed to provide evidence of work toward the project goals and objectives and of the sustainability of the program. NWREL staff will conduct yearly site visits and focus group interviews to prepare a report about what is working and what is not. Niess and Science and Math Education staff will provide continuous monitoring, data collection, and evaluation. Each yearly report will be formative in nature to assist the project participants in moving forward with successful programs. The NWREL evaluations and the interpretation of their results will be supported by the National Center for Women and Information Technology’s (NCWIT) Extension Services.

Evaluation will focus on the learning outcomes for the pre-college students in the classrooms (both in terms of NETS knowledge and their understanding and perception of Computing and Engineering as a disciplines), the Fellows’ performance and evolution as mentors and educators, and the development of sustainable and generalizable educational strategies, tools, and programs.

6. Preliminary List of Additional Faculty Participants
Michael Bailey (EECS); Ron Metoyer (EECS); Tom Plant (EECS); Skip Rochefort (Chemical Engineering, OSU Precollege Programs); Weng-Keen Wong (EECS).
References


GK-12 Fellowships: Experiential Learning of High School Biology, Chemistry and Engineering through Virtual Laboratories

PI: Milo Koretsky  Co-PI: Christine Kelly

Science, Technology, Engineering, and Mathematics (STEM) Faculty advisors and departments involved:
- Chih-hung (Alex) Chang (School of Chemical, Biological and Environmental Engineering)
- Goran N. Jovanovic (School of Chemical, Biological and Environmental Engineering)
- Joseph McGuire (School of Chemical, Biological and Environmental Engineering)
- Gregory L. Rorrer (School of Chemical, Biological and Environmental Engineering)
- Lewis Semprini (School of Chemical, Biological and Environmental Engineering)

Number of STEM graduate fellows per year: 5 (years 1 and 5) to 10 (years 2, 3, and 4)
Number of K-12 classes anticipated to be served per year: 30 (years 1 and 5) to 60 (years 2, 3, and 4).
Number of K-12 teachers working with the fellows: 5 (years 1 and 5) to 10 (years 2, 3, and 4)
Number of Schools and School District Partners: 5 (years 1 and 5) to 10 (years 2, 3, and 4)
Target audience of the project (elementary, middle, or high school grades): High school
Setting (urban, suburban or rural): Mostly urban, one rural school will be targeted

NSF supported STEM discipline(s) or theme(s) involved: Science, Engineering and Technology

Goals and Objectives. This project extends our well developed instructional techniques utilizing virtual laboratories to the high school level. The goals are to use the virtual laboratory (1) as a tool for scaffolding problem-based instruction with real world content in regional high schools and (2) as a mechanism for collaboration between GK-12 fellows and high school teachers. Through these activities, fellows will develop improved communication, teaching, and team building skills and a deeper understanding of their own research. The high school teachers will be provided with a tool and content for inquiry-based and problem-based learning. These situated learning experiences will provide high school students a richer exposure to science and engineering and stimulate an interest in careers in these fields. This program will provide a catalyst for a systematic, broader based change both in high school education and in graduate education in the School of Chemical, Biological, and Environmental Engineering (CBEE) at Oregon State University (OSU).

The objectives crafted to achieve these goals are as follows:
1. Over five years, place 20 GK-12 fellows at 10 regional high schools to develop and implement virtual laboratories in the science and engineering classroom.
2. Apply a three-phase virtual laboratory deployment at each high school: (1) implement an existing virtual laboratory (CVD, Bioreactor, or Pure Water Lab), (2) develop and deliver a new virtual laboratory, (3) improve the new virtual laboratory based on assessment from phase 2.
3. Develop 10 new virtual laboratory models in the research areas of the GK-12 fellows.
4. Provide high school teachers with curriculum for 13 different virtual laboratories as a resource for learning in the chemistry, biology and engineering disciplines.
5. Deliver a workshop to high school teachers in the summer after Project Year 2.
6. Leverage methods already in place to assess learning and evaluate the effectiveness in meeting the project goals and objectives.
7. Disseminate the results through conferences (e.g., to high school teachers through the Oregon
Because this project is centered within a single unit, we will be able to systematically integrate the fellows’ experience closely with their own research, facilitate team building and collaboration between fellows, and provide the fellows a community supported, high quality learning environment. This integration is difficult in projects distributed across multiple departments and cultures. Along with the benefits, such a tight integration may pose a problem for a single discipline unit. However, in this case because CBEE has vibrant research efforts that include elements of chemistry, biology, the physical sciences, and a variety of engineering disciplines, the 20 fellows will be engaged in a wide breadth of research activities, and will be able to translate that breadth to the high schools. We believe this approach will result in a superior experience for GK-12 fellows and has the highest potential for GK-12 activities to be permanently incorporated in graduate training.

