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FINAL CCLI COV REPORT
FY 2009 NSF COMMITTEE OF VISITORS (COV) REVIEW

Guidance to NSF Staff: This document is the FY 2009 CCLI NSF Committee of Visitors Final Report of the CCLI Program. The COV followed the specific guidance for the COV review process as described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) at <www.inside.nsf.gov/od/oia/cov>.

FY 2009 CCLI REPORT FOR
NSF COMMITTEES OF VISITORS (COVs)

The NSF Program Staff completed this table.

Date of COV: September 24-25, 2009
Program/Cluster/Section: Course, Curriculum, and Laboratory Improvement (CCLI) Program
Division: Division of Undergraduate Education (DUE)
Directorate: Education and Human Resources Directorate
Number of actions reviewed: **Awards:** 34 **Declinations:** 36 **Other:** 0
Total number of actions within Program/Cluster/Division during period under review: **Awards:** 935 **Declinations:** 2,823 **Other:** 42
Manner in which reviewed actions were selected: Proposals from each phase (Phase 1, Phase 2, and Phase 3) were sorted by proposal number into their fiscal year of funding (there were three years of funding) with awards and declines put into separate categories. This resulted in essentially 9 different cells for awards and 9 for declines. The top and bottom two proposals on the list (sorted by proposal identification number) were selected in each category, resulting in 36 awards and 36 declines. However, two randomly selected awards were removed from the declination list due to conflicts of interest. Only proposals submitted for the regular competition were included in the sort. Special projects were not included. This selection method produced a sort representing all disciplines and multiple institution types, including minority serving institutions, and was accepted by the Chair of the COV, Marcia Linn.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? **Comments:** The panel review system that has evolved for CCLI (advance reading and rating by individual reviewers followed by panel ranking into categories) seems a fair and efficient method. The COV learned that the budget for CCLI travel is insufficient to support more than a few site visits. We applaud the efforts of program officers to include visits to projects in conjunction with other trips. Visits to Phase III projects seem especially valuable.	YES
2. Are both merit review criteria addressed a) In individual reviews? Though not universally, most reviewers appear to have addressed both criteria. In proposals receiving awards the reviewers clearly brought out the intellectual merits of the proposals and evaluated BI. The educational nature of the CCLI program sometimes blurs the distinction between the criteria (i.e. an intellectually meritorious proposal in education is expected to have a broader impact). Educational innovations that are successful will also impact a broader segment of the population. b) In panel summaries? The summaries always address both criteria. The	YES

[1] If "Not Applicable" please explain why in the "Comments" section.

comments under IM are typically about project logistics and evaluation (e.g. #0618445); comments about BI are typically about outreach and dissemination. As expected the impacts of proposals are more substantial for Phase 3 than for Phase 1 proposals **(e.g. #08117625).** c) In Program Officer review analyses? In all proposals reviewed by the panel the PO review analyses were clear and addressed both criteria. In cases where the proposals appeared to have merit but were not competitive in their present form, the correspondence from the PO to the PI addressed the evaluation of the panel, and the comments made by the panel could help the PI prepare a more competitive proposal. **Comments:** DUE - #0737553 –This declination addressed both criteria. In fact the broader impact criteria were clearly present. The reviewers pointed out that this regional university could serve as a resource to the surrounding community, and awarding this grant to the university would have served to greatly increase STEM education in the region. In spite of the obvious and positive impact that this grant would have on the region, the proposal lacked intellectual merit and the reviewers came to the conclusion that the proposal did not describe enough scientific and pedagogical detail to support it. The PO addressed the concerns of the panel and declined the proposal. In looking at the history of the proposers (and there were three of them), none of them has been successful in obtaining an NSF grant. The PO advised the proposers to read over the reviewer comments and consider resubmitting. DUE - #0737533 The reviewers addressed both criteria finding compelling presentation of intellectual ideas and evidence of the PI's awareness of the STEM knowledge base that supported development of the proposed ideas. The proposal clearly spelled out the broader impacts, and reviewers commented on the PI's novel idea about including citizenship in the development of new courses. The reviewers felt this well thought out proposal clearly incorporated learning strategies in the course development and cited this proposal as an "excellent example of best-practice in course development, in addition to providing web-accessible course resources," thereby serving as a model for other projects.	
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? **Comments:** DUE - #0737553 The reviews seemed to have consensus about the lack of detail presented and concluded that this proposal was not competitive. DUE - #0737533 Reviewers reached consensus as to the quality and innovation of this proposal and substantiated their opinions. As one panelist put it, "the proposed project starts with sound science, adds active learning, and incorporates development of supporting literacies -- fundamental skills necessary for students to grasp concepts in a timely manner."	YES

