REPORT OF THE FY 2002 COMMITTEE OF VISITORS

FOR THE

INSTRUCTIONAL MATERIALS DEVELOPMENT PROGRAM

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

DIVISION OF ELEMENTARY, SECONDARY, AND INFORMAL EDUCATION

NATIONAL SCIENCE FOUNDATION

April 9-10, 2002

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INTRODUCTION

This report describes the findings of the Committee of Visitors (COV), which met on April 9-10, 2002 to conduct a review of the Instructional Materials Development (IMD) program at the National Science Foundation (NSF). The report is based on discussions and analyses performed by committee members during a meeting at NSF on April 9-10 as well as subsequent analyses and communications during the weeks following the meeting.

COV CHARGE

The COV was charged by the NSF to assess the quality and integrity of the proposal review process for the IMD program. Such reviews recur every three years. With the advent of the Government Performance and Results Act (GPRA), the NSF has also charged the COV to evaluate or review the program's impact and its contributions to the Foundation's performance goals for research and education. The NSF pointed out to the COV that programs might be major or minor contributors to these performance goals. To support the review process, the NSF developed a set of core questions to be addressed by the COV and provided a report template to standardize reporting.

The COV review of program management was to consider actions taken on proposals to IMD that were completed during the previous three fiscal years. The COV evaluation of grantee results was to consider examples of direct accomplishments of projects supported by programs under review that were either currently active at the time of the COV review or were closed out during the previous three fiscal years. The COV evaluation was also to consider significant impacts and advances that have developed since the previous COV and are demonstrably linked to NSF investments, regardless of when those investments were made.

METHOD OF REVIEW

Review Panel

The review panel was to consist of eight members. Dr. B. Jean Floten, original chair of the committee, was unable to attend due to personal reasons. Dr. Lawrence Woolf was then asked to chair the committee and he agreed. Dr. Yolanda S. George, a panel member, was unable to attend due to illness. This report is based on the deliberations of the six members shown on the front page of this document.

Materials Provided to COV

Prior to the COV meeting, the NSF sent a notebook of background materials to COV members. This information consisted of

- Core questions and a report template
- The previous IMD COV report dated July 24-25, 1997
- Strategic Plan for the Division of Elementary, Secondary, and Informal Education FY1995 – FY2000 and progress toward meeting milestones
- IMD annual reports 1999, 2000, 2001
- Proposal guidelines for IMD
- Sections of a joint WestEd and Abt Associates June 2000 "Final Report on the Evaluation of the National Science Foundation's Instructional Materials Development Program"
- A list of comprehensive K-12 curricula funded by the IMD program
- Articles summarizing reviews of science and mathematics textbooks

At the COV meeting, the NSF provided the following additional information that was added to the committee's notebooks.

- Funding rates, funding summary, and dwell times for awards
- 1999 demographic data on PIs, co-PIs, and reviewers, and summary data on grants
- 2000 demographic data on PIs, co-PIs, and reviewers, and summary data on grants
- 2001 demographic data on PIs, co-PIs, and reviewers, and summary data on grants

- Evaluation reports for NSF Conference for Developers of Comprehensive K-12 Math and Science Curriculum Programs 2000 and 2001
- IMD web site information and sample emails concerning public criticism of NSF funded mathematics curricula.

Additional information provided to the committee included the following.

- List of awards in FY1999, FY2000, and FY2001
- List of declinations in FY1999, FY2000, and FY2001
- Proposal actions in FY1999, FY2000, and FY2001
- Awards closed in FY1999, FY2000, and FY2001
- FY2001 discouraged preliminary proposals
- FY2001 encouraged preliminary proposals
- A tabulation of the relationship between preliminary proposals, formal proposals submitted, and anticipated awards for FY2000.
- A list of PIs who are first time grantees for IMD for FY1999-FY2001

From 1999-2001, the IMD program received 282 proposals and made 89 awards and 187 declinations (6 proposals were withdrawn). IMD staff provided the following random selection of proposal jackets to the COV panel members for review.