**Project Plan.** With funding from the National Science Foundation’s Course, Curriculum and Laboratory Improvement Program (CCLI) under Proof-of-Concept grant NSF0442832 and Phase 2 grant NSF0717905, and from Intel Corp. through the Faculty Fellows program, we have developed two virtual laboratories, the Virtual Chemical Vapor Deposition (CVD) laboratory and the Virtual BioReactor laboratory. Figure 1 shows a screenshot of the Virtual CVD laboratory. In a virtual laboratory, simulations based on mathematical models implemented on a computer replace the physical laboratory. These laboratories are not meant to replace the physical laboratories in the curriculum, but rather a virtual laboratory can be designed to extend the range of the learner specifically allowing completion of tasks not otherwise obtainable. These virtual laboratories have been implemented in the capstone laboratory sequence in CBEE at OSU, as well as in the Chemical Engineering program at UC Berkeley and the Graduate Materials Science program at the University of Oregon. Our intent in these projects is to provide students in Chemical, Biological and Environmental Engineering and Materials Science a capstone experience in which they can apply experimental design in a context similar to that of a practicing engineer in industry. In addition, research is being performed to explore the types of cognition and social interactions of student teams as they engage in these virtual laboratories, to determine the role of instructional design in the response of student teams, and to ascertain whether virtual laboratories can effectively promote types of learning that are difficult or impossible to achieve from physical laboratories.

The idea of using virtual laboratories to facilitate project based learning is compelling since, once the software has been developed, the cost to transfer it is relatively small, consisting mostly of developing teacher expertise. While the implementation has largely been at the university level, the software design allows the application itself to be used without modification in other contexts. Whatever the course is, students can run the reactor and take measurements to collect data. Indeed, one objective of CCLI Phase 2 is to demonstrate the utility of the Virtual CVD laboratory as a learning platform at the high school level. In order to achieve this objective, new, level-appropriate assignments have been developed to provide context.
for chemistry and engineering classes. The primary relationship in this curricular development has been a collaboration between Adam Kirsch, Science Teacher at Crescent Valley High School (CVHS) and Debra Gilbuena, a graduate student in CBEE at OSU. The content has been constructed to fit well with high school curricula in Oregon, including the relation to state learning standards in areas of both science and math, and to reinforce learning introduced earlier in the year. In Spring Semester 2008, it is being delivered to approximately 200 high school students in eight Chemistry and Engineering classes. The current graduate student writes:

In my opinion, thus far it has been a wonderful and rewarding project in which I not only learned more about CVD but also teaching and education at the high school level. I’ve really appreciated the opportunity to see high school lesson plan development, work closely with an awesome high school teacher, and work with high school students engaged in the learning process.

- Debra Gilbuena, CBEE Graduate Student

The high school implementation at CVHS will lead to a two-day workshop at Oregon State University with ten high school science teachers. In the workshop, high school teachers will learn how to use the Virtual CVD laboratory including both the 3D Student Client and the Instructor Interface, review of how the Virtual CVD laboratory has been used and learn the plan for how student learning will be assessed and evaluated at the high school level.

