CORE QUESTIONS and REPORT TEMPLATE
for
FY 2005 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2005 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2005. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at http://www.inside.nsf.gov/od/gpra/.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments in the form of outputs and outcomes that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. It is important to recognize that the reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions.

FY 2005 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

Date of COV:	April 21-22, 2005
Program/Cluster:	Instructional Materials Development (IMD) Program
Division:	Elementary, Secondary and Informal Education
Directorate:	Education and Human Resources
Number of actions reviewed by COV: Awards: 18 **Declinations:** 20 **Other:** 4	
Total number of actions within Program/Cluster/Division during period being reviewed by COV: **Awards:** 67 **Declinations:** 226 **Other:** Supplemental Awards 25, Declinations 9	
Manner in which reviewed actions were selected: The reviewed actions or proposal jackets were randomly selected at two levels. The IMD program officers used a random process to select the initial set of proposal jackets for review. COV members then randomly selected a set to review and analyze. Requests for other proposal jackets were provided by the IMD upon request.	

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 procedures. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) The IMD program's review process has been honed over several years and works well to identify important significant work. From the preliminary proposal process, through the *ad hoc* reviews and the negotiation of final awards, the COV found the process appropriate. Specifically, the COV found the documentation in the proposal jackets to be thorough and complete, and assessed the comments of the reviewers to be fair, impartial and substantive. Site visits were not observed or reviewed because of the limited travel funds for Program Officers. There are more meritorious proposals than available funding. This causes Program Officers to meet and select from among several well-reviewed proposals. Because this process is critical to the future of IMD materials, it is important that the collective make up (e.g. subject matter expertise, familiarity with various sectors of education, gender, race, and ethnicity) of the group of Program Officers	**Yes**

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

be adequately diverse. The COV noted, for example, that the current roster of Program Officers in IMD includes only one classroom teacher.	
2. Is the review process efficient and effective? The COV found the process to be efficient and generally effective. The preliminary proposal process is effective. Specifically, it was felt that the NSF FastLane process helps panelists review the work effectively. The COV noted several instances of confusing wording in the solicitations, for example within the Program Solicitation NSF 02-067 in Section II, Program Description, A. Instructional Materials for Students, Project Characteristics. In the first sentence in this section, the solicitation states, “Proposed instructional materials *must…*” whereas the second sentence of the second paragraphs states “These projects *should have* the potential to enhance student learning…” The Solicitation uses the words “should” and “must” in a manner that seems inconsistent and sometimes arbitrary. More consistent use of these words would focus the submitted proposals and would improve the effectiveness of the reviews. The COV also suggests that Program Officers carefully consider if they should fund proposals that do not address issues that the solicitation states must or should be addressed.	**In general, yes**
3. Are reviews consistent with priorities and criteria stated in the program’s solicitations, announcements, and guidelines? In general, the COV found reviews to be consistent with the priorities and criteria stated in the program’s materials. One example where the COV felt this was well addressed was found in a proposal on technology. This proposal included a matrix showing other IMD funded projects followed by how the technology-related proposal addresses a missing cell in the matrix. However, in other instances, the COV found that the rationale (included under the section titled “Additional Review Criteria”) for several proposals and how the proposed work related to previous work was either missing or weak. A greater emphasis must be placed on the articulation of a clear and compelling rationale in *each* proposal review. The IMD should work to encourage in all proposals greater clarity about the rationale and connection to other work. The Committee felt that the review mechanism would be improved by the creation of a checklist or template for reviewers to use to guide their comments and analyses. This would ensure that panelists were focused on key points that are requested in the program solicitations and would lend an element of uniformity to responses that would enhance coherence and comparability.	**Yes**
4. Do the individual reviews (either mail or panel) provide sufficient information for the Principal Investigator(s) to understand the basis for the reviewer’s recommendation? In general, yes. The COV noted improvement in the quality of this aspect in the more recent reviews.	**Yes**

5. Do the panel summaries provide sufficient information for the Principal Investigator(s) to understand the basis for the panel recommendation? In general, the COV felt that sufficient information was given to the Principal Investigator(s). To enhance this element of the review process, the COV suggests that comments given to the Principal Investigator(s) be prioritized and that comments include concrete specific details. Precision and clarity of language when commenting on key points is desired. In some instances, there seemed to be a random quality to the summaries, leading to an unclear sense of priorities for strengthening the proposed work. This could be addressed by following a specific format and making clear that comments are related to the key elements in the solicitation.	**Yes**
6. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? In general the COV found the documentation by Program Officers to be extensive, complete and solidly based on peer review comments. Generally, the communication between Principal Investigator(s) and Program Officers was impressive and particularly meritorious with regard to preliminary proposals. In one instance, however, a summary analysis stated that "No specific mention is made in the proposal of alternative strategies for achieving equity and outreach directed to areas with high minority or underserved populations" and then two paragraphs later the report noted "Broad impact is evident from the specific efforts to reach under-served populations." Clearly, recommendations and justifications need to follow from consistent and coherent statements in the reviews and summary analysis.	**Yes**
7. Is the time to decision appropriate? The average time to decision from 2002-2005 is appropriate and has improved toward 5 months as an acceptable time to decision. In instances where the panels determine that the proposal will not be funded, the NSF is urged to reduce this time even further. In instances where there is negotiation between the Program Officer and Principal Investigator(s), the time is understandably longer.	**Yes**

8. Discuss any issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures: As noted above, the COV is generally pleased with the work of the Program with regard to the quality and effectiveness of the merit review process. Suggestions to enhance this already strong program include the following (and have been noted above): - The use of a template and/or a checklist that is correlated to the program solicitation for reviewers and program officers would increase consistency in reviews and summaries. - Clarity in language in the program solicitation regarding 'should' and 'must' would enhance consistency in submitted proposals. - Greater emphasis on the delineation of a rationale for the proposed work and how it relates to other previous or current work in the field would enhance the quality and coherence of the proposal reviews and analysis. - Prioritization of comments and issues of concern in the summaries for Principal Investigator(s) would improve the quality of the feedback. - Shorten the response time when it is known that a proposal will not be funded.

A.2 Questions concerning the implementation of the NSF Merit Review Criteria (<u>intellectual merit</u> and <u>broader impacts</u>) by reviewers and Program Officers. Provide comments in the space below the question. Discuss issues or concerns in the space provided.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? The COV felt that, after October 2002, the individual reviews often addressed both merit criteria. Prior to this time, the individual reviews were less consistent in this regard. More specifically, the COV felt that all reviewers would benefit from a checklist offered by the Program Officers addressing specifically the intellectual merit and broader impact criteria. Intellectual merit seems to not be well understood by many reviewers and sometimes led to generic comments that did not specifically address intellectual merit.	**Yes**
2. Have the panel summaries addressed both merit review criteria? Again, after October 2002, the summaries addressed both merit review criteria. The COV found an excellent example of this (a declination).	**Yes**

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

3. Have the Review Analyses (Form 7s) addressed both merit review criteria? In general yes. A noteworthy example of the completion of Form 7s was found in one particular jacket. This review analysis provided evidence and well formulated logic for the elements in the project that met the key elements in both review criteria.	**Yes**
4. Discuss any issues the COV has identified with respect to implementation of NSF's merit review criteria. The COV felt that the proposal reviews were uneven at times and that the broader impact statements were weaker in general than those for intellectual merit. It seems that both reviewers and Program Officers lack a clear understanding of the broader impact criteria. As a result, many statements were overly general. Program Officers are encouraged to provide clear and explicit guidance to reviewers about the criteria for intellectual merit and its implications for a particular solicitation. The review process would be better served if reviewers were provided exemplars of broader impact and intellectual merit reviews.	