- A total of 21 randomly selected and 12 hand-picked exemplary awards for a total of 33 awards from FY1999, FY2000, and FY2001.
- A total of 15 randomly selected declinations from FY1999, FY2000, and FY2001.
- From FY2001, a total of 5 randomly selected preliminary proposals that were encouraged and a total of 5 randomly selected preliminary proposals that were discouraged.

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

A1. Quality and effectiveness of the program's use of merit review procedures

a. Appropriateness of review mechanism

The IMD program's merit review process is working very well and, based on the jackets the COV reviewed, leads to the funding of strong proposals and appropriate declination of weaker proposals. The documentation in the proposal jackets is complete. The reviewers' critiques are detailed, thoughtful, and used by the program officer in constructing arguments for declination or funding. The comments of the reviewers are also useful to the PI in either carrying out a funded project or in revising for resubmission. The program officers' analyses of the proposals are clearly based on the reviews, the negotiation of issues raised by the reviewers, and their own careful analysis of the proposal and its fit with the goals of IMD. We were impressed with the care and thoroughness of the program officers' analyses and the ways in which the program officers work with the PIs to improve the proposed work.

b. Effectiveness of the program review process

The review process in IMD results in strong proposals being funded and these are often improved through the process of negotiation with the program officer. The review process is one of the jewels of NSF overall and certainly is so in IMD. Several different kinds of proposals are submitted to IMD and are appropriately reviewed in different ways.

- ***SGER Grants:*** SGER grants are reviewed internally because of the small cap on requests ($100K) and the

very fast turnaround time required. Our conclusion is that the process is working and is appropriate for such proposals.

• ***Preliminary proposals:*** Full proposals require a preliminary proposal, which is typically reviewed by two or three reviewers. This process requires a great deal of program officers' time, but yields more responsive and competitive proposals. The data provided to the COV indicated a relatively high acceptance rate for those that are encouraged to develop a full proposal and a correspondingly low acceptance rate for those who were not encouraged to develop full proposals, but chose to do so. For example, in FY2000, 24% of the full proposals based upon the encouraged preliminary proposals were funded, while only 1% of the full proposals based upon the discouraged preliminary proposals were funded, indicating that the system is working as desired. For each preliminary proposal, the program officers provided detailed feedback and raised important issues to be addressed in the full proposal. This process should be continued as an essential tool for enhancing the efficiency of the review process and promoting well-designed projects that are consistent with program goals.

• ***Full proposals:*** The number of reviewers for full proposals ranged from 3 to 14 in the sample that we reviewed. The number of reviewers seemed to match the size and complexity of the proposal submitted. The majority of the proposals have five written reviews and another two to three panel reviewers. The quality of the review panels and their reviews, in conjunction with the work of the program officer, lead to an impressive array of projects representing the strategic goals of IMD.

c. ***Appropriateness of time to decision and efficiency of review process***

The time to decision is acceptable for the sample we reviewed. For FY1999-FY2001, the time to decision averaged 6.3 months, compared to an agency wide average of 6.1 months. More than 75% of the PIs received feedback from the program within 9 months of proposal submission. In some cases, the time for PIs to respond to questions contributed to the delay. While reducing time to decision should remain a goal, the complexity of the negotiations with the PIs on large-scale grants is both time-consuming and essential.

d. ***Completeness of documentation for making recommendations***

The program officers in IMD do a consistently outstanding job of providing clear and detailed documentation in the jackets. It is easy to trace the history of the proposal through review, negotiation, and implementation. This is invaluable information for both internal quality control and for external review by committees such as this. In cases where substantial issues were raised by the panel of reviewers, the documentation showed that the program officer resolved these issues through negotiation with the PI. The level and quality of the interaction of program officers with proposal writers is a major strength of the IMD process.

e. Consistency with priorities and criteria stated in program solicitations, announcements, and guidelines

We found that the funded proposals were responsive to program solicitations, announcements and guidelines.