The model for more extensive deployment of virtual laboratories through the GK-12 Fellows Program is based on the success of this initial interaction with CVHS. The program will be implemented at 10 high schools in the state of Oregon. It is anticipated virtual laboratories would be used in between 4 and 8 classes at each high school. There will be a 3 phase cycle for each high school, as illustrated in Table 1. Phase 1 (year 1) consists of implementation of a developed virtual laboratory in the high school. This phase is similar to the pilot we are using at CVHS and would allow the GK-12 fellows and teachers to become familiar with the virtual laboratory instructional methodology and pedagogy. For Project Year 1, the labs would include the Virtual CVD and BioReactor Laboratories, and the Pure Water Laboratory. The Pure Water Laboratory was developed by Richard Herz of UCSD and Greg Ogden of University of Arizona under a separate CCLI grant. Phase 2 (year 2) consists of development of a new virtual laboratory in the research area of the GK-12 fellows. Two fellows, one second year and one first year, would be at each school. This phase would foster integration of the research area of the fellows in curriculum development and ultimately contribute 10 new virtual laboratory models. In Phase 3 (year 3), an improvement cycle of the new virtual laboratory based on assessment and evaluation in phase 2 would be completed.

**Table 1. Implementation schedule**

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<th>Project Year</th>
<th>High Schools 1-5</th>
<th>High Schools 6-10</th>
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<tr>
<td>1</td>
<td>5 Fellows (year 1; phase 1)</td>
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<td>2</td>
<td>5 Fellows (year 2; phase 2) 5 Fellows (year 1; phase 2)</td>
<td>5 Fellows (year 1; phase 1)</td>
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<td>4</td>
<td>5 Fellows (year 2; phase 2) 5 Fellows (year 1; phase 2)</td>
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</tr>
<tr>
<td>5</td>
<td>5 Fellows (year 2; phase 3)</td>
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**Recruitment and Selection.** CBEE currently receives about 50 GK-12 qualifying applications for doctoral study in each year. To enrich the pool of qualified applicants with respect to interests in education, communication, etc., we will advertise the fellowship opportunities though relevant venues (e.g. American Society for Engineering Education), and personally recruit from schools with a strong emphasis in these characteristics (e.g. Purdue University). Students admitted under traditional selection criteria (GPA, letters of recommendation, personal statements, work and research history, and GRA scores) to the doctoral programs will be asked to apply to the GK-12 fellowship program. The GK-12 application (written statements, resumes, and letters of reference
focusing on teaching potential) will include assessment of the applicant’s commitment to education, social maturity, demonstrated outreach, teaching, and community involvement.

**Organization, Management and Institutional Commitment.** CBEE combines the ABET accredited undergraduate engineering programs of Chemical, Bio-, and Environmental Engineering, and graduate programs in Chemical and Environmental Engineering. This unique pairing of the three science-based engineering disciplines results in improved collaboration, synergy and systems understanding for faculty and students alike. The research efforts in the school can be classified into three categories: (1) biomaterials and bioprocesses, (2) environmental processes, and (3) microtechnology, microelectronics, and nanotechnology. Research thrust area leaders (Drs. Chang, Jovanovic, McGuire, Rorrer and Semprini) will facilitate placement of fellows with appropriate advisors and projects. Samples of research projects in the school (Table 2) illustrate that there is appropriate depth and breadth of funded research in the school to accommodate the proposed 20 fellows and are projects from which new virtual laboratories can be developed.

### Table 2. Samples of funded research projects in CBEE

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<thead>
<tr>
<th>Biomaterials and Bioprocesses</th>
<th>Environmental Processes</th>
<th>Micro- and Nanotechnology</th>
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<tbody>
<tr>
<td>Synergies between Enzymes in the Bioconversion to Ethanol (DOT)</td>
<td>Global Transcriptional Responses in Nitrogen Cycling and Nutrient Removal Processes (NSF)</td>
<td>Implement. of Sustainable Energy Related Processes in Microstructured Reactors (NSF, Career)</td>
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**Evaluation.** The Northwest Regional Educational Laboratory (NWREL) will collaborate to provide the evaluation for the project. The assessment and evaluation will be led by Dr. Edith Gummer, who is also involved in this role for the two NSF-CCLI virtual laboratory grants. Assessment efforts will be focused on evaluating the conceptual objectives of the project: developing fellow’s skills, enriching high school teachers’ knowledge and teaching portfolios, and compelling delivery of experimental learning and discipline content to high school students.

**List of Faculty Participants (not including PI/Co-PI).** Chih-hung (Alex) Chang (CBEE); Goran N. Jovanovic (CBEE); Joseph McGuire (CBEE); Gregory L. Rorrer (CBEE); Lewis Semprini (CBEE); Edith Gummer (NWREL); Adam Kirsch (CVHS).