A.3 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[3]
1. Did the program make use of an adequate number of reviewers? The panel found that the IMD review panels contained an adequate number of reviewers. For example, the 7 review panels used in 2002 consisted of from 5 to 10 reviewers. In 2003, the 5 review panels consisted of from 7 to 10 reviewers.	**Yes**
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? The COV generally found an under representation in classroom teachers on review panels. In 2002, only 10 out of 30 reviewers were classroom teachers; in 2003, only 6 out of 26 were classroom teachers. In the review of one proposal, there were seven PhD's and no high school teachers on the panel.	**Not always**

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

3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? The panel found that the reviewers did reflect a reasonable balance among characteristics such as geography, type of institution, and underrepresented groups. For example, the geographic distribution of reviewers in the 2002 panels consisted of 18% from the south Atlantic coast states, 27% from the middle Atlantic coast states, 7% from New England, 33% from the Central and Mountain states, and 15% from the Pacific coast states. The 55 members of the 2002 panels consisted of 29 from universities and colleges, 1 from a community college, 13 from K-12 schools, 7 from non-profits, 2 from professional societies, and 3 with other affiliations, indicating reasonable institutional diversity. Gender balance was also evident: for example the 2002 panels consisted of 31 females and 24 males. Underrepresented groups were reasonably well represented in the 2002 panels, which consisted of 6 African-Americans, 7 Hispanics, 1 Asian, and 41 Whites. Finally, the 2002 panels consisted of 29 reviewers new to the process, indicating a good balance of new perspectives on the panels.	**Yes**
4. Did the program recognize and resolve conflicts of interest when appropriate? Conflicts of interest were appropriately and well handled.	**Yes**
5. Discuss any issues the COV has identified relevant to selection of reviewers. The COV did not consider there to be any major issues relevant to the selection of reviewers that required significant immediate attention. However, the COV would like IMD to pay attention to the following areas of concern: (1) It was noted that on the 2002 and 2003 panels, none of the panelists were from industry. Given that a secondary effect of the IMD is fostering the next generation of scientists, mathematicians, and engineers that enter the industrial workforce, industry representatives should provide input to the K-12 education of their future employees. (2) A balance between university professors and practicing K-12 teachers on panels should be ensured. (3) Engineers and technology professionals should be adequately represented on future panels, including science and mathematics panels. (4) Consideration needs to be given to a selection of panelists representing divergent points of view about mathematics and science education.	

A.4 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[4], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. The COV feels that the portfolio of projects supported by the program is good and has been improving during the period covered by this review. We urge the Foundation to develop projects in states not traditionally represented in the portfolio and also to include more technology based projects as a way to deepen understanding of this critical subject matter. We would also suggest a greater emphasis on literacy and cognitive science in the future.	**Appropriate**
2. Are awards appropriate in size and duration for the scope of the projects? The COV finds that overall the awards were of adequate duration and size for the various projects. A review of project files provided evidence that both the review panels and Program Officers provided PIs with appropriate and substantive comments about the scope of work, work plan, timeline as related to the timely completion of the work, the adequacy of the budget, and the personnel. When concerns were raised about the ability to carry out the proposed work in a timely fashion and with adequate funding, suggestions and modifications to the scale and scope of the work scaling were made to maximize the probability that high quality work could be completed in a timely manner. A deep and thorough analysis of all the funded proposals and final reports for FY 2002, FY2003 and FY 2004 was beyond the scope of the COV and duration of the visitation.	**Yes**
3. Does the program portfolio have an appropriate balance of: • **High-risk projects?** The COV found that the program portfolio contained an appropriate balance of high risk projects The COV identified the following exemplars of high risk projects funded between 2002 and 2004: *CENSNet: An Architecture for Authentic Web-Based Science Inquiry in Middle and High School* (ESI-0352572), *SGER: Connections Between Mathematics and Biology in the High Schools* (ESI-0421887), *Mathematics Through Technology and Internet Modules (MTTIM)* (ESI-0436233), and *ESIE: Using Student-generated Strategies in Instructional Interactions to Build Multiplicative Structures in Urban Schools* (ESI-0138877).	**Yes**

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

CENSNet: An Architecture for Authentic Web-Based Science Inquiry in Middle and High School (ESI-0352572) is a web-based architecture that provides middle and high school students and teachers access to live scientific data from the Center for Embedded Networked Sensing (CENS, a NSF Science and Technology Center funded in 2002) and curricular models built around sensor networks that target core life science content and inquiry standards. It allows schools to do investigations and inquiry in the same way and in the same environment as scientists. *SGER: Connections between Mathematics and Biology in the High Schools: An Experimental Program* (ESI-0421887) is an exploratory project that will investigate ways to connect mathematical and biological sciences in high school classrooms. The project will have a major instructional materials development component through a module-writing activity and through a research experience for high school teachers. Teachers will learn about mathematical biology, then will use their knowledge to construct modules for classroom use. They will work with content experts in mathematics and biology, and will try their modules in their own classrooms. Other teachers will try the same modules in different classrooms. The modules will then be revised and disseminated. *Mathematics Through Technology and Internet Modules (MTTIM)* (ESI-0436233) is creating six internet-based instructional modules and accompanying teacher guides for students, grades 5-8. The modules will use internet sites as a source of realistic, current data for students to use in classroom activities and investigations. The mathematics focus of the project materials includes exploratory data analysis, rates of change, proportional reasoning, and relationships among fractions, decimals, and percents. There will be a project focus on connecting mathematics to other disciplines such as science and social studies. The goal of the project, *ESIE: Using Student-generated Strategies in Instructional Interactions to Build Multiplicative Structures in Urban Schools* (ESI-0138877), is to model the development of children's multiplicative reasoning in urban classrooms, grades K-5. The project proposes to analyze teacher-student interactions during instruction to understand how students' productions (e.g., strategies, invented notations, arguments, claims, explanations) are used for collective construction of complex mathematical knowledge that can lead to enhanced student outcomes. The project proposes, through observation at elementary classrooms in urban, low-income schools, (1) to identify and classify teacher-student interactions that help generate student productions and the sequence that lead to significant mathematical understandings and practices; and (2) to create models of thinking - a space of possible teaching and learning actions - that can help teachers adapt or reproduce effective teaching actions.	

4. Does the program portfolio have an appropriate balance of: • **Multidisciplinary projects?** The IMD program had an appropriate balance of multidisciplinary projects. In FY 2004, there were 131 active awards, 26 of these awards were classified as multidisciplinary projects. Theses projects constitute 20% of the IMD portfolio and approximately 33% ($11.9 million) of the total dollar investment.	**Yes**
5. Does the program portfolio have an appropriate balance of: • **Innovative projects?** The COV found that the Program portfolio contained an appropriate balance of innovative projects. The COV identified the following exemplars of innovative projects funded between 2002 and 2004: *Seeds of Science/Roots of Reading: Effective Tools for Developing Literacy through Science in the Early Grades* (ESI-0242733), *Visualization in Technology Education (VisTE)* (ESI-0137811), *Engineering is Elementary: Engineering and Technology Lessons for Children* (ESI-0454526), and *Molecular Logic: Bringing the Power of Molecular Models to High School Biology* (ESI-0242701). *Seeds of Science/Roots of Reading: Effective Tools for Developing Literacy through Science in the Early Grades* (ESI-0242733) is a three-year pilot project that will develop and field-test three modules for grades 1-3 incorporating science and literacy. Each module will consist of a cluster of inquiry-centered science investigations and a set of nine readers. These research-based resources for literacy development will emphasize science content related to the investigations. The staff of the Lawrence Hall of Science and faculty from the Graduate School of Education at the University of California-Berkeley will work with literacy experts from the School of Education at the University of Michigan to develop the readers. The science materials will be based upon successful Great Explorations in Math and Science (GEMS) curriculum units, revised to enhance their alignment with the National Science Education Standards. *Visualization in Technology Education (VisTE)* (ESI-0137811) is an initiative designed to promote the use of graphic visualization tools among students in grades 9-12. By using simple and complex visualization tools, students can conduct research, analyze phenomena, solve problems, and communicate major topics identified in the Standards for Technology Literacy (STL), as well as topics aligned with national science and mathematics standards. Over three years, partnership members will create 12 modules reflecting the 20 STL standards and corresponding benchmarks. Combined, the modules will form a discrete course in graphic visualization. However, each of the 12 modules could be used in existing technology education courses as a stand-alone activity. *Engineering is Elementary: Engineering and Technology Lessons for Children* (ESI-0454526) will develop lessons to engage students, grades 1-5, in engineering activities integrated with their science lessons. The project addresses the need to develop a broad understanding of what engineers do and the uses and implications of the technologies they create. At the heart of engineering is an understanding of the engineering design process -- a flexible method of solving problems that is parallel to the inquiry process in science. The goals of the project are to increase the level of technological literacy of the students and to increase the understanding of technology and engineering of	**Yes**