A2. Implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers

a. Percentage of reviews addressing intellectual merit:

The COV found that all reviews (100%) in the proposal jackets provided to the COV addressed the intellectual merit criterion.

b. Percentage of reviews addressing broader impacts:

The majority of reviews (80-90%) in the proposal jackets provided to the COV addressed the broader impact criterion. The COV found that reviewers were more likely to comment on intellectual merit and less likely to comment on broader impacts. In addition, reviewers often used a definition of broader impact more limited than the one described in the IMD proposal review criteria. For example, reviewers were not consistent in commenting on the participation of underrepresented groups unless this was an explicit target population of the proposal. The COV panel felt that the reviewers should be given additional guidance on this point, perhaps by a reminder in FastLane.

c. Percentage of analyses addressing intellectual merit:

All review analyses addressed the intellectual merit criterion.

d. Percentage of analyses addressing broader impacts:

All review analyses addressed the broader impacts criterion. We encourage the NSF to continue to address the broader impact on underrepresented groups in their analyses.

A3. Selection of reviewers

a. Use of adequate number of reviewers for balanced review:

The number of reviewers in the proposals examined ranged from 3 to 14, which the COV considered to be adequate. Typically 3 to 5 reviewers commented on each proposal. Proposals requesting cross program funds or large awards were reviewed by more than 5 reviewers.

b. Appropriate expertise and qualifications of reviewers:

Reviewers personally known by COV members had outstanding qualifications for judging scientific quality, soundness of approach, and likely success in diverse classrooms. Although proposal jackets and the program officer's response to the PI did indicate a range of expertise on the panel, it is difficult to come to a more precise judgment on this point without additional information. In particular, Form 7 does not indicate the position (e.g., teacher) or expertise (e.g., assessment) of the panel members and this information would be helpful in judging the qualifications of the panel members.

c. Appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups:

The review panels reflected some geographic and considerable institutional diversity and included members of underrepresented groups. We want to encourage the IMD program to seek a broader geographic balance of reviewers on the panels, particularly from outside the Northeast and Mid-Atlantic states. The COV encourages the program to continue its efforts to ensure that underrepresented groups are members of all review panels.

d. Recognition and resolution of conflicts of interest when appropriate:

The NSF goes to great lengths to recognize and resolve conflicts of interest and these issues are well documented in the proposal jackets.

e. Provision of adequate documentation to justify actions:

The NSF proposal jackets provide a thorough and complete document trail to justify the actions taken. The program was extremely thorough in documenting the decisions that resulted in an award or declination – and PIs were given a set of specific factors that formed the basis for the award decision. Such detailed feedback

should prove useful to PIs as they implement the awarded project. Further, the feedback to PIs serves to highlight critical issues when considering resubmissions and future submissions.

f. General concerns relevant to selection of reviewers:

The COV appreciates the difficulty securing enough panel members from underrepresented groups and the difficulty of obtaining a geographically diverse set of reviewers, and we encourage the NSF to continue its efforts in both these areas.

While there was generally a teacher on the review panels, there occasionally was not, and the COV recommends that practicing teachers be represented on each review panel. We agree with the finding of the WestEd/Abt Associates report that "the most successful proposals were informed by the realities of kindergarten to grade 12 classrooms. In this regard, it seems important for developers to include teachers at every stage ... to ensure that their voices are heard." Equally important is the voice of the practicing scientists, engineers, or mathematicians to judge the alignment of materials with key concepts and techniques of their fields – it was not always evident that each panel had a representative from this group and we recommend that there be one.

A4. Resulting portfolio of awards under review

a. Overall quality of the research and/or education projects

Based on a review of the lists of funded projects, the contents of selected jackets, and the COV members' knowledge of many of the IMD projects, the COV judged the quality of the funded projects to be very high. The COV also reviewed selected declined proposals and found the reasons for declination to be appropriate.

b. Appropriateness of award size and duration for the scope of the projects

The COV believes that most proposals are of appropriate size, duration, and budget. A full response to this question would require a thorough review of proposals and budgets that was beyond the scope of this committee. The review panels and program officers were careful to inform PIs when there was concern about the ability to carry out the proposed work given budget, personnel, or time constraints. In these cases, suggestions were made to scale back or reconsider the scope of work to maximize the probability that high quality work could be completed in a timely fashion.

c. Appropriate balance of program portfolio

From the review of the selected jackets and drawing on the knowledge of the committee members, it is clear that funded projects are represented in each of three categories of proposals: high risk, multidisciplinary, and innovative. To determine the actual balance is beyond the scope of the committee.