**School District Involvement.** As part of the current CCLI virtual Laboratory project, the Virtual CVD laboratory is being implemented Spring 2008 in a pilot program at CVHS. A two-day workshop will be held at Oregon State University on August 6-7, 2008 with ten high school teachers attending. Adam Kirsch the high school science teacher implementing the Virtual CVD laboratory at VCVHS in Spring 2008 is serving as high school coordinator for the workshop. In the GK-12 project, five of the ten participants from the (CCLI) workshop will selected to host GK-12 fellows. A second workshop, funded by this project, will be held in the summer after Project Year 2, from which High Schools 6-10 (see Table 1) will be selected.
Letter of Intent -- 2008 GK-12 Solicitation

Project: *Sustainable Engineering and Global Science (SEGS) in K-12 Schools and Community Outreach*

**PI** Skip Rochefort, School of Chemical, Biological, and Environmental Engineering (CBEE, COE) and Director, OSU Precollege Programs

**Co-PIs:** Janine Trempy (COS); Dan Arp, Botany and Plant Pathology (COS, CAS, University Honors College); Lew Semprini, CBEE (COE) and Subsurface Biosphere Initiative; Bob Duncan (COAS); Dan Cox, O.H. Hinsdale Wave Research Lab (COE).

**STEM Faculty advisors and departments involved:** COE, COS, CAS, COAS, SMED

See below for complete list of participants.

**Number of STEM graduate fellows per year:** Ten (10) graduate fellows per year, with 2-3 mentor fellows staying for more than one year as their program of study permits.

**Number of K-12 classes anticipated to be served per year:** 40 – 50 per year (typically 4 classes per day per teacher with content introduced in each classroom).

**Number of K-12 teachers working with the fellows per year:** 10 teachers per year. Same teachers for first 3 years (if possible), with Master Teachers from this group (5) working with new teachers as the program is expanded throughout Oregon and in the last two years.

**School District Partners:** Corvallis; Albany; Philomath; Lebanon; Sweet Home; Lincoln (Siletz Charter & Early College High School) until year 3. Recruit teachers from outside these districts (Portland and central/eastern Oregon) for years 4 and 5 to provide national model.

**Target Audience of the Project** Middle School and High School classrooms; K-grey through community outreach programs.

**Setting** Urban, suburban and rural

**NSF supported disciplines or theme(s) involved:** Science, Math, Engineering, and Technology
PROJECT DESCRIPTION

Goals and Objectives
We propose to develop and implement a model (SEGS: Sustainable Engineering and Global Science) with a focus on engaged learning experiences about sustainability. In this model, graduate students, in collaboration with faculty, and working directly with classroom teachers, will use educational best practices to develop a “suite” of STEM-based learning modules on sustainability that cross all disciplines and could be implemented in both middle and high schools, and community outreach. Once developed and implemented, it is envisioned that these modules would evolve to meet the changing sustainability landscape, with the goal of bringing the most recent social, environmental, and technological developments into the classrooms.

The long term goal for the proposed SEGS Model would be that the STEM-based learning modules on sustainability become an integral component of the schools and school district programs, meet the state and national standards for STEM education in middle and high schools, and become available nationwide to establish OSU as a leader in K-12 sustainability education and outreach.

Project Plan
Given that the issue of sustainability and sustainable practices is highly cross-disciplinary, and that OSU is a national leader in many of these areas such as water issues and alternative energy, we have sought to involve faculty and graduate students from a wide range of Colleges, Departments, and Centers in this GK-12 program. The classroom implementation will be carried out by a graduate student under the guidance of a faculty mentor, teamed with a grade 6-12 classroom teacher. Initially, we will recruit a group (10) of experienced grade 6-12 teachers from each of the school districts (we have an extensive list of contacts from previous GK-12 programs by Arp, Rochefort, and Rao), and work with them for a period of three years. In years 4 and 5 we will move to new school districts and teachers, retaining half of the original group as Master Teachers to assist with the training of the new teachers. The focus of the last two years will be to demonstrate portability and sustainability of the project concepts (learning modules). We will partner with NSTA for distribution through their network.