elementary teachers in order to enable them to teach these subjects to their students. By creating and testing lessons that are closely integrated with elementary science topics and linked to popular and effective science programs, the project strengthens the science program while introducing key engineering concepts and fostering positive attitudes toward engineering in ways that include girls and boys from a wide variety of ethnic and cultural backgrounds. The project seeks to expand children's images of engineering and to broaden their interests and expectations for the future. *Molecular Logic: Bringing the Power of Molecular Models to High School Biology* (ESI-0242701) is designed to improve the ability of all students to understand fundamental biological phenomena in terms of the interactions of atoms and molecules. The project does this by enhancing biology courses with guided explorations of powerful atomic and molecular computational models. These models are embedded in eight modules that are linked both to standards and to typical textbooks, and they are easily implemented in diverse educational settings. The models are designed to cover basic science concepts using an approach that is accurate, grade-appropriate, and accessible to students with different learning styles. Exploration of the models requires problem solving and fosters critical thinking. Collaboration around model-based challenges is used to strengthen student communication skills. The associated materials provide connections to technology, engineering, social questions and scientists. Computational models are central to the project. The models are also available at no cost online as hybrid materials that include text and additional computational resources.	
6. Does the program portfolio have an appropriate balance of: • **Funding for centers, groups and awards to individuals?** The Committee concluded that there was a reasonable distribution of funding to centers, groups, and individuals. However, the COV also observed the very positive role of centers and urge a consideration of continued funding in this area. In 2004, no awards were made to centers.	**Yes**
7. Does the program portfolio have an appropriate balance of: • **Awards to new investigators?** While NSF did not provide details regarding the number of awards to new investigators, some information was provided on the “Exemplary IMD Projects” sheets. At least two of the awards in the last three years went to new IMD Principal Investigators: William Sandoval (CENSNet, ESI-0352572) and Jacqueline Barber (Seeds of Science/Roots of Reading, ESI-0242733).	**Yes**

8. Does the program portfolio have an appropriate balance of: • **Geographical distribution of Principal Investigators?** The geographical balance for current portfolio, FY04, is listed below: South Atlantic 13 Pacific 20 Mid Atlantic 29 East North Central 19 West North Central 2 West South Central 4 New England 32 Mountain 12 East South Central 0 Outlying Areas 0 All sections of the country are represented except the East South Central section of the country (AL, MS, TN). However, the geographical balance shows the proposals are concentrated in a few areas (e.g., CA, MA). NSF should develop strategies to fund a small percentage of proposals from underrepresented geographical regions. Collaborative relationships between regional investigators and some of the large curriculum developing organizations should be encouraged.	**Yes**
9. Does the program portfolio have an appropriate balance of: • **Institutional types?** In FY 2003, 42% of the funded proposals were awarded to colleges and universities, 8% went to educational consulting organizations, 35% went to non-profit institutions, 11% went to professional societies, and 4% went to museums. In FY 2004, 50% of the funded proposals were awarded to colleges and universities, 3% went to educational consulting organizations, 3% went to industry, 36% went to non-profit institutions, and 8% to professional societies. The institutional balance is reasonable. K-12 school districts were not represented as lead institutions on any of the funded proposals in FY 2003 or FY 2004. School districts, however, were included as partners.	**Yes**
10. Does the program portfolio have an appropriate balance of: • **Projects that integrate research and education?** The COV felt that the balance was appropriate. Particularly noteworthy examples of projects that related education and research were projects *Integrating Scientific Research and Technology into 9-12 Grade Earth Science* (ESI-0442136) and *A Longitudinal Comparison of the Effects of the Connected Mathematics Program and Other Curricula on Middle School Students' Learning of Algebra* (ESI-0454739).	**Yes**

11. Does the program portfolio have an appropriate balance: • **Across disciplines and subdisciplines of the activity and of emerging opportunities?** In reviewing the FY 2002, FY 2003, and FY 2004 Program portfolios, it appears that approximately 42% of IMD projects funded were in the area of science, 36% were in mathematics, 20% were multidisciplinary, and 2% were in technology. Within the area of science, there was a larger number of IMD projects funded related to the biological sciences than the other major sub-disciplines (chemistry, physics, earth sciences). In the area of mathematics, projects were distributed in a balanced manner across sub-areas. During FY 2004, several IMD projects *NIMD: Probing the Nanoworld -- Instructional Materials Development* (ESI-0426401) and *NanoSense: The Basic Sense behind NanoScience* (ESI-0426319) in the emerging field of nanoscience were funded. The overall collection of projects across the portfolio is balanced appropriately given the overall programmatic emphasis that is present in the current K–12 STEM curricula.	**Yes**
12. Does the program portfolio have appropriate participation of underrepresented groups? It was not possible to determine from the FY 2002 – FY 2004 award abstracts or proposals specific information related to the level of participation of individuals from underrepresented groups who were project PI's, project personnel, or project participants. It could be inferred from the location of projects that there were likely individuals from underrepresented groups participating to some degree in the projects due to the demographics of the location. Specific data from FY 2002 and FY 2003 regarding the race/ethnicity of IMD panel members was available, and it indicated that approximately 13% were African American, 2 % Asian, 9% Hispanic, and 76% White. It is noted that the IMD staff have attempted to achieve an appropriate level of participation of individuals from underrepresented groups on IMD panels, and that there is an active effort to increase submission of proposals from individuals who are from underrepresented populations.	**Could not be determined**
13. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. The program needs to continue to consider issues of equity and excellence. In particular, attention and explicit coordinative efforts must be given the Elementary and Secondary Education Act, No Child Left Behind. The Program must address the need for the country to educate the next generation of scientists and engineers while at the same time addressing educational equity.	**In general, yes**

14. Discuss any concerns relevant to the quality of the projects or the balance of the portfolio.

The COV noted the need for more impact studies so the result of the funding on the goals of impact and excellence are clear. More specifically, the COV noted the need for more materials focused on secondary physics, technology, and the elements of mathematics necessary for success in science. A greater emphasis on projects that integrate mathematics and science would be welcome.

Further, the IMD program should continue to support the development of technology education instructional materials in order to increase technological literacy for all, as well as to catalyze the development of the next generation of engineers and technologists. Technology education instructional materials should be aligned with the *Standards for Technological Literacy: Content Standards for the Study of Technology.*

The IMD program should also support the development of instructional materials in the area of educational technology (sometimes called information technology). Students should be literate in the use of information technologies such as home computers, handheld computers, internet, and e-mail.

A.5 Management of the program under review. Please comment on:

1. Management of the program.

The COV felt that all elements of the program were well managed.

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

In 2002, the program solicitation for the Instructional Materials Development program included four components: Instructional Materials for Students, Dissemination and Implementation Sites, Assessment, and Applied Research. In 2003 and 2004, the Solicitation included three components: Instructional Materials for Students, Assessment, and Applied Research. In 2003, the areas of special interest were Impact Assessments and Emerging Technologies. In the 2004 Solicitations, the areas of special interest were High School Science, Emerging Technologies, Impact Assessments, Studies of Learning Structures, and Research to Practice. A Solicitation for Nanoscale Science and Engineering Education proposals was also included in 2003.

The addition of these special interest areas indicate that the Program Officers are being responsive to the issues of impact and high risk studies highlighted in the 2002 COV Report, the need to identify what works in K-12 education, and the influence of standards-based reform and accountability issues.

The Centers for Learning and Teaching program is a comprehensive effort that provides substantive opportunities for research in formal and informal education in areas that include: science, mathematics, engineering, and technology curriculum, pedagogy, and tools; the relationship between learning and teaching; educational policies that impact the education of rural, urban, low income, and/or minority students; and methods for studying the effects of assessment practices. All funded CLTs support graduate students and post-doctoral fellows who are conducting research that relate to the focus of the Center and their area of interest. Many of the research topics address areas of interest to the IMD program. CLT research topics, papers, presentations, relevant conferences, and websites should be made available to IMD teams. When appropriate, the CLT teams could be encouraged by NSF to construct research questions that would address the common issues of the CLT and IMD programs.