Although the process varies by proposal, most CCLI reviewers attempted to provide substantive comments per the Reviewer Instructions. In a few cases reviewer comments appear to ignore instructions and summarized the proposed work rather than give reasons for the rating. Among awarded proposals, reviewers point out the intellectual merits and address BI. Reviewers gave substantive comments on non-competitive proposals and sometimes suggested ideas that would make the proposal more competitive. The COV recommends providing mentoring for new panelists along with providing them with examples of exemplary reviews.	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? **Comments:** The panel summaries included the rationale when consensus was reached. In some cases the summaries more fully explained reasons (e.g. declined proposals such as #0737555, #0817135) than others (e.g. funded proposals such as #0717905). When panelists disagreed (ratings from F to E), they summarized opposing arguments, although it was not always clear if "some panelists" represented a single dissenting view or a split panel. Phase 3 proposals, which typically had >12 reviewers, especially depict this split. Summaries were more substantive for funded projects and for those on the cusp than for those with consistent low ratings. Considering program manager work loads this variation seems appropriate. Panel summaries sometimes appear vague when the positive and negative comments are part of one large paragraph. An example of this type of summary appears in DUE - #0737553. The COV prefers a summary format that describes strengths and weaknesses in different sections. DUE - #0737533 reflects reviews that were all very positive; the panel summary validates these reviews.	YES

5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) **Comments:** The documentation in the jacket includes the complete set of RANKING rationale from individual reviews, panel summaries, and program officer Review Analysis. As expected, the impact of budget constraints or allocation policies on FUNDING DECISIONS is not always documented in individual jackets. The efforts to overcome budget constraints were available in cases where the program officer employed co-funding opportunities for successful awards. (e.g. #0618185). The COV appreciated clarification from program offices about the response to budget constraints. DUE - #0737553 Yes	YES
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) **Comments:** See #5 above. DUE - #0737553 provides a clear and encouraging rationale. DUE - #0737533 describes a situation where the panel expressed concerns and the PO asked for clarification of them. The proposal award followed once the PI supplied the clarification, and after some additional budget negotiations. The COV suggests gathering information about resubmitted proposals following program officer mentoring.	YES
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once	YES

the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. **Comments:** The dwell time data reviewed by the COV confirms the program's success of meeting NSF's performance goal "70% in 6 months" for all proposals in the period of review. NSF staff explained that the increase in *long* dwell time for Phase 1 awards is likely explained by delays caused by PIs attaining IRB approval.	
8. Additional comments on the quality and effectiveness of the program's use of merit review process: The merit review process is working well for the CCLI program. Reviewers are now well aware of the IM/BI criteria and provide informative and useful feedback to PIs. The COV found little evidence of involvement in important program decisions regarding funding allocation (by discipline, by education level, by topic) in the community as represented by reviewers. See Section A3. The COV commends program staff for the increasing efficiencies in proposal review.	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:** The COV applauds the outstanding success of the CCLI program officers in reviewer selections that result in truly diverse and highly talented review panels. Clearly, the CCLI program officers make a careful effort to create a panel of reviewers whose expertise and background match the discipline and scope of the proposal. For example, the design of a proposed study entitled	YES

[2] If "Not Applicable" please explain why in the "Comments" section.

Impact Of Professional Development Programs On Future Stem Faculty, project # 0817537, explores a critical juncture of graduate and undergraduate education: the preparation of future faculty for their pivotal role as teachers of undergraduates who will become the next generation of scientists, engineers, mathematicians, and science and math teachers. Such a proposed study requires not only reviewers having STEM expertise but also education and interdisciplinary specialists. The panel of reviewers for this project included eight STEM experts from universities, one STEM expert at the community college level, one with expertise in Interdisciplinary Research, one from a College of Education, one Center for Learning specialist, and one from Psychology.	
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, and based on anonymous, voluntary information gathered at the start of each panel. Report rates exceeded 95% for each year and phase. **Comments:** The makeup of review teams included individuals spanning a variety of institutions, including two-year, four-year, minority-serving, large and small, public and private, as well as geographic diversity. Approximately 67% of the reviewers came from public institutions, 26% from private institutions, 3% from industry or government and 3% from other categories. For Phase I, slightly over half (52%) of the institutions highest degree awarded are Ph.D.s, 18% masters, 18% bachelors. For Phase II and III, the percentage of doctoral degree awarding institutions increased, approximately 60% for Phase II. Based on those who reported, 60% of the reviewers were male, 40% female, and 16% were minority. Geographically, 36% came from the south, 20% from the northeast, 24% from the north central region and 20% from the west. These results are based on tables in Book 1: 3.2, a-e (Phase 1), and 5.2, a-3 (Phases 2 and 3).	YES
3. Did the program recognize and resolve conflicts of interest when appropriate? **Comments:** We found that, in most cases, panel members have no conflict of interest with proposals assigned to their panel. Program management maintains a list of reviewers who claimed a conflict of interest, correlated to the review panel ID#, the reviewer's name, the proposal ID and the proposal's institution. (See Book II, A.5, B.5, and C.5.) As a result, most, although not all, of the review analysis documents	YES

addressed the issue of conflicts-of-interest.	
4. Additional comments on reviewer selection: None noted.	