In the initial 3 year period a series of classroom tested “learning modules” would be developed (similar to Foss kit idea) in the various STEM fields, with a focus on sustainability issues. GK-12 Fellows would not be assigned to a specific teacher/school for an entire year, but would work initially with a teacher/school to develop a self-contained learning module (probably 5-15 class hours of module time) that the teacher could integrate into their normal school-year program. The Fellow would then move to another teacher/school to deliver that same module. The most important component of this plan, which is completely aligned with the greater goals of the GK-12 program, is that the GK-12 Fellows would initially deliver these modules in the classroom with the teacher as a partner, such that when the Fellow moves out of the classroom, the teacher has the knowledge, tools, desire, and capability to continue to use that learning module in future years. In the process, the teacher acts as a mentor for the GK-12 Fellow in the skills and attributes needed for successful interaction with K-12 students. In this model, the GK-12 Fellows can be considered as consultants, in which they work with the client (teacher/school), deliver a product to meet their needs (learning module), implement and train the teacher as needed, and then develop that module for worldwide dissemination through TeachEngineering.com. The teachers have the valuable and somewhat non-traditional role of both client and mentor.
It is envisioned that these "learning modules" could be tied to state and national standards with the help of the TeachEngineering.com group (http://www.teachengineering.com/), which is promoted as a repository for teaching materials by the NSF GK-12 Directorate. We have worked with Rene Reitsma in the OSU College of Business for several years to foster this collaboration and begin the process of joining this ever-expanding international learning community.

**Expected and Measurable Outcomes**

The educational best practices implemented in the SEGS Model include: 1) learning environments that promote inclusion, reciprocity and cooperation, 2) opportunities to be part of small group learning activities focused on both discovery and application based learning, 3) implementation of pedagogy that honors diverse ways of learning, and 4) high expectations for student success.

As a result of the proposed activities, OSU will:

1. Design, construct and employ STEM-based learning modules on sustainability,
2. Prepare and train graduate students to incorporate their research into curricula for middle and high school students using educational best practices,
3. Create educational environments that improve communication, teaching and team building skills for the GK12 fellows.
4. Assemble innovative professional opportunities for middle and high school teachers to learn how cutting edge research in the areas of sustainability can be integrated with educational best practices to engage students in the learning process.
5. Enrich learning environments for middle and high school students with the use of educational best practices that prepare them for success in college STEM disciplines as well as STEM based careers.
6. Build on existing partnerships and create new partnerships between institutions of higher education and local school districts.

**Community Outreach**

As an outgrowth of this effort we propose to incorporate STEM-based learning modules on sustainability into free-choice learning environments through community outreach activities. STEM undergraduates from the pool of dual-degree majors, College of Engineering and Science Ambassador programs, and the extensive volunteer network in COE and COS would be recruited to volunteer for outreach activities under the guidance of the GK-12 fellows and GK-12 faculty. This model has already been sustained from a previous GK-12 funded activity in the form of Family Science and Engineering Nights, Intel ISEF State Science Fairs, and Discovery Days community outreaches, which reach 8000 – 10,000 K-12 age children and their families each year in informal learning environments (school gymnasiums and similar venues). The recent Corvallis Town Hall meeting that drew hundreds of people leads us to believe that communities are “hungry” for information and activities on sustainable living topics, and we will partner with these groups to leverage the resources and activities developed in the classrooms to make them available to the entire community.

**Assessment and Evaluation Plan**

An Evaluation Plan will be implemented by an individual who has discipline familiarity with the proposed effort but who is not participating directly in the training of GK12 Fellows, the development of modules or the transfer of modules to the middle and high schools. This Evaluation Plan will be both formative and summative. Specific and measurable outcomes have been proposed and are described in this pre-proposal. If selected to develop a full proposal, then an Evaluation Plan (consisting of Project Description, Evaluation Overview, Evaluation
Design, and Data Analysis Plan) will be developed, in consultation with OSU’s Assessment Office, and an individual to implement the Evaluation Plan will be identified. Janine Trempy, who developed and administers the assessment process for all College of Science units, has received NSF sponsored training in developing and implementing Evaluation Plans for assessing outcomes in educational efforts such as CCLI proposals. Thus, she is qualified to oversee, in consultation with the project PI and Co-PIs and partners, the development of the Evaluation Plan, using NSF suggested guidelines. An independent assessor will be identified to implement the Evaluation Plan.