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

The COV found that the NSF IMD program planning and prioritization process that guided the development of the portfolio to be well done and thoroughly documented in the materials provided to the COV, particularly in the IMD portion of the ESIE Annual Reports. In general, the COV found that the program plan was guided by NSF goals as outlined in the NSF Strategic Plan for FY 2003 - 2008. More specifically, the IMD plan was guided by national standards and other NRC documents, all of which are listed as references in IMD Program Solicitations. In addition, the program prioritization was guided by the 2001 COV report recommendations, by a formal third-party evaluation released in 2000 entitled "Final Report on the Evaluation of the National Science Foundation's Instructional Materials Development Program," by the results of the Third International Mathematics and Science Study (TIMSS), the 2003 Program for International Student Assessment (PISA), by annual conferences(and proceedings) of developers of STEM instructional materials funded by IMD, and by financial and other programmatic constraints discussed in the IMD portion of the ESIE's divisional annual reports. This planning and prioritization process led, in 2002 and earlier, to the development of middle school science projects using the "Backward Design" paradigm and the planned elimination of Dissemination and Implementation Sites. In 2003, this process led to a focus on developing high school materials for a non-traditional physics-chemistry-biology sequence, materials for technology education, and impact studies. In 2004, IMD indicated priorities in updating previously developed elementary science materials, and a focus on high school science needs, goals, constraints, and instructional materials. The priorities outlined in the documents above are backed up by high priority areas of interest specifically called out in the IMD program solicitations. In both 2002 and 2003, the IMD solicitation called specifically for impact assessments and materials that use technology in innovative ways, directly responding to two of the recommendations made in the 2001 COV report. The 2004 solicitation noted that high school science and materials that use technology in innovative ways were areas of special interest, consistent with the planning process outlined above.

4. Additional concerns relevant to the management of the program.

The COV felt that the focus of the IMD should move toward impact and concern itself less with the launching of new materials. The COV recommends the leveraging of existing materials by launching more impact studies and implementing the findings from those studies.

PART B. RESULTS: OUTPUTS AND OUTCOMES OF NSF INVESTMENTS

NSF investments produce results that appear over time. The answers to the first three (People, Ideas and Tools) questions in this section are to be based on the COV's study of award results, which are direct and indirect accomplishments of projects supported by the program. These projects may be currently active or closed out during the previous three fiscal years. The COV review may also include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made. Incremental progress made on results reported in prior fiscal years may also be considered.

The following questions are developed using the NSF outcome goals in the NSF Strategic Plan. The COV should look carefully at and comment on (1) noteworthy achievements of the year based on NSF awards; (2) the ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcomes; and (3) expectations for future performance based on the current set of awards. NSF asks the COV to provide comments on the degree to which past investments in research and education have contributed to NSF's progress towards its annual strategic outcome goals and to its mission:

- To promote the progress of science.
- To advance national health, prosperity, and welfare.
- To secure the national defense.
- And for other purposes.

Excellence in managing NSF underpins all of the agency's activities. For the response to the Outcome Goal for Organizational Excellence, the COV should comment, where appropriate, on NSF providing an agile, innovative organization. Critical indicators in this area include (1) operation of a credible, efficient merit review system; (2) utilizing and sustaining broad access to new and emerging technologies for business application; (3) developing a diverse, capable, motivated staff that operates with efficiency and integrity; and (4) developing and using performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

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

B.1 OUTCOME GOAL for PEOPLE: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments

Developing a diverse, competitive, and globally engaged STEM workforce

The IMD program contributes to NSF's investment in *People* by supporting development and dissemination of instructional materials designed to fully engage U. S. students in productive STEM learning experiences that prepare them to be highly qualified members of the global S & E workforce. The range and types of IMD-funded projects in STEM education demonstrate a thoughtful, strategic vision regarding the educational materials needed to prepare a diverse, competitive workforce and citizenry for the new global economy. Specific IMD investments have been targeted in ways that reflect advances made in both the fields of science and technology as well as in our understanding of the nature of learning and teaching. These investments, in turn, have a strong potential to positively influence the future STEM education of individual students, their preparation for the workforce, and ability to contribute to national competitiveness. The following list of GRPA Nuggets and IMD Award Descriptions provide examples of specific STEM Outcome Goals for People achieved through IMD investments:

GRPA Nuggets

Nugget ID: 10806 - Success of The Algebra Project

- The mathematics literacy project in Algebra has demonstrated success with students in urban areas with high poverty populations and few resources, and has the potential of diversifying the pool of STEM professionals.

  Title: *Raising the Floor: The Development of Selected Experientially Based Mathematics Instructional Modules for Previously Under-Served Target Population* (ESI-0137855)

  Principal Investigators: R. Moses, G. Budzban, and A. Shaw

Two high-school algebra modules are developed consistent with current research on student learning. Each module spans from four-to-six weeks of classroom instruction; incorporates the use of technology; and includes a curriculum unit, teachers' guide, assessment materials, and materials to support community-based mathematics literacy events. One module uses the "Road Coloring Problem" to introduce students to functions and lays the foundation for matrix multiplication. The other module uses games to enhance students' mathematical understanding, and helps students learn polynomials and introduce elementary counting and probability concepts. The materials embody a pedagogical approach whereby mathematics emerges from the students' careful observation and systematic analysis of familiar events that are mathematically rich. Teachers using the materials form professional communities by collaborating online. The materials are pilot- and field-tested in several geographically and demographically diverse sites. The project has formative and summative evaluation components.

Nugget ID: 10643 – *Developing Literacy Through Science*

- This project addresses the critical need for science education materials that incorporate research-based, foundational dimensions of literacy. It has the strong potential of profoundly improving student understanding of the physical world and basic literacy abilities.

  NSF Award: ESI-0242733

  Title: *Seeds of Science/Roots of Reading: Effective Tools for Developing Literacy through Science in the Early Grades*

  Principal Investigators: J. Barber and D. Pearson

  This project develops and field-tests three modules, grades 2-3, incorporating science and literacy. Each module consists of a cluster of inquiry-centered science investigations and a set of nine readers. These research-based resources for literacy development emphasize science content related to the investigations. The staff of the Lawrence Hall of Science and faculty from the Graduate School of Education at the University of California-Berkeley are working with literacy experts from the School of Education at the University of Michigan to develop the readers. The science materials are based upon successful *Great Explorations in Math and Science (GEMS)* curriculum units that are revised to enhance their alignment with the National Science Education Standards. Teachers involved in the field test receive professional development in the use of the resources. They also have access to an assessment system, developed as a part of the project that will provide formative feedback on students' progress in both literacy and science. The research component of this project examines teachers' responses to these materials, to their effectiveness in a variety of classroom settings, and to merging science with literacy instruction.

Nugget ID: 8207 – *Everyday Mathematics Curriculum to Reach Nearly 4,000,000 Elementary Students*

- This report indicates the research- and standards-based, K-6 curriculum, *Everyday Mathematics*, is being adopted and implemented by large school systems of low SES status and high minority populations.

Nugget ID: 8205 – *Innovative Middle Grades Curricula Lead to Student Achievement Gains*

- This research-based, multidisciplinary curriculum, grades 9-10, reports preliminary results from pre- and post-tests showing significant gains in student achievement.

Nugget ID: 10809 – *Expanding National Library of Manipulatives (NLVM) Reaches U.S. and International Audiences of K-8 Math Learners*

- On an average school day, the NLVM web site has more than 1,240,00 hits and nearly 750,000 file requests, and is providing quality materials for K-8 students of mathematics.

Nugget ID: 10801 – *TECH-know Curriculum Shown Especially Successful with Young Girls*

- This project has increased the achievement of girls from underrepresented and economically disadvantaged populations through using alternative instructional strategies involving technological literacy.

IMD Award Descriptions

- **NSF Award:** ESI-0454526

  Title: *Engineering is Elementary: Engineering and Technology Lessons for Children*

  Principal Investigators: C. Cunningham, C. Sneider, I. Miaoulis, and N. Yocom de Romero

  The *Engineering is Elementary: Engineering and Technology Lessons for Children* project is developing lessons to engage students, grades 1–5, in engineering activities integrated with their science lessons. The project addresses the need to develop a broad understanding of what engineers do and the uses and implications of the technologies they create. At the heart of engineering is an understanding of the engineering design process – a flexible method of solving problems that is parallel to the inquiry process in science. The goals of the project are to increase the level of technological literacy of the students and to increase the understanding of technology and engineering of elementary teachers in order to enable them to teach these subjects to their students. The project is developing 16 units, each of which includes an illustrated storybook, teacher background materials, teacher's guide, assessment tools, student duplication masters, quick cards, references and resources. The instructional effort is strengthened by the project website, posters, teacher professional development materials and overviews for administrators and other stakeholders. By creating and testing the lessons that are closely integrated with elementary science topics and linked to popular and effective science programs, the project strengthens the science program while introducing key engineering concepts and fostering positive attitudes toward engineering in ways that include girls and boys from a wide range of ethnic and cultural backgrounds. The project seeks to expand children's images of engineering and to broaden their interests and expectations for the future.