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. **Comments:** The program focuses on high quality research and education. The ratings of reviewers for awarded projects, and the efforts of the program officers to refine proposals and improve quality reflect the impressive quality of the proposals. We commend program officers for shaping projects that are not fully compatible to reduce budgets and allocate funds to appropriate activities. Example. #0618400 - MIT Haystack Observatory and 2 community colleges. This project requested a Phase 2 with a budget more compatible with Phase 3. The program officers from three programs worked to find a way to provide sufficient funds to support a transition to a sustainable model. The focus on the telescope and independent research projects rather than providing guidance for students and instructors is not directly consistent with Phase 2 [or 3], so the decision was appropriate. In addition, panel review summaries of specific declines reflect a commitment to high standards: Example Proposal # 081040 - The investigators reference the work of Gardner on page one of their proposal. That work already provides a set of compelling factors that influence innovation adoption. It is not clear that the proposed work would enable greater specificity or granularity of	APPROPRIATE

[3] If "Not Appropriate" please explain why in the "Comments" section.

rationales among institutions. The panel suggested that the investigators consider submitting a very significantly scaled back proposal, perhaps just from the lead institution, of more limited scope as a more appropriate first step. The scope might include selective surveys from sets of institutions with differing environments and missions as well as a case study approach. **Commitment to multidisciplinary projects and broadly useful technologies is well established:** Example of broadly useful technology: significant educational technology innovations and software extensions that enable the ASU award-winning online software Java-Digital Signal Processing (J-DSP) to be used in multiple disciplines including digital signal processing, earth systems and geology, renewable energy systems, arts and media, ion-channel systems, and genomics. See Inventions and Impact 2: Building Excellence in Undergraduate Science: Technology, Engineering and Mathematics (STEM) Education; A Conference of CCLI Programs, National Science Foundation, Division of Undergraduate Education, 13-15 August, 2008, Washington, DC.	
2. Does the program portfolio promote the integration of research and education? **Comments:** Yes, this commitment is evident in proposals and in review summaries with a number of good examples. Proposers are learning in this area. Although no one would do research in chemistry without undertaking prior work in the field, the belief that prior work in education is important is still new to some potential award recipients. Example with educational theory #0717828 Kansas - This proposal describes an enhancement to a biology curriculum to make it more accessible to Native American and Alaskan Native students [indigenous people]. The proposers draw on constructivist learning theory and prepare students to conduct independent projects. Examples of good evaluation models found in the review of jackets: the requirement of a broad assessment of multidisciplinary practices across many universities (ASU); several workshops for training faculty to work with J-DSP and the associated teaching and assessment materials (ASU). The COV recommends continuing efforts to ensure that proposers reference leading-edge research to improve capabilities and facilitate course improvement.	APPROPRIATE
3. Are awards appropriate in size and duration for the scope of the projects? **Comments:**	APPROPRIATE

Award size and duration appear to have been well tailored to the scope of the projects as reflected in negotiation of awards and supplements. The program is sensitive to the need to supplement awarded funds when additional activities can be effectively and efficiently implemented. [#613426]	
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? **Comments:** The number of innovative/potentially transformative projects is impressively high. These include both technological innovations as well as assessment (formative and summative) enhancements. The balance is appropriate. Innovation appears in many formats. During the period of our review the ratio of total award dollars of Phase 1 to Phase 2&3 was around 40%:60%. One approach is to respond to advances in the field and incorporate them into curriculum improvement. An example is #0942190 from the 2009 solicitation. This collaborative project targets a new direction in CS education: parallel processing and programming to take advantage of multiple processors. Another approach is to disseminate programs deemed effective to new users. Many projects focus on creating materials for other university users. The innovation here is to offer professional development at the university level. Here we address the question about the effectiveness of the approach. It would be advantageous to incorporate research from precollege into the expectations for these programs. Short workshops have not been successful for precollege and are likely to have similar disadvantages for college faculty. It is difficult to change an established teaching practice. Finding ways to monitor and support instructors who choose to experiment with new materials is desirable. In addition, adding research-based customizations has proven to be highly valuable as a mechanism to ensure effective use of new materials. New proposals could support this process of using evidence to customize materials. A third approach is to incorporate new technologies. Here the innovation is an advance that ideally would be coupled with innovative teaching strategies. Some proposals combine innovative technologies with effective use of web-based instruction. This area encourages more use of design and learning environments in delivery of instruction. Common LMS for university courses like Blackboard lack support for many innovative technologies.	APPROPRIATE