• High-risk proposals

The committee discussed the many definitions of high risk. In our interpretation, high risk means: projects that, if successful, might add significantly to the existing body of knowledge about instructional materials development; or projects that are directed by new or emerging leaders and institutions in the field. A review of the jackets indicates that there are proposals represented in the IMD portfolio that meet this definition of high risk. As an example, the panel considered The Development of a Cognition-Based Assessment System for Core Mathematics Concepts (Award #0099047) to be high risk and indeed the reviewers commented on this as well. The COV agreed that there is a need for a balance between the development of new materials and revisions of existing materials as well as a balance between modules and comprehensive materials, as IMD wished to interpret appropriate balance of program portfolio. Indeed, the COV agreed that the IMD portfolio is balanced in this regard.

• Multidisciplinary proposals

There seems to be an appropriate balance between multidisciplinary materials and single disciplinary materials.

• Innovative proposals

The committee found sufficient examples of materials that were innovative in content and pedagogy. Examples of innovative materials includes EMPower (Award #9911410), in which a new and critical population is being served by mathematics reform curricula, and Exploring Earth (Award #0095684) in which visualizations and student investigations are being integrated into an earth science textbook that is widely used.

d. Of those awards reviewed by the committee, what percentage of projects address the integration of research and education?

IMD materials are based on research in teaching and learning and therefore inherently integrate research and education. Therefore, essentially all of the projects address the integration of research and education from this perspective.

e. General comments regarding the quality of the projects and the balance of the portfolio

As noted in the preceding comments, the COV finds that, in general, the funded projects are of high quality and that there is a balance of high risk, multidisciplinary, and innovative proposals. Nevertheless, four issues merit attention in the immediate future: impact studies, high risk studies, new development in elementary science, and development of preschool curriculum. Each is discussed in turn.

1. Impact studies. A critical issue in the wide scale and continued use of NSF funded materials is the lack of long-term impact studies. Currently, development projects incorporate significant pilot and field-testing. However, none are funded to systematically examine the impact of curricular materials once the programs are used in the field. We strongly encourage the IMD to fund impact studies to build a base of evidence for the effectiveness of various curricular projects. The COV wishes to encourage the IMD to consider 1) expanding grants in time and dollars to allow for the collection of summative data that might inform the materials development process as a whole; or 2) funding companion projects that use third party reviewers to collect summative data. Issues regarding who should conduct these studies (e.g., curriculum developers or independent groups) merit careful consideration. Further, the COV feels strongly that a broad definition of impact is appropriate given the dearth of information available. Student outcomes should not be the sole measure of impact. Rather, this work would profit from articulation of expected outcomes for teachers, schools, and students for a given curriculum or program of instruction.

2. High risk studies. Although the COV recognizes the need for large-scale curriculum projects, the resources needed to support these efforts diminishes the dollars available for small and high-risk projects. This has two possible implications: one is the loss to the field of important ideas that might be developed were there funding available to try things out on a small scale. Another is the difficulty for new institutions and young PIs to get onto the playing field. We suggest that there be some funding set aside for small innovative projects to develop novel ideas and to utilize the talents of new investigators. The SGER proposals, although intended to support some of these efforts, are insufficient ($100K over 2 years) for many projects.

3. Elementary science curricula. In the sciences, there has been a shift in emphasis from elementary materials to secondary (middle and high school) materials development. This shift in recent years was essential given the lack of secondary materials and, as a result, important work has been supported. Now that there are middle and high school materials available, we encourage the IMD to rebalance its programs to meet the

current need for elementary curricula. There is considerable new research that emphasizes the role of literacy, mathematics, and technology in children's science learning. Moreover, there is an increased understanding of how children learn and ways to assess that learning that can be used to improve elementary curriculum development. Further, large-scale NSF-funded elementary science materials were developed prior to the publication of the National Science Education Standards (NSES). Producing and/or revising elementary materials that match the NSES and build on research on learning and assessment should be a priority.