- **NSF Award:** ESI-0332499

  Title: *Materials Worlds Modules 2002*

  Principal Investigator: R. P. H. Chang

  The *Materials World Modules (MWM)* are inquiry-based, supplementary materials that bridge the gap between traditional science curricula and real-world applications. The original modules were content based. The *MWM-2002* modules are concept-based modules designed to develop "enduring understandings" through a series of hands-on learning experiences culminating in a design task, which serves as evidence of conceptual understanding. Five modules have been developed and tested: Structure and Properties of Matter, Forces and Motion, Materials and the Environment, Properties of Solutions, and Bonding and Polarity. To be developed and field tested are Nanotechnology, Electrical Conductivity, Kinetics in Catalytic Reactions, Biotechnology, and Light and Color. The modules are developed in partnership with teachers. The inquiry-based, design modules are integrated with digital resources, video-based teacher training workshops, real-time teacher evaluations, comprehensive student assessments and cyberinfrastructure support. Teachers can customize, on-line, the modules for local conditions. Evaluation of the materials includes student outcomes, teacher satisfaction and alignment to standards. Other support is sought for large-scale dissemination.

- **NSF Award:** ESI-0352504

  Title: *Engineering Inquiry-based Learning Modules for Technology Education*

  Principal Investigators: J. Ross, T. Bayles, B. Jarrell, and C. Parker

  The University of Maryland-Baltimore County and the University of Maryland-Baltimore in cooperation with technology education teachers and industrial collaborators are developing modular instructional materials for students. The materials are designed to increase the awareness of, and interest in, career opportunities in engineering and technology. The modules use authentic, real-world engineering applications and hands-on experiences to build problem-solving skills and contribute to the technological literacy of secondary students. The modules specifically target the ITEA Content Standards for Technological Literacy and related benchmarks. Specifically, the project is developing the five case studies in CD format, using real-world examples to introduce students to engineering design and decision-making processes. Inquiry-based learning with hands-on experiences is used to maximize student interest and understanding. The project is conducting research to demonstrate the effectiveness of the modules in increasing technological literacy and building awareness of, and interest in, engineering and technology careers. The project is also conducting research to determine how interactive, authentic, problem-solving simulations impact and facilitate student learning. It is also providing professional development opportunities for technology education teachers, including an overview of the program and acquaintance with the curriculum case studies prior to their use in the classroom, as well as increasing the involvement of women and other underrepresented groups in engineering and technology by providing female and minority role models in the classroom and developing case studies that encourage interest and participation by all groups.

- **NSF Award:** ESI-0137305

  Title: *Elementary, Secondary, and Informal Education: Show-Me Project (renewal)*

  Principal Investigators: B. Reys, I. Papick, R. Reys, F. Arbaugh, and J. Tarr

  This project continues the work of the Show-Me Center, an IMD-supported Implementation and Dissemination Site focused on middle school mathematics materials. The Center consists of a Middle School Mathematics Center (University of Missouri) and four Curriculum Satellite Centers (University of Wisconsin, Michigan State University, University of Montana, and the Education Development Center in Newton, MA). The goals of the Center are: (1) to disseminate information supporting awareness, examination, and implementation of comprehensive, standards-based middle school mathematics curricula; (2) to develop leadership infrastructure to support curriculum reform utilizing Show-Me Regional Associates, experienced teacher users of curricula (Show-Me Master Teachers) and district leadership teams to carry the message and work at the local levels; (3) to provide professional development and teacher renewal during which Center staff help school districts design and implement coherent and long-term professional development for teachers organized around standards-based curriculum adoption; and (4) to monitor the impact of standards-based curricula on student learning. The Center initiates data collection through the Show-Me Postdoctoral Fellow program so that the extent and quality of implementation and its effects on student learning and teacher development are documented and disseminated.

B.2 <u>OUTCOME GOAL for IDEAS</u>: "Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

<u>Comments</u>

In a broad sense, <u>all</u> IMD Projects involve the development of ideas that enable discovery across the frontier of science and engineering, connected to learning, innovation, and service. We will highlight a small sampling of projects whose primary outcome was ideas. In particular, we will highlight programs that contributed in the following discovery areas: contributions to the fundamental knowledge base, leadership in fostering newly developed or emerging areas, building connections between discovery and learning or innovation, and establishing partnerships that enable the flow of ideas between academic, public or private sector.

Discoveries that contribute to the fundamental knowledge base. The following sampling of projects emphasizes research into how students learn and effective teacher-student interactions.

- **NSF Award:** ESI-0138877

  Title: *Elementary, Secondary, and Informal Education: Using Student-generated Strategies in Instructional Interactions to Build Multiplicative Structures in Urban Schools*

  Principal Investigators: S. Empson and C. Drake

  The goal of this project is to model the development of children's multiplicative reasoning in urban classrooms, grades K-5. The project proposes to analyze teacher-student interactions during instruction to understand how students' productions (e.g., strategies, invented notations, arguments, claims, and explanations) are used for collective construction of complex mathematical knowledge that can lead to enhanced student outcomes. The project proposes, through observation at elementary classrooms in urban, low-income schools, (1) to identify and classify teacher-student interactions that help generate student productions and the sequence that lead to significant mathematical understandings and practices and (2) to create models of thinking - a space of possible teaching and learning actions - that can help teachers adapt or reproduce effective teaching actions. The models created are tested with other teachers in the last phase of the study. The research uses two types of cases: longitudinal cases of the development of individual student's thinking, and cross-sectional cases in which the focus is the sequence of teacher-student interactions. A secondary goal is to understand how children's reasoning about the strand of multiplicative structures - including fractions, ratios, proportions, multiplication, and division - become integrated.

- **NSF Award:** ESI-0348841

  Title: *A Study on Learning Science, Kindergarten through Eighth Grade*

  Principal Investigator: J. Moon

  The National Academy of Sciences, through their Committee on Science Education, is overseeing a research synthesis on children's science learning, grades K-8. The proposal makes the case that there has not yet been a study of this kind that pulls together research from multiple disciplines (science content, learning theory in the cognitive sciences, developmental psychology, social psychology and anthropology) and incorporates research from the standards movement along with the impact of accountability at all levels of the education system. The study proposes to address the following questions: (1) What does a comprehensive picture of how children acquire scientific ideas look like? (2) How can this comprehensive understanding be helpful to advancing goals around student achievement and equity in opportunities to learn science? How can this knowledge help advance the design of science assessments? (3) What other lines of research need to be pursued to make our understanding about how students learn science more complete? An NRC study committee that reflects a multidisciplinary perspective and includes expertise in science and science education, cognitive psychology, child development, learning theory, education policy and education research is carrying out the study. The work will be disseminated through commissioned papers and workshops, as well as analyzed and synthesized into an NRC report. The NRC is working with the Merck Institute for Science Education to provide a short, policy-oriented document to accompany the full-length report. Target audiences include educators, researchers and policymakers.

- **NSF Award:** ESI-0454739

  Title: *A Longitudinal Comparison on the Effects of the Connected Mathematics Program and Other Curricula on Middle School Students' Learning of Algebra*

  Principal Investigators: J. Cai and J. Moyer

  This project compares the effects on algebraic learning when using the *Connected Math Program* to the effects of using other (non-NSF supported) middle school mathematics curriculum materials at the middle school level. Research questions to be addressed are: What are the similarities and differences between the intended treatment of algebra in the *CMP* curriculum and in non-*CMP* curricula? What are the key features of the *CMP* and non-*CMP* experience for students and teachers, and how might these features explain performance differences of *CMP* and non-*CMP* students? What are the similarities and differences in performance between *CMP* students and a comparable group of non-*CMP* students on tasks measuring a broad spectrum of mathematical thinking and reasoning skills, with a focus on algebra? The algebra focus skills/concepts to be assessed are: conceptual understanding and problem solving; algebraic manipulative skills; solution strategies, representations and mathematical justifications.

Leadership in fostering newly developing or emerging areas. The following highlighted programs demonstrate leadership in developing instructional materials that align with state and national content standards.

- **NSF Award:** ESI-0352473

  Title: *Linking Middle and Early High School Science and Mathematics Assessment Items to Local, State and National Content Standards*

  Principal Investigators: G. DeBoer and J. Roseman

  The project is developing a bank of mathematics and science assessment items and related tools aligned with state and national content standards that will be available to test developers, curriculum developers, researchers, teachers, teacher educators, parents and students. Building on the work of a previous grant that developed a process for analyzing assessment items related to national standards, this work is developing items that are not aligned to any particular materials development project, but focus instead on major ideas and themes in the standards documents. Specific tools include a bank of about 300 test items, 16 assessment maps (10 in science, 6 in mathematics) and the inclusion of materials that target students with English as a second language.