5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? **Comments:** The percent of interdisciplinary projects in Phase 1 has remained at approximately 10-11% over the three years; the percent in Phase 2 is almost double while those in Phase 3 are constant at 13%. Overall the percentages for multidisciplinary research seem appropriate. To increase the balance and success of the program portfolio, the COV suggests providing guidance to assist PIs in planning interdisciplinary proposals. Ideally the proportion of interdisciplinary projects in Phase 2 and Phase 3 would increase due to the need for more students trained to work across disciplinary boundaries.	APPROPRIATE

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? **Comments:** Yes. Summaries provided by the program show appropriate balance by institution type as shown in Tables 3.7.3, 4.7.3 and 5.7.3.	APPROPRIATE
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. **Comments:** The COV found an impressively high rate of proposal submissions from	APPROPRIATE

investigators new to NSF each year. Total numbers have remained constant for the past three years at about 100 new investigators submitting. We commend the program on the impressive increase in the number of projects from new investigators that have been funded. This number has tripled from a level of 12% in 2006 to 34% in 2008. Figure 4.8.	
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? **Comments:** The distribution includes proposers for almost every state. See 3.7.1 for Phase I. Our review showed considerable variability in number of proposals submitted and number of awards by state. This variability appears to reflect in part the size of state population. Program officers work to increase the number of submissions by states that have few submissions.	APPROPRIATE
9. Does the program portfolio have an appropriate balance of: • Institutional types? **Comments:** The distribution by institution type has changed over the last 3 years (Figure 4.7.3). We are pleased to see that the community college level has increased five fold [although only to 5% total]. The doctorate level institution has decreased from 72% to 63%. In addition, collaborators in collaborative projects include many additional community colleges. This involvement is partially due to the new incentive for including such groups.	APPROPRIATE
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? **Comments:** The distribution is reasonable. (See 2.5.2 and 4.7.2.) First, the funding rates are similar across disciplines with appropriate annual fluctuations.	APPROPRIATE

Second, Engineering and Computer Science have submitted more proposals than other disciplines and therefore a higher proportion of funded proposals Example #0535580 - LSU Cogeneration technology integrated into undergraduate chemical and mechanical engineering curriculum. The project was able to implement and revise the modules several times during the grant period. The feedback from students influenced the revisions. At the second revision, the proposers drew on educational research to scaffold learners and focus their attention. The funding of interdisciplinary projects is commendable and high. The COV feels the program would further benefit from additional resources aimed at technical support to enhance evaluation and to conduct longitudinal studies of program effectiveness.	
11. Does the program portfolio have appropriate participation of underrepresented groups? **Comments:** A significant number of MSIs and HSIs are among the institutions receiving funding from the program. There are more male than female PIs submitting proposals by a ratio of about 3 to 1. The PIs are about 75% Caucasian. There are about 18% Asian PIs. Other groups have small numbers of PIs. The rate of funding among diverse groups is reasonably similar. Notably, the rate of funding for groups with a small number of submitting PIs (African American, Hispanic, and American Indian) has increased in the aggregate. The numbers are too small to be sure of a trend. In addition, (see 3.6.2) awards targeted to women, minorities, and preservice teachers have at least doubled over the period. We commend the program for enhancing course improvement opportunities for these populations. The COV recommends finding ways to increase the number of proposed activities that focus on broadening participation in STEM disciplines, especially among women and minorities.	APPROPRIATE
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. **Comments:** Yes.	APPROPRIATE

National Science Board, *The Science and Engineering Workforce: Realizing America's Potential*, National Science Foundation, August 14, 2003.

Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology,
Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies, Washington, D.C.: National Academies Press, 2007.

Richard A. Duschl, Heidi A. Schweingruber, and Andrew W. Shouse (eds.), *Taking Science to School: Learning and Teaching Science in Grades K – 8*, Washington, D.C.: National Academies Press, 2007.

Reach Higher, American: Overcoming Crisis in the US Workforce
NIGMS: Modeling Scientific Workshop Diversity

Grigg, W., Lauko, M., & Brockway, D. (2006). *The Nation's Report Card: Science 2005 (NCES 2006-466)*. Washington, DC: U.S. Government Printing Office.

In addition to these citations, a number of other reports address specific disciplines. For example:

AAAS: Workforce Development: Preparing the Next Generation against Infectious Disease Threats.

13. Additional comments on the quality of the projects or the balance of the portfolio:

None noted.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

Despite the relatively small number of Program Officers, the program appears to be managed very well. The jackets we reviewed gave adequate attention to all requirements. The well-constructed panels include representation from a wide variety of institutional types, paying attention to size, Carnegie classification, minority serving, 2 and 4 year, etc. The program adjusted, based on analysis of the needs and state of undergraduate STEM education, to replace program tracks with the phases of project development. Program management addressed the

need to increase and improve project evaluation, and worked successfully to increase the capacity of institutions to evaluate project performance.