4. Early Childhood. NSF's attention to preschool curriculum is a welcome one. With the publication of Eager to Learn and the increased public and policy interest in the early years, it is critical to continue to support the development and use of meaningful mathematics and science curricula for young students. Important also is the role of literacy skills in mathematics and science, particularly for this age group. We strongly encourage the IMD program to continue to support high quality early childhood materials development with special attention paid to the integration of literacy with mathematics and science.

PART B. RESULTS: OUTPUTS AND OUTCOMES OF NSF INVESTMENTS

There are many reasons why a review process such as this can only begin to address outputs and outcomes. First and most importantly, there exists relatively little long-term in-depth research on the complex issue of program impact. What is emerging suggests positive outcomes, however more must be done. Second, the time constraints on the committee do not allow for thorough review of the programs as a whole. Given these limitations, the COV has chosen to highlight specific studies under each indicator as a way to illustrate the high quality of the reviewed projects.

We found it insufficient to consider only the proposals funded in the previous three years. The development cycle of a typical project is five years, including pilot testing, field-testing, and multiple revisions. Following this development phase, another 3 to 5 years is needed to measure impact on student performance. Thus, for criteria such as B.1.a, "improved science and mathematics performance for U.S. K-12 students involved in NSF activities," it is more appropriate to look at materials funded in 1992-95. In the following sections, we provide a brief description of a study or studies that exemplify a particular goal. In addition, we have included some more recent projects that we judge to be of particular merit, but for which no outcomes are yet available.

B.1.a Goal for People: Developing "a diverse, internationally competitive and globally engaged workforce of scientists, engineers, and well-prepared citizens."

Improved science and mathematics performance for U.S. K-12 students involved in NSF activities

• NSF Award Number: 9252984

Title: Everyday Mathematics

PI Name: Max Bell

The Pittsburgh Public Schools conducted a study of the impact of Everyday Mathematics on student performance. Results indicate that students in classrooms where teachers (a) have appropriate professional

development and (b) are implementing the curriculum as intended by its developers outperform their peers in control classrooms on items that measure both basic skills and conceptual understanding. Additionally, the traditional gap between the performance of African American students and that of white students is narrowed: African American students in Everyday Mathematics classrooms actually outperform white students in the control classrooms (Briars and Resnick, 2000).

• NSF Award Number: 9255297 and 9844097

Title: Core Plus Mathematics Project (CPMP)

PI Name: Christian Hirsch

The University of Michigan conducted a study of the articulation between high school and college for students who received training using the NSF-supported Core Plus curricula. Transcripts of over 200 students showed that students in a district of high socioeconomic status near Detroit who had studied with the NSF-supported Core Plus materials for four years had higher grades, on average, in their first university mathematics course than students from a control school in a similar Detroit suburb. This pattern also held when comparing Core Plus students to others from the same school who graduated before the curriculum was implemented. In addition, Core Plus students were just as likely as their peers to take advanced courses (Calculus II, Differential Equations, etc.) upon entry to the university.

In 1999-2000, a test comprised of released items from the Third International Mathematics and Science Study (TIMSS) was administered at three study sites to assess effectiveness of the CPMP curriculum. Results indicate that CPMP students performed at a mean level similar to students in the Netherlands, the top country in mathematics literacy in TIMSS; in advanced mathematics, CPMP students scored above the international average on probability, statistics, and transformation geometry; at the end of their junior year, CPMP students performed considerably better in those areas than typical U.S. seniors enrolled in pre-calculus, calculus and Advanced Placement (AP) calculus.

• NSF Award Number: 9255863

Title: Active Physics

PI Name: Bernard Khoury

When NSF funded Active Physics, it sought to expand the number of high school students taking physics. Active Physics was to provide an alternative to traditional text books for students entering high school. Active Physics introduces 9th grade students to science knowledge and skills through inquiry around themes of communication, home, medicine, predictions, sports, and transportation. Since 1998, more than 500,000 students have completed units, with market potential expected to reach millions. A growing number of the 322 districts implementing the course have begun to note increased SAT 9 scores for their students. Active Physics was recently approved by the University of California as meeting the "d-laboratory science" requirement. Review by University of California (UC) faculty found that the course (1) provides a solid foundation for college-level work and (2) helps students develop a deeper conceptual understanding of physics than that provided by more traditional approaches emphasizing numerical problems. The UC faculty also noted that introduction of physics prior to chemistry and biology helps students develop a better understanding of core concepts in these disciplines that have their basis in physics.