NSF Award: ESI-0137807

Title: *Middle School Science Curriculum Materials: Meeting Standards and Fostering Inquiry through Project-Based Inquiry Science Units*

Principal Investigators: J. Kolodner, B. Reiser, J. Krajcik, P. Camp, and R. Schneider

This comprehensive, project-based, inquiry-driven, middle school, science curriculum builds upon modules developed for Learning by Design at Georgia Institute of Technology and by LeTUS at the University of Michigan and Northwestern University. The latter were specifically designed for urban settings. The 15 units address national science content and process standards, focus on helping students acquire a qualitative understanding of the science principles and move them toward a quantitative understanding. The time per unit is long enough that students can change their ideas in light of the evidence. The project develops a framework to assure complete coverage of fundamental topics. The pedagogy, use of software and the development of a scientific and collaborative culture are consistent, persistent and pervasive across the entire curriculum. The materials cover topics in physical, Earth/space and life sciences appropriate to the middle school and provide experience with diverse modes of scientific investigation -- experiment, observation, modeling, data mining, and history -- and standards of evidence are covered. Instructional technology is infused throughout and science is connected to the students' world by the use of engineering design. Assessments are embedded. The student and teacher materials are pilot tested locally and field tested more broadly. Materials for professional development of teachers are also developed.

Connections between discovery and learning or innovation. The following two projects are examples of instructional material development that link important discoveries in science in the areas of mathematical biology and nanoscale science with high school experiences.

- **NSF Award:** ESI-0421887

  Title: *SGER: Connections between Mathematics and Biology in the High Schools: An Experimental Program*

  Principal Investigator: F. Roberts

  This exploratory program investigates ways to connect the mathematical and biological sciences in high school classrooms. The program has a major instructional materials development component through a module-writing activity and through a research experience for high school teachers. Teachers learn about mathematical biology, then use their knowledge to construct modules for classroom use. They work with content experts in mathematics and biology, and try their modules in their own classrooms. Other teachers try the same modules in different classrooms. The modules are then revised and disseminated. *Intellectual Merit:* The focus is on topics from computational biology and bioinformatics. Teachers learn about sequence alignment algorithms, finding the smallest number of mutations of a certain type to switch one sequence into another, algorithms for finding a sequence from its fragments, and other mathematical techniques. Specific topics involve trees, DNA fragment assembly, phylogenetic trees, tree parsimony and genome rearrangements. Research projects for teachers center around physical mapping and the shortest common superstring problem. Research in teaching and learning informs the program, and, in turn, the project provides new insights into the process of interdisciplinary learning. *Broader Impact:* The project trains a group of teachers to develop at the interface between the biological and mathematical sciences and to bring interdisciplinary activities back to their schools. It disseminates results widely through materials, presentations at conferences, a website and a report. Teachers learn about the nature of interdisciplinary research by doing it.

- **NSF Award:** ESI-0426319

  Title: *NanoSense: The Basic Sense behind NanoScience*

  Principal Investigators: P. Schank and T. Stanford

  Working closely with chemists, physicists, educators and nanoscientists, SRI generates NanoSense -- nanoscience activities that build on their ChemSense activities. That curricular framework is extended to include five or six nanosense activities -- created, classroom tested and disseminated -- to help high school students understand the underlying principles, applications and implications of nanoscale science. These units help students visualize physical, chemical and biological principles that govern the behavior of particles at nanoscales. Some of the activities are simple, one-day enrichment activities, while others span several class periods. The work introduces an interdisciplinary element into the disjoint high school curriculum and provides real world examples of science and technology in action. Research along with the development determines how students improve their understanding of nanoscience concepts and technological applications improve over time and how teachers use these tools and activities to support student discourse and understanding. An invitational workshop of science educators and researchers and nanoscience researchers is to identify and prioritize a coherent set of concepts and potential ideas that underlie an understanding of the scale continuum between nanoscale and macroscale on which instructional materials research and certificate programs can be built.

Partnerships that enable the flow of ideas among academic, public or private sector. The IMD COV highlights two projects that disseminate ideas to a broader audience. The dissemination efforts also provide opportunity for posing new research questions and directions as a result of the interactions among the broader audience.

- **NSF Award:** ESI-0418911

  Title: *Assessing Mathematical Proficieny -- A Conference on Assessment in Mathematics Education, University of California, Berkeley, March, 2004*

  Principal Investigator: D. Eisenbud

  The authors held a conference on assessment in mathematics education at the Mathematical Sciences Research Institute at the University of California-Berkeley in March, 2004. Participants were drawn from the mathematics research community, together with researchers in mathematics education, psychometricians and school and district education personnel. Conference sessions assumed various formats, from individual presentations to panel discussion to small group discussion. A volume of proceedings were generated and disseminated. The goals of the project were to examine a variety of issues connected with assessment in mathematics education, including the effect of assessment on curriculum and instruction, issues of ethics and equity, and questions of tools and methods for assessment. An important outcome of the project is the identification of research questions and directions for development of new assessment tools.

- **NSF Award:** ESI-0137826

  Title: *Elementary, Secondary and Informal Education: K-12 Mathematics Curriculum Center: Phase III*

  Principal Investigators: J. Mark and D. Spencer

  The Education Development Center continues the work of the K-12 Mathematics Curriculum Center, an IMD-supported Implementation and Dissemination Site. The Center continues to offer seminars designed to build capacity in the field. In particular, this work assists mathematics coordinators, lead teachers and staff developers in designing professional development programs that support teachers using Standards-based materials; help districts consider the alignment between their new curriculum, classroom assessment and high-stakes tests; and help school districts develop plans for collecting and analyzing data and reporting results in order to evaluate the impact of their curriculum implementation. The Center draws on its experience with delivering seminars to districts in the past to develop on-line courses as a way of extending Center services to a wider audience. Another strong focus is to support the work of other mathematics implementation projects by developing materials and other products of use to these projects, by studying successful approaches and barriers to implementation, and by facilitating communications among these projects.

B.3 OUTCOME GOAL for TOOLS: Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."

Comments

In a broad sense, all IMD projects involve development of specific tools and infrastructure that support critical elements of learning mathematics and science. We will highlight a small sample of projects whose primary focus was the development of specialized learning tools.

- **NSF Award:** ESI-0242733

  Title: *Seeds of Science/Roots of Reading: Effective Tools for Developing Literacy through Science in the Early Grades*

  Principal Investigator: J. Barber

  (Excerpted from the PI's Abstract). This project develops and field-tests three modules, grades 2-3, incorporating science and literacy. Each module consists of a cluster of inquiry-centered science investigations and a set of nine readers. These research-based resources for literacy development emphasize science content related to the investigations. The science materials are based upon successful *Great Explorations in Math and Science* (GEMS) curriculum units, revised to enhance their alignment with the National Science Education Standards. The research component of this project examines teachers' responses to these materials, to their effectiveness in a variety of classroom settings, and to merging science with literacy instruction.

- **NSF Award:** ESI-0352572

  Title: *CENSNet: An Architecture for Authentic Web-based Science Inquiry in Middle and High School*

  Principal Investigator: W. Sandoval

  This 48-month project will provide middle and high school students and teachers access to live scientific data from the Center for Embedded Networked Sensing (CENS). It will result in curricular modules that are built around sensor networks and that target core life science content and inquiry standards. Current funding for scientific research has provided an ecosystem-monitoring network that supports extensive remote investigations of the James Reserve in California. This project adds the educational interface and supporting materials to support authentic investigations by schools. It allows schools to do investigations and inquiry in the same way and in the same environment as scientists. The proposed project aims to create a student-friendly view of the CENS sensor network, with wrap-around instructional activities for classroom use in a broad range of sciences.

- **NSF Award:** ESI-0352522

  Title: *TEEMSS II: Technology-enhanced Elementary and Middle School Science*

  Principal Investigator: R. Tinker

  This three-year project develops 15 units of information and computer-based learning materials keyed to the National Science Education Standards, grades 3-8. The emphasis is on helping students develop a deep understanding of science inquiry, which is supported through innovative uses of computers, probe ware and networking. The units are developed by experienced curriculum specialists, scientists and teachers to support an active inquiry-based learning environment, and will be appropriate for use with a wide range of curriculum materials. The design is such that it is possible for schools with limited resources to use the materials. Included are software, implementation assistance for teachers, an online course for teachers, and materials for parents.