The COV commends Program Officers for what appears to be an extremely well run program. Book 1 outstandingly presents data on publications, panel composition, geographical distribution, etc. in easy to read format. The jackets are comprehensive and include "behind the scenes" correspondences which further demonstrate the support provided by the Program Officers. The program solicitations have evolved to better align with objectives and provide support to improve the quality of proposals and the outcomes of funded proposals. The current program monitoring system is undergoing redesign by the firm, ICF Macro. The new program monitoring system will include a common set of items to ascertain how effectively program goals are being met. The COV suggests developing a method of longitudinally measuring the impacts of grants well beyond the funding period (say five and ten years later) to strengthen understanding of the effectiveness of the program.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

The CCLI program responded to an analysis of the state of undergraduate education by raising standards on evaluation and more clearly delineating strategies. The COV found evidence of program officers asking guiding questions during the negotiation stage to help the PI develop an evaluation plan (DUE #0618872/DUE #0739423 – Washington State University, Bernard J Van Wie, PI). Positive outcomes appear in the 2007-08 annual report which contained the negotiated assessment surveys and outcomes. The work resulted in several publications.

The program staff members appear very responsive to emerging research and education opportunities. The program held retreats to identify and discuss response to emerging issues and concerns, and subsequently made adjustments based on analysis of the needs and state of undergraduate STEM education, to replace the old program tracks with the current phases of project development.

The COV suggests the program could benefit from increased funding to support the program's priorities.

A specific example of responsiveness to education opportunities is found in Proposal #0717874: Biological Sciences (61). This project is developing a five-course curriculum in indigenous science focused on the needs of Native American and Alaska Native students seeking careers in STEM disciplines, especially biology and environmental science. Courses at three of the mainstream institutions with the highest number of Native American undergraduate and graduate students in the country are being enhanced by the development of web-based interactive applications, which are helping to compensate for the lack of published textbooks in the field, as well as by distance-delivery technology that is allowing faculty to provide lectures and discussions for courses offered at other institutions. Assessment of student progress and evaluation of project objectives addresses course content as well as cultural context and sensitivity. A long-term goal is to disseminate the curricular materials to programs at tribal colleges and universities and at mainstream institutions with interest in Indigenous science, as well as to programs training tribal environmental professionals, resource management agency personnel, and communities.

DUE – #0737533 – The project's creation of a new integrated science course entitled *Global*

Sustainability will prepare students for their roles as active and effective citizens in an industrialized democracy. This course, which aims at both STEM and non-STEM students in the first and second years of their academic careers, will create connections to the social sciences by presenting science in global context.

In addition to integrating the natural sciences, i.e. biological, physical and Earth, the project will focus on improving student critical thinking and problem-solving skills." There have been four case studies developed: "The four case studies currently in our sustainability catalog are: *Water in Bangladesh: Tube Wells and Arsenic*; *Energy: Coal, China & Climate Change*; *Gold: Satisfying a Global Demand*; and *Energy: Petroleum – A Critical Resource*."

The program is responsive to emerging research and education opportunities, demonstrated by the evolving program solicitations and provides support of best practices in pedagogy, assessment of student learning, etc. Several proposals involved incorporating faculty research into the curriculum and co-funded initiatives in areas such as nanotechnology (Book 2 section A.2.7). One example of responsiveness to education opportunities: The CCLI program acted on an analysis of the state of undergraduate education by raising standards on evaluation and more clearly delineating strategies.

The COV found evidence for a few proposals in emerging areas including nanotechnology and climate change. Examples of integrating research into curriculum:

DUE - #0633490 – Authentic Research Experience in Microbiology, Muth, CUNY Brooklyn College

DUE - #0736872 – Teaching science with minnows and liverworts: Integration of faculty research and science education.

Good evidence that the program is responsive to emerging research can be found in such funded projects as #536501 Innovative Multi-disciplinary Nanoscience Experiments for Teaching Fundamentals in Science and Engineering; #536541 Interdisciplinary Nanoelectronics Laboratory for the Engineering/Science Undergraduate Curriculum; #633185 Integrating Nanotechnology and Its Environmental and Health Implications to Undergraduate Engineering Education; #737395 Collaborative: Bringing Nanotechnology into the Classroom: From a Doctoral Institution to Four and Two Year Colleges; #536694 Forging a New Path to Greater STEM Learning in General Education: Development and Evaluation of an Interdisciplinary, Problem-focused Core Curriculum on Earth Sustainability; #623539 IRES: US-Brazil International Research Experience for Students: Sustainability Research: An Integrative Undergraduate Experience; #736739 Collaborative Project: Development of Materials for Teaching Design for Sustainability via Spiral Learning; #535957 Greening the Chemistry Laboratory Curriculum; and #633227 Educating Green Citizens and Scientists for a Sustainable Future.