• NSF Award Number: 9050210

Title: Investigations in Number, Data, and Space

PI Name: Susan Jo Russell

And

NSF Award Number: 9150217

Title: Connected Mathematics Project

PI Name: Glenda Lappan

The TIMSS-Repeat study conducted in 1999 offers evidence of the impact of NSF-supported mathematics curriculum materials on student achievement. Two groups of students from Michigan participated in TIMSS-R. The first group was a set of randomly selected schools that served as the state sample. The second group was an "invitational" group of schools who met certain criteria including use of instructional materials developed with NSF support, a well-articulated district curriculum, use of assessment data to inform instructional decisions, professional development to support teachers and good communication with the community. This group consisted of 21 schools representing rural, suburban, and urban environments. The Michigan state sample (score of 517) was the highest performing state group among the 12 states participating in TIMSS-R. The Michigan invitational group (score of 532) performed significantly higher than the Michigan state sample, indicating the positive effect of standards-based reform efforts within these schools (Mullis, et al., 2001).

Additional research studies of student achievement in mathematics are documented on the websites of the following implementation centers: http://Showmecenter.missouri.edu/; http://www.comap.com/elementary/projects/arc/; http://www.ithaca.edu/compass/.

A recent paper by Alan Schoenfeld at the University of California, Berkeley [2002] summarizes many of these studies and gives extensive attention to the study conducted by the Pittsburgh Public Schools described above. See

Schoenfeld, A.H. 2002. Making Mathematics Work for All Children: Issues of Standards, Testing, and Equity. Educational Researcher, 31(1), 13-25.

Indicators of Impact

Another way of gauging the impact of curricular materials is to look at their acceptance by schools and teachers as measured by market share. At this time, it is unrealistic to expect that these materials will soon capture a major segment of the textbook market. A more realistic expectation is that the materials will gain a foothold in the marketplace; that their use will lead to significantly positive student outcomes; and that the larger commercial publishers will find it profitable to begin to publish texts with features similar to those supported by IMD.

The relatively new elementary mathematics materials are now used in over 1,200 school districts and account for approximately 12% of the market. At the middle school level, mathematics materials developed with NSF support are used in nearly 4,600 school districts. To get a picture of the usage, see and click on Sites and Stories at http://Showmecenter.missouri.edu/. Large commercial publishers have noticed the impact on student achievement and on market share and a number of their middle school mathematics texts are incorporating ideas and approaches first found in the NSF-supported materials. Commercial publishers have also noticed the use and acceptance of science materials. An interesting result is the Exploring Earth project at TERC (Award #0095684) in which inquiry-based science is being infused into an earth science textbook with 40% of the market.

Professional development of the SMET instructional workforce involved in NSF activities

Many of the projects supported by IMD provide significant professional development of the SMET

workforce. The funding of the eight Dissemination and Implementation Centers exemplifies this activity.

We are delighted to see that all curriculum development projects now require the creation of professional development materials for teachers, and encourage the production of a professional development implementation plan concurrent with the publication of the materials.

• NSF Award Number: 9730174

Title: Leadership and Assistance for Science Education Reform (LASER)

PI Name: Lapp

The LASER (Leadership and Assistance for Science Education Reform) has eight regional sites around the country that are providing effective professional development experiences for teachers.

• NSF Award Number: 0001377

Title: Furthering the Impact of COMPASS: A National Secondary Mathematics Implementation Project

PI Name: Eric Robinson

The Furthering the Impact of COMPASS project provides effective professional development experiences for high school mathematics teachers.

• NSF Award Number: 9726403

Title: MARS: Mathematics Assessment Resource Service

PI Name: Wilcox

AND

• NSF Award Number: 0099047

Title: Development of a Cognitive-Based Assessment System for Core Mathematics Concepts in Grades K-8

PI Name: Battista

These projects provide formative assessment tools for teachers to improve the efficacy of their teaching.