- **NSF Award:** ESI-0137811

  Title: *Visualization in Technology Education*

  Principal Investigator: A. Clark

  Visualization in Technology Education (VisTE) is a standards-based initiative designed to promote the use of graphic visualization tools among students, grades 9-12. By using simple and complex visualization tools, students conduct research, analyze phenomena, solve problems and communicate major topics identified in the Standards for Technology Literacy (STL), as well as topics aligned with national science and mathematics standards. *VisTE* has forged a national coalition of institutions and individuals committed to the development of these materials. Over three years, partnership members will create 12 modules reflecting the 20 STL standards and corresponding benchmarks. Combined, the modules form a discrete course in graphic visualization.

B.4 OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."

Comments

The COV considers the NSF in general and the IMD program in particular to be models for organizational excellence. An agile business is one that responds quickly to new opportunities, realities, and recommendations from customers, experts, and peers. NSF ensures that it is agile by using a COV, whose members are IMD's customers, peers, and experts, every three years to independently assess its effectiveness and make recommendations on improving its performance. As discussed previously in this report, the IMD was very responsive to the previous COV's recommendations, discussing them in a formal document, and including its recommendations as areas of special interest in its program solicitations. The use of other external evaluations and the annual Principal Investigators conference ensure that the IMD Program Officers stay responsive to those most familiar with the constraints as well as the promises of new instructional materials.

An innovative business ensures that its customers can respond in the most cost and time effective manner. IMD uses a preliminary proposal process to provide feedback to its customers (those sending proposals) on strengths and weaknesses of their proposed effort prior to the proposer spending significant time and effort on a full proposal. An innovative business also includes all stakeholders in the decision-making process - this is accomplished at IMD via both the COV process as well as by the panel members, who review the preliminary proposals and the full proposals. The panel members are all stakeholders in this process and are also experts in their areas. In addition, the decision making process for determining winning proposals is relatively rapid. State-of-the-art businesses promote pilot plant testing and modification of new processes prior to full-scale production. Likewise, the IMD materials development process leads curriculum developers to first pilot test their materials, which are revised, the field tested in diverse schools, reviewed again, and then finally published for widespread dissemination.

A state-of-the-art business quickly adopts technology that improves its efficiency. This is evidenced by the NSF in general and IMD in particular adopting the FastLane computerized system for review panels and travel reimbursements. NSF managers are all organized, highly educated and experienced in their areas of management, keys for a state-of-the-art business. Ethical behavior is also a hallmark of this. The NSF peer review process used in IMD is generally considered to be the gold standard by which proposals should be reviewed. The reviews are performed by independent reviewers along with a well-prepared NSF Program Officer. The proposal review and contract award negotiation processes are carefully documented and subject to external review during a COV. Conflicts of interest are actively sought after and those reviewers who have such conflicts are excused from the review process. This high level of integrity is standard procedure at NSF and IMD.

PART C. OTHER TOPICS

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

The COV applauds the current special interest area on high school science. It encourages the convening power of the NSF to bring together key stakeholders such as The College Board, Educational Testing Service (ETS), admissions personnel of both high schools and post-secondary institutes, scientists, mathematicians, engineers and parents to address the emerging issues of AP courses in the high school science programs. While much is made and said of AP courses, little evidence is provided that indicates a cognitive framework anchored to current research on the learning of science and mathematics, the advantages or disadvantages of AP courses, and the added value they represent both as indicators of rich and robust courses, or truly standardized courses with well defined end of course examinations.

Currently no NSF-funded materials address AP science courses, which dominate advanced high school science courses for many future scientists and engineers. The NSF should assess whether the content and pedagogy of current AP science courses are consistent with what is known about the science of learning. IMD should specifically address the advantages and disadvantages of current AP courses. As AP courses involve high schools, colleges and universities, the College Board, ETS, and the college admissions of many high school students, these issues are complex and NSF should be the national organization to address this issue.

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.

Our views have been previously expressed in the other parts of the COV.

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

1. While many standards-based instructional materials have been developed through the IMD program, little is known of the key implementation issues faced once in use by teachers in U.S.

schools. It is therefore recommended that a series of studies be undertaken that draw from the knowledge and experience of teachers using the materials and the use of the NSF materials. The various studies could focus on the effectiveness of the teacher support materials and teacher content knowledge, the professional development structures and mechanisms required or absent for successful implementation, the fundamental assertions about knowledge and cognition that frame the materials and the connects or disconnects with both teacher practice and student understandings of how and what to know. Clearly deeper knowledge about cognition and social cultural contexts would provide a service to the field and also could guide future directions for the IMD.

2.   It is recommended that the NSF support a series of forums or mechanisms that focus on the teaching and learning of science. Such an endeavor can bring to the public forum, key issues and concerns about science education, state standards and policies, standards based instructional materials including inquiry-based materials. Proceedings and findings could be made available to the field and disseminated to a broader public audience.

3.   This comment concerns a request made to the COV for ideas for possible future directions for ESIE. "Workforce for the 21st Century" was denoted an NSF priority area in the latest NSF 2003-2008 Strategic Plan. Currently students are not necessarily trained to enter the workforce after high school; many students at the college level are prepared to enter graduate school, but not the industrial workforce after college; and graduate students are often prepared to become university researchers, but are not always prepared to enter the industrial workforce. NSF should determine the skills and knowledge needed by today's industrial STEM workforce for those who desire to enter the industrial workforce after high school, college, or graduate school. Then instructional materials should be developed that consider workforce needs more than current materials. By doing this, NSF would be directly addressing its stated mission to "advance the national … prosperity … and to secure the national defense." This differs somewhat from the current IMD focus on achieving science, mathematics, and technology literacy, following national documents; these workforce relevant materials would complement or supplement current curricula based on national documents - but would certainly not replace them. It is likely they would also follow these national documents.

It is recommended that the IMD unit undertake a research study that focuses on the school to career literature, scientific and technological workforce issues that emerging as a national concern and the nature of science and mathematics programs in today's high school. One could also add to this, the entire urban education context, where many of the dilemmas currently exist about achievement and school to career issues. This would serve to identify authentic problems that would provide the rationale for a new direction for the IMD and that could be addressed through multiple new solicitations.

4.   Exemplary instructional materials developed through the IMD program and used with high fidelity are but one of several crucial variables that determine the effectiveness of student learning in science within the K – 12 educational system. Of equal importance is:

- the quality of the design and coherence within a school district's K – 12 science program sequence;
- the depth of the domain-specific content understanding, pedagogical content knowledge, and understanding of the research on student learning possessed by science classroom practitioners in the system;
- an ability on the part of science educators to develop engaging science lessons that optimize the use of the exemplary instructional resources;
- science teachers' knowledge and incorporation of assessment practices that allow for diagnostic and formative monitoring of student conceptual development, and appropriate, timely instructional intervention when needed; and

- the capacity of district science educators to work collaboratively and constructively in purposeful activities that lead to continuous improvement in the students' learning, achievement and performance, and in the classroom practices of the individuals in the learning community.

With these crucial variables in mind, there is a need for definitive research supported by ESIE that delineates the impact that system-wide use of exemplary instructional materials have in conjunction with other variables mentioned above on student achievement and performance in educational systems that have K–12 science program structural and functional coherence. Successful student preparation for post-secondary pursuits related to science and engineering opportunities is dependent on cumulative K–12 STEM learning experiences, and it is important to understand the impact that a truly functional K–12 educational system using system-wide exemplary science instructional materials has on both student STEM achievement and STEM post-secondary success. With current global competitiveness in technological development that is dependent on high quality STEM education and a well-prepared STEM workforce, there is an urgent need to identify research-supported holistic approaches that can address the efficacy of K–12 system-level solutions. This need is true for science, mathematics and technology instructional materials/curricula. Definitive findings from such research would help in leveraging policy, funding, and practices in ways that have greater system-wide impact. Thus we recommend that a meta-analysis of these results be conducted to inform future solicitations.

It is recommended that there be a meta-analysis of the results of various other NSF-funded projects that have used IMD developed programs. This analysis should focus on the issues of context that emerged as key elements in many of the USI, USP, and LSC. Since all of these programs by and large adopted and implemented IMD developed materials, much could be learned and made public as a white paper to the field.

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

1. IMD should develop statistics about impact for completed funded programs that are summarized for COV panels. For example, how many copies have been sold, how many schools/teachers/ students/districts use these materials? How many website hits does the website get every year? What is the evidence for improved learning with these materials, especially compared to previously used materials?