As noted in Section C the COV encourages the program to continue to strengthen the research base of proposals by emphasizing this requirement and encouraging proposers to see their contribution as part of a cumulative process of innovation.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

Internal analysis of the CCLI program led to the adjustment of program solicitations for the years 2006, 2007 and 2008 to more appropriately reflect and emphasize the importance of scope, size and state of maturity. As previously noted, solicitation required proposals to address the cyclic model of knowledge production and improvement of practice.

In addition, the program commissioned SRI International to design and conduct a descriptive study of the program portfolio focused on project evaluations that had been conducted or proposed for CCLI during the years 1999 through 2006. Based on this study and internal discussion, CCLI made adjustments to the program solicitation. Program staff also took steps to make technical assistance available to project staff (PIs and evaluators).

Planning and prioritization has guided the development of the portfolio, with evaluation becoming increasingly more important. One example: The grant writing workshops for faculty from minority serving institutions deserves praise. Could this program be expanded to community colleges? Program Officer Chang sponsored a pilot program in chemistry for community colleges, which seems like an excellent model.

On January 23, 2009, at FETC, the Partnership for 21st Century Skills released the 21st Century Learning Environments White Paper, which finds that successful learning environments break through the barriers that separate schools from the real world, educators from each other and policymakers from the communities they serve. While a tremendous amount of attention has been paid to standards, assessments, professional development, and curriculum and instruction, the paper notes that learning environments are an essential component to supporting positive 21st century outcomes for students. The report, sponsored by Cisco Systems, explains that the term 'learning environment' has traditionally suggested a concrete place but, in today's interconnected world, a learning environment can be virtual, online and remote. While the relationship of physical spaces and technological systems to learning continues to be ever important, even more important is how - and whether - these environments support the positive human relationships that matter most to learning, according to the report. The most essential element of all learning environments has always been the community of students, educators, parents, business and civic leaders, and policymakers that constitute the human resources of an education system, each of these constituents needing support in a 21st century context.

Silva, E. (2008). *Measuring skills for the 21st century*. Washington, DC: Education Sector. Available: www.educationsector.org/usr_doc/MeasuringSkills.pdf

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

Program Solicitation 07-543 which replaced NSF 06-536 underwent revision in response to the NSF FY 2006 core questions recommendation to articulate how the intellectual merit criteria are interpreted for undergraduate educational reform. “The fourth bullet now named Assessing Student Achievement has been redefined to include projects that design tools to measure the effectiveness of new materials and instructional methods, etc…” This is one example of the increased focus on evaluating student learning and effectiveness.

The FY 2006 report describes the limited allocation of travel funds for Program Officers. At $5500-$6000 per year this still seems to be the case. The COV recommends increasing the travel budget to allow for adequate outreach activities, site visits, and the opportunity to attend

scientific conferences. The report further points out that a small percentage of awards went to minority serving institutions. To address this shortfall, the program offered grant writing workshops and webinars. The funding rate for minority serving institutions has increased from 8% in FY 2006 to 30% in FY 2008 (COV Book 1 – 6.4.1).

Program officers are asking for more details on the evaluation. For example: #0736068 Johns Hopkins. This proposal to design laboratories that allow students to test and build electronic devices such as transistors originally lacked an evaluation plan. The PI enlisted the aid of the center for educational resources to generate a plan. Although the plan focuses primarily on qualitative analysis it is definitely an improvement over no evaluation. The main focus of the annual report is on how to make the laboratories more reproducible at other institutions. The report also summarizes the evaluation and notes that redesign is underway to increase outcomes. The COV recommends that projects focues on laboratories should be encouraged to take advantage of research on innovative laboratory practices [suchas tjhose in American's Lab Report] to increase student learning.

5. Additional comments on program management:

Although there was a slight increase in the budget in 2008, funding levels for this important program are still significantly below 2000-2005 levels. Experiences as panel reviewers indicate that confusion about the goals of the CCLI program continues – many submitters still seem to view an award as an equipment grant - and many of those that submit proposals still do not understand what constitutes a solid evaluation plan and who would qualify as an external evaluator.

PART B. RESULTS OF NSF INVESTMENTS

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The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship, although the COV does not review accomplishments under Stewardship.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

Comments:

The program has achieved success in advancing the frontier of knowledge. Critical fields such as nanotechnology, environmental protection and energy conservation have received special attention.