Contributions to development of a diverse workforce through participation of underrepresented groups (women, underrepresented minorities, persons with disabilities) in NSF activities

• NSF Award Number: 9816320

Title: Children’s Math Worlds: Developing Children’s Mathematical Understanding in English and in Spanish from Kindergarten through Grade 3

PI Name: Fuson

And

• NSF Award Number: 9550532

Title: Multi-Math Adaptations

PI Name: Khalsa

Many projects contribute to the specific development of the workforce through participation of underrepresented groups. Two specific examples funded during this COV review period are: 1) Children's Math Worlds, a K-3 math project that addresses the needs of Latinos populations; and 2) Multi-Math Adaptations, which is developing mathematics material for people with a variety of disabilities.

Vigilance to the needs of underrepresented populations is always needed and we encourage IMD staff to continue to ensure: 1) trial testing of materials with diverse audiences; 2) development of specific materials as needed; and 3) inclusion of the needs of underrepresented populations in the review of all proposals.

Participation of NSF scientists and engineers in international studies, collaborations, or partnerships

This indicator is only minimally relevant to the IMD program. While there are several projects that have been funded, they represent a very small percentage of the total portfolio. One example is:

•NSF Award: #0114768

Title: SGER: The Development of Students' Informal and Formal Algebraic Thinking: Case Studies of Intended K-8 Mathematics Curricula in China, Singapore and the United States

PI Name: Jinfa Cai

This project will examine how algebraic concepts are taught in China, Singapore, and the US, and will attempt to determine how the differences in students' levels of achievements are related to differences in curricula in these countries.

Awardee communication with the public in order to provide information about the process and benefits of NSF supported science, mathematics and engineering activities

The focus of IMD is curriculum development and the implementation of curriculum. These materials reach the public in a variety of ways including parents who see them in the hands of their children and school boards and adoption committees who review them. The COV found several excellent examples of programs that are specifically meeting this indicator in innovative ways.

•NSF Award Number: ESI 9911410

Title: Extending Mathematical Power - EMPower,

PI Name: Myriam Steinbeck

TERC is adapting and extending the materials from three NSF-funded instructional materials development projects in order to meet the needs of out of school youth, adult learners, and other non-traditional students enrolled in adult basic education, pre-GED, GED/high school equivalency, and transitional courses to college. "These materials will provide them with the opportunity to obtain a high school diploma … and meet the mathematical demands in their roles as parents, workers and community members." (proposal p.14)

•NSF Award Number: 9705397

Title: Primes: Parents Rediscovering and Interacting with Math and Engaging Schools

PI Name Shelley V. Goldman

This award to the Institute for Research on Learning, later moved to Stanford University, funds a multifaceted effort to help parents become more involved in the mathematics education of their children. New materials and collaborative activity structures are being developed; outreach, training, and technical assistance to communities are provided; and these products are disseminated to the educational community. Concerted efforts, including repeated phone calls and visits to homes, were made to reach low income and minority parents. The outreach activities include planning support and workshops for schools, community organizations, and parent groups.

In addition to the individual projects, the COV believes that the Implementation and Dissemination Centers are critical players in informing the public of the existence and quality of NSF developed curricula. Taken together, the eight centers, four in mathematics and four in science, bring curricula and technical assistance in selection and implementation to districts across the country. The EDC Center specifically serves underserved districts and regions of the country. The LASER Center has, as one of its five key elements, the development of strategies to enhance community support for standards-based reform efforts.

B.2.a Goal for Ideas: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Discoveries that contribute to the fundamental knowledge base

The COV considers the IMD program successful in demonstrating significant achievement of this indicator.

• NSF Award Number: 9816818

Title: Mathematics Learning Study: Helping All Children Toward Success in Mathematics Learning

PI Names: Bybee/Feurer

A multidisciplinary study team was constituted by the NAS to review and synthesize research on mathematics teaching and learning and make recommendations for improvement. The Mathematics Learning Study was co-funded by ESIE and the US Department of Education. The study defined "successful mathematics learning," described the status of US students' mathematical understanding, and made recommendations for improving mathematics teaching and learning. The committee produced a widely distributed book "Adding it Up." A short, policy-oriented version is forthcoming.