**Recruitment and Selection of Fellows and Teachers**

Given the experience of the PI and Co-PI’s with past GK-12 programs, K-12 outreach, and the large number of affiliated faculty to serve as liaisons, it is not envisioned that recruitment of students to the GK-12 program will be an issue. Rather, what has been learned from past GK-12 experiences is that selection and training (in education practices) of the Fellows, selection of the teachers, and the eventual partnering of these two somewhat disparate groups is the absolute key to success of the program. We have years of experience (successes and failures!) with this and feel that our collective “history” will serve us well as we move forward in this process.

**Faculty Participants and Partners**

Representatives of the proposed partnerships are listed below and more may be added:

- **COE** – Skip Rochefort (School of Chemical, Biological, and Environmental Engineering (CBEE); Director of Precollege Programs; COSEY Outreach Center Co-Director; past GK-12 co-PI); Lew Semprini (CBEE and Subsurface Biosphere Initiative); Michelle Bothwell (CBEE, engineering and environmental ethics); Hong Liu, Biological and Ecological Engineering (BEE); Roger Ely, BEE; Dan Cox (School of Civil and Construction Engineering Management, Director, Hinsdale Wave Research Laboratory); Alicia-Lyman Holt (Outreach Coordinator, HWRL); Ellen Momsen (WME Director and COE Ambassadors)

- **COS** - Janine Trempy (Associate Dean for Student Engagement/Assessment/Outreach in the College Science, COSEY Outreach Center Co-Director,); Dan Arp (Botany and Plant Pathology, Subsurface Biosphere Initiative, and Dean of UHC), Margie Haak (Coordinator of COS Outreach and COS Ambassadors), SMED (Free Choice Learning Faculty), SEPS (Kari VanZee, Coordinator of K-12 outreach and teacher training), Geosciences (Roger Nielsen), Martin Schuster (Environmental Microbiology)

- **COAS** – Bob Duncan (Associate Dean) and COAS faculty to be determined.

- **CAS** – Dan Arp (Botany and Plant Pathology, UHC Dean, and Subsurface Biosphere Initiative and past GK-12 PI), Dan Edge (Chair of Fisheries and Wildlife), Jerri Bartholomew (Director of the Salmon Disease Lab), Sujaya Rao (Crop and Soil Science and past GK-12 PI)

- **COB** - Rene Reitsma (TeachEngineering.com -- Module national deployment)

- **CLA** – Denise Lach (Sociology Dept. and Water Resources Institute)

- **Outreach and Engagement** - Tryna Luton (K-12 online and Siletz Academy partner); Roger Rennenkamp (Director, Extension 4H Youth Development); Mario Magana (4H Latino Youth Development Coordinator).

**OSU Centers:** Institute for Water and Watersheds (Dr. Todd Jarvis, Associate Director); Hatfield Marine Science Center and Marine Science Program (Sean Rowe); ONAMI (Skip Rung, CEO); BEST (The Built Environment and Sustainable Technologies Research Center, Dr. Ken Williamson); O.H. Hinsdale Wave Research Laboratory and HWRL/NSF NEES Tsunami Facility (Dan Cox, Director)

**Community Partners:** ASOSU - Student Sustainability Initiative and Center; Corvallis Sustainability Coalition
Additional information that was not required for LOI but provides some insight into how the GK-12 program will be operated.

**BUDGET** (rough draft per YEAR): $600,000 yr x 5 years = $3 million
- Graduate Students (10/yr @ $40,500 total) = $405,000
- Teachers (10/yr @ $4500) $45,000
  - *sub-total* (stipend and cost of education funds – indirect costs) = $450,000
- Coordinator (0.5 FTE – salary + OPE) = $40,000
- PI (1 mo salary + OPE) = $10,000
- Evaluation and Assessment: $15,000/yr
- Supplies (for learning modules and outreach): $20,000-$40,000/yr (fluctuates by cycle of development of modules)
- Summer Teacher Workshops: $25,000
- Travel to NSF and meetings, etc.
  - *Total = $600,000*