Examples of program success in achieving the goal for discovery are:

1. #0311052 – students in the US and Switzerland collaborated to improve heat recovery equipment.
2. #0126806 – students studied ecosystem-level processes through an interdisciplinary approach which resulted in an 80% increase in analytical skills and a 90% increase in learning (student self-assessment).
3. #0535560 – will integrate real time data and analysis from the newly constructed 25 MW cogeneration system into the chemical and mechanical engineering curricula. Data available via the web allow sophomore year engineering students to perform real world material and energy balance calculations on major unit operations including gas and steam turbines, air conditioning systems, cooling towers and boilers.
4. #0737533 – developed materials which could serve to engage students and promote scientific literacy.
5. #0618400 MIT Haystack Observatory and 2 community colleges. Students have made advances in radio astronomy.

The COV applauds the NSF CCLI program for its efforts to disseminate advances using a variety of vehicles including such initiatives as the National Science Digital Library (NSDL). Efforts to determine the effectiveness of the dissemination activities would be helpful.
These efforts should promote a culture of advancing scholarship built on previous knowledge.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments:

The success of the merit review process, as documented in section A has ensured the funding of "world class" CCLI projects. Furthermore, the review criteria and NSF efforts to inspire PIs to think about inclusivity have resulted in a broad range of funded CCLI projects that promote expanded diversity in the STEM workforce.

One example of a project targeted at cultivating a world-class, broadly inclusive science and engineering workforce is the Phase III project (#0813481) awarded to the American Association of Physics Teachers to train young faculty on recent advances in educational pedagogy and assist them with integrating the workshop material into their classrooms. Using this train-the-trainer approach assures broad impact at a variety of institutions.

A second example is the PHASE III PROJECT (#0817596) awarded to a team including Arizona State, Johns Hopkins, University of Washington-Bothell and Prairie View A&M to develop and deploy JAVA-DSP for use in On-Line Laboratories and Collaboration. The project is multidisciplinary and designed for use in K-12 outreach and undergraduate education with a focus on broadening participation in engineering.

Many CCLI projects seek to expand the scientific literacy of all citizens by providing help to teachers in improving their implementation of innovative teaching strategies. For example, the CATS (Community of Astronomy Teaching Scholars) project (#0715517) encompasses a far-reaching, community-building effort focused on stimulating, disseminating, and institutionalizing innovative and effective approaches to teaching and learning in the context of undergraduate physical science courses. These CCLI projects offer teachers workshops to learn how to integrate interactive learning

strategies for introductory astronomy courses.

The Phase I project (#0736271) awarded to Middlesex Community College is another excellent example of a project that has impact on a diverse student population through its focus on mathematics across the curriculum. Its focus on the developmental math courses and partnering of mathematics and non-mathematics courses and faculty enhances the opportunity for broad impact. Furthermore, the curricula and training will integrate cultural issues that impact daily life and the community.

A very high percentage of American undergraduates take only one or two science classes. Thus, in the CCLI context, it is conceivable to expect that the charge of expanding "the scientific literacy of all citizens" might lead to a particular programmatic focus on projects addressing this population. Certain individual projects focus on introductory courses. For example, the University of Hawaii's project (#0618690) inspires non-science majors through the topic of ethnobotany). University of Wyoming (#0737533) created a new course on sustainability for STEM and non-STEM majors. However, the disaggregated program data does not break out student impact *by course level*, so we cannot identify a particular programmatic focus on introductory courses.

The COV recommends making sure that a balance exists between learning and development of new technologies. Include findings of these balances in annual reports. See #0736068 Johns Hopkins where the project pushed learning but reported on development of projects.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

The CCLI program staff has worked diligently to encourage and stimulate investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools, inter alia, by giving presentations, writing papers, attending professional conferences, sponsoring workshops, and through awards to professional societies. Increased attention to cyberlearning, consistent with the NSF-wide effort to advance this area would be desirable. Examples of capability building include:

DUE - #0737533 The progress report appears to give evidence that the PO made the correct decision in terms of the quality of the science that was involved in this project. The material under development seems very interesting and capable of engaging students. The novelty of the project that reviewers found so compelling in their findings has materialized and has the potential for wider dissemination.

DUE - #0715039 This project had two project reports that made it possible to see progress being made from one year to the next. The reports appear to have been taken seriously by the PI and provide a good amount of detail about the activities. The proposal received funding because of its potential for increasing numeracy ability in students. The project is also collecting videos of student activity. This archive of student learning experiences has the potential for initiating future research on learning.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

BROADENING PARTICIPATION IN STEM: The COV commends the program for developing and hosting proposal writing workshops for community colleges and minority serving institutions. These workshops clearly have had a positive impact on the number and quality of proposals subsequently submitted and will ultimately assist in broadening participation in the stem disciplines. We encourage the program to expand these efforts, especially to institutions who serve diverse populations of students. Additionally, we suggest the program find ways to increase the number of project activities focused on broadening participation in the stem disciplines, and to get PIs to document how their intellectual contributions are broadening participation in the stem disciplines. Since the percentage of minority students at community colleges is substantial, increasing NSF funding at the community colleges for projects that serve to increase minority participation would be transformative.