• NSF Award Number: 0099047

Title: The Development of a Cognition-Based Assessment System for Core Mathematics Concepts

PI Names: Michael Battista

This proof of concept proposal seeks to develop a cognition based assessment system for use by teachers in identifying student progress toward mastery of core mathematical ideas. The project will describe cognitive paths taken by students in learning core mathematical ideas. In addition, the project will design assessments that can be used to monitor student progress by teachers, districts or program evaluators.

The project will apply the results, theories, and methods of modern research in mathematics education to create a Cognition Based Assessment System that can be used to assess in detail the cognitive underpinnings of the progress students make in constructing understanding and mastery of core mathematical ideas in grades K-8.

Leadership in fostering newly developing or emerging areas

The COV considers the IMD program successful in demonstrating significant achievement of this indicator.

• NSF Award Number: 9911410

Title: Extending Mathematical Power (EMPower)

PI Name: Myriam Steinbeck

The Education Research Collaborative at TERC is taking a leadership role in addressing the needs of students who have not been successful in traditional education settings. The EMPower project seeks to adapt and extend the materials from three NSF-funded instructional materials projects in order to meet the needs of out-of-school youth, adult learners, and other non-traditional students enrolled in adult basic education, pre-GED, GED/high school equivalency, and transitional courses to college. Instructional units and instructional support materials are being developed around 8 topic areas in mathematics. Pilot and field sites represent an exceptionally diverse population including ESL, those identified as learning disabled, students residing in homeless shelters, and a large proportion of minority students.

•NSF Award Number: 9626809

PI Names: William Dugger

Title: Technology for All Americans: Phase II

The International Technology Education Association will take the lead in the development of technology education standards for K-12 with benchmarks at grades 2, 5, 8, and 12. The project builds on the findings of an earlier report "Rationale and Structure for the Study of Technology," which identified six components of technological literacy for all students. Using this as a basis, the project develops and undertakes extensive review of the technological concepts and processes students should understand and be able to apply in grades K-12.

Connections between discovery and learning or innovation

The IMD program has made a number of significant awards that range from the development of technological tools for exploration of large data sets to the careful development of detailed classroom protocols to develop a culture of collaboration in middle school science classrooms around innovative units in earth science. We list some projects that exemplify this criterion below.

•NSF Award Number: 9819250

Title: Developmental Biology: An Interactive CD-ROM for the High School Classroom

PI Name: Pasquale

This interactive CD ROM module for the high school classroom updates the treatment of developmental biology and promotes teaching of the subject through interactive, inquiry-based instruction. It highlights the role of genes in development, evolution, and applications of developmental biology. The CD received an award of distinction in the Communicator Awards 2001 Video competition.

•NSF Award Number: 9553883

Title: Building Bridges Between the Macroscopic and Microscopic: Student Led Investigations in Multidisciplinary Science

PI Name: H. Eugene Stanley

Building Bridges Between the Macroscopic and Microscopic: Student Led Investigations in Multidisciplinary Science develops molecular dynamics modeling tools and assessments that enable students to visualize atomic motion, and manipulate atomic interaction. These lead to quantitative investigations of macromolecular properties of biological, chemical and physical systems. Scientist/teacher teams can adopt research grade scientific models into high school science learning tools. Real-time simulations are coupled to scripted movies that introduce the scientific concepts.

•NSF Award Number: 9818946

PI Name: Cliff Konold

The University of Massachusetts is developing a statistical software package, Tinker Plots, for middle school mathematics. The software allows students to explore ways of displaying data and making sense of it. The grant provides funds for the revision of appropriate units in each of the five sets of middle school materials developed with NSF support so as to take advantage of the features of the software.

•NSF Award Number: 9818828

Title: Learning by Design

PI Name: Janet Kolodner.

This project carefully develops a design culture in classrooms, and then uses the ideas of design to understand topics in physical and Earth science.

Partnerships