It is recommended that the IMD undertake studies that provide evidence of the impact of funded programs that have had sufficient time to penetrate the field. The range of studies could include both quantitative data that consider total number of books sold, number of programs, teachers, districts as well as fidelity of implementation studies and, whenever possible, student achievement indicators and data. There is also a need for implementation studies that can provide a deep analysis of the fidelity of implementation, effectiveness of materials in diverse contexts, of contextual issues such as the variance in state standards and frameworks, funding and teacher content knowledge and experience. Such an analysis could provide insights and new ideas about the revision of programs or the development of a solicitation that would be more aligned to the results of these studies.

2. The NSF uses criteria of intellectual merit and broader impact to assess proposals. There needs to be some assessment of the actual achieved technical merit and achieved broader impact at the conclusion of the funded programs. While this information is incomplete, as the broader impact may develop over time, nevertheless, some assessment is better than none. It is suggested that, the actual achievements should be compared to the proposed achievements to allow the COV to determine some degree of program success. A significant absence for the COV is the determination of whether or not the funded proposals produced the quality and quantity of products that they proposed, and whether they achieved their goals for intellectual merit and broader impact

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

1. Include all funded abstracts for all 3 years.

2. Number all pages by Tab number and sequential page number in that tab- this will make it easier for COV members to discuss a particular document.

3. Include relevant information needed to complete the review and make it easy to find by including the correlation in an index. For example, IMD did not provide information pertinent to A.4,7: Awards to new investigators. This information should be provided and the pages where this information is found in the reviewer notebook should be cross-referenced to A.4,7 in an index or table of contents. The notebook did provide much relevant information, for example the geographical distribution of Principal Investigators. But the pages where that information was located should have been cross-referenced to A.4,8 somewhere in an index.

4. Provide relevant information for all three years, not just two of the three years. For example, IMD provided tables of panel distributions by gender, race, geographic division, and type of institution for 2002 and 2003, but not 2004.

5. In many of the documents provided to the COV, there are a number of acronyms and abbreviations. The COV would like to see an explanation of all non-obvious abbreviations provided in writing as part of the reviewer package.

6. The COV found it very useful to have a member that had served on the previous COV. Previous experience helped the COV quickly understand the scope of the project and how to divide the work to most effectively use the expertise of various team members.

7. In the NSF response to the COV, clearly delineate (by bolding, quotation marks or other means) the COV comments from the NSF responses. In the NSF staff response to the 2002 COV, it was sometimes difficult to determine if comments were those of the COV or the NSF response. For example, on page 6 of the staff response, the last full paragraph is a COV comment, but appears in the response to be due to NSF staff.

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For the 2005 Committee of Visitors for the Instructional Materials Development Program
Katherine K. Merseth
Chair

NATIONAL SCIENCE FOUNDATION
INSTRUCTIONAL MATERIALS DEVELOPMENT

COMMITTEE OF VISITORS REPORT
2005
RECOMMENDATIONS

#1 The use of a template and/or a checklist that is correlated to the program solicitation for reviewers and program officers would increase consistency in reviews and summaries. (A.3)

#2 Clarity in language in the program solicitation regarding ‘should’ and ‘must’ would enhance consistency in submitted proposals. (A.2)

#3 Greater emphasis on the delineation of a rationale for the proposed work and how it relates to other previous or current work in the field would enhance the quality and coherence of the proposal reviews and analysis. (A.3)

#4 Prioritization of comments and issues of concern in the summaries for Principal Investigator(s) would improve the quality of the feedback. (A.5)

#5 Shorten the response time when it is known that a proposal will not be funded. (A.7)

#6 Program Officers are encouraged to provide clear and explicit guidance to reviewers about the criteria for intellectual merit and its implications for a particular solicitation. The review process would be better served if reviewers were provided exemplars of broad impact and intellectual merit reviews. (A.2,4)

#7 The COV would like IMD to pay attention to the following areas of concern: (A.3,5)

a. It was noted that on the 2002 and 2003 panels, none of the panelists were from industry. Given that a secondary effect of the IMD is fostering the next generation of scientists, mathematicians, and engineers that enter the industrial workforce, industry representatives should provide input to the K-12 education of their future employees.
b. A balance between university professors and practicing K-12 teachers on panels should be ensured.
c. Engineers and technology professionals should be adequately represented on future panels, including science and mathematics panels.
d. Consideration needs to be given to a selection of panelists representing divergent points of view about mathematics and science education.

#8 The COV noted the need for more impact studies so the result of the funding on the goals of impact and excellence are clear. More specifically, the COV noted the need for more materials focused on secondary physics, technology and the elements of math necessary for success in science. A greater emphasis on projects that integrate math and science would be welcome. (A.4,14)

#9 Further, the IMD program should continue to support the development of technology education instructional materials in order to increase technological literacy for all, as well as to catalyze the development of the next generation of engineers and technologists. Technology education instructional materials should be aligned with the Standards for Technological Literacy: Content Standards for the Study of Technology. (A.4,14)

#10 The IMD program should also support the development of instructional materials in the area of Educational Technology (sometimes called information technology). Students should be literate in the use of information technologies such as home computers, handheld computers, Internet, and e-mail. (A.4,14)

#11 The COV felt that the focus of the IMD should move toward impact and concern itself less with the launching of new materials. The COV recommends the leveraging of existing materials by launching more impact studies and implementing the findings from those studies. (A.5,4)

#12 The COV recommends that a series of studies be undertaken that draw from the knowledge and experience of teachers using the materials and the use of the NSF materials. The various studies could focus on the effectiveness of the teacher support materials and teacher content knowledge, the professional development structures and mechanisms required or absent for successful implementation, the fundamental assertions about knowledge and cognition that frame the materials and the connects or disconnects with both teacher practice and student understandings of how and what to know. (C.3,1)

#13 It is recommended that the NSF support a series of forums or mechanisms that focus on the teaching and learning of science. Such an endeavor can bring to the public forum, key issues and concerns about science education, state standards and policies, standards based instructional materials including inquiry-based materials. Proceedings and findings could be made available to the field and disseminated to a broader public audience. (C.3,2)

#14 The COV recommends that the IMD develop statistics about impact for completed funded programs that are summarized for COV panels. For example, how many copies have been sold, how many schools/teachers/students/districts use these materials? How many website hits does the website get every year? What is the evidence for improved learning with these materials, especially compared to previously used materials? (C.4,1)

#15 It is recommended that the IMD undertake studies that provide evidence of the impact of funded programs that have had sufficient time to penetrate the field. The range of studies could include both quantitative data that consider total number of books sold, number of programs, teachers, districts as well as fidelity of implementation studies and whenever possible, student achievement indicators and data. There is also a need for implementation studies that can provide a deep analysis of the fidelity of implementation, effectiveness of materials in diverse contexts, of contextual issues such as the variance in state standards and frameworks, funding and teacher content knowledge and experience. (C.4,1)

#16 The NSF uses criteria of technical merit and broader impact to assess proposals. There needs to be some assessment of the actual achieved technical merit and achieved broader impact at the conclusion of the funded programs. While this information is incomplete, as the broader impact may develop over time, nevertheless, some assessment is better than none in order to allow the COV to determine some degree of success of the program. A significant absence for the COV is the determination of whether or not the funded proposals produced the quality and quantity of products that they proposed, and whether they achieved their goals for technical merit and broader impact. (C.4,2)

#17 Include all funded abstracts for all 3 years. (C.5,1)

#18 Number all pages by Tab number and sequential page number in that tab- this will make it easier for COV members to discuss a particular document. (C.5,2)

#19 Include relevant information needed to complete the review and make it easy to find by including the correlation in an index. For example, IMD did not provide information pertinent to A.4.7: Awards to New Investigators. This information should be provided and the pages where this information is found in the reviewer notebook should be cross-referenced to A.4.7 in an index or table of contents. The notebook did provide much relevant information, for example the geographical distribution of Principal Investigators. But the pages where that information was located should have been cross-referenced to A.4.8 somewhere in an index. (C.5,3)

#20 Provide relevant information for all three years, not just two of the three years. For example, IMD provided tables of panel distributions by gender, race, geographic division, and type of institution for 2002 and 2003, but not 2004. (C.5,4)

#21 In many of the documents provided to the COV, there are a number of acronyms and abbreviations. The COV would like to see an explanation of all non-obvious abbreviations provided in writing as part of the reviewer package. (C.5,5)

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