INCREASING INNOVATION ACROSS THE UNIVERSITY: Developing faculty expertise is a key component of the cyclic model for knowledge production and improvement of practice in teaching and learning. However, evidence of transformations in faculty practices is low. A majority of instructors at the undergraduate level are still "talking heads." We encourage selection of innovative programs for training new members of the profession. A study by NCES (2002, pg. 209) reports that, in higher education, 83% of instructional faculty use lectures as the primary instructional method for undergraduate classes.

The COV suggests seeking better models for professional development. To increase effectiveness, proposers can build on successful programs from a wide range of professional development programs in precollege, industry, and university settings. Research suggests better results occur when instructors use evidence from success and failure to customize innovations. Drawing on findings which show that short, one-time, summer programs are generally ineffective, we encourage professional development efforts to create programs that provide mentoring and encouragement over a period of time, and support a process of iterative refinement.

We suggest asking projects offering faculty development workshops to track evidence showing that learning materials and teaching strategies (that have demonstrated success in their original contexts) have been disseminated to new educational settings or adopted more widely. Efforts to show that programs lead to change in instructor practices are essential. We would like to know whether changes in instructor practice also extend to changes in student learning. Many educational evaluation methods are available to investigate this important question including cohort comparison studies, studies of the efficiency of instruction, and dose-response studies.

EVALUATION RESEARCH: The COV feels the program would benefit from additional resources to support an effort to provide technical support for evaluation and to conduct longitudinal studies of program effectiveness. For example, one of the Program Officers discussed an email that had recently been received on the long-term impacts of the author's 1999 NSF DUE grant (#9980909), which included development of FirstGlance software. In February 2006 *Nature Structural and Molecular Biology* (http://www.nature.com/nsmb) began providing "3D view" links to FirstGlance in Jmol; and in December 2006, ACS Chemical Biology (http://moleculesinmotion.com) began providing "3D view" links to FirstGlance (open-source). It was just fortuitous that the NSF learned about this outcome since no mechanism currently exists to longitudinally track project outcomes.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

Travel

It is commendable that the travel budget for program officers has been increased to $6000 per year. Attending scientific conferences is not only important for program officers in order to keep abreast of the latest developments, but this presence also allows for significant interactions and conversations to occur between the scientific community and the programs officers. Site visits are sometimes necessary in order to evaluate and manage a complex portfolio of activities. The COV also noted that program officers are performing more outreach to community colleges and minority institutions. Just these three activities exhaust the budget available for program officers.

The COV recommends an increase in the travel budget. This increase would allow program officers to be more effective in managing their complex programs.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

We commend the CCLI program for emphasizing the importance of drawing on research in education when designing educational innovations, planning professional development, and planning evaluations. We note that the program officers often mentor proposers to add evaluation and design components that incorporate contemporary ideas about learning and instruction. We encourage the continuation and strengthening of this effort. We hope that new proposals will draw on findings from prior research on learning in the discipline being studied. We think that findings from related disciplines can often be helpful.

Ultimately we hope that the CCLI work will contribute to a progressing research program that has broad implications for college teaching. For example, many proposals address the challenge of making large undergraduate courses more relevant to the lives of students. It would be helpful to consolidate the results of these studies and ensure that the general findings have an impact on future projects. Programs such as REESE can fund this sort of work as can educational research studies in CCLI.

Similarly, many proposals seek to use new technologies, and to make laboratories or other active learning experiences more effective. A synthesis of work in this area, drawing broadly on upper level precollege and college experiences from earlier CCLI studies could strengthen these studies. Ultimately encouraging development and use of open-source learning environments would be effective.

In addition, research in education has developed a wide range of methods for determining whether programs are effective, including design research, case study methods, and powerful statistical procedures such as HLM or IRT. Compiling examples of how new research methods could be used in CCLI projects would enhance the opportunities for new proposals.

Program funding: the COV notes that the CCLI program funding, as represented in Figure 2.2, is still significantly (~20%) below its 2002 level. We note the number of submissions is now at or

above 2002 levels for CCLI. We suggest that the program could benefit from increased funding to accommodate the priorities identified in this report.

C.4. Please provide comments on any other issues the COV feels are relevant.

None noted

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

Throughout the entire COV review process, the CCLI program directors and staff members have been consistently and uniformly available to answer questions raised and provide information requested. The program directors' knowledge of the various projects and all aspects of the program is noteworthy. Their successful efforts to stay abreast of new and emerging issues, to promote and increase the capacity of the CCLI community, and to broaden participation in STEM education are impressive. They appear to support each other well and are pleasant and easy to work with professionals.

SIGNATURE BLOCK:

Marcia C. Linn

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For the Course, Curriculum & Laboratory Improvement (CCLI) COV
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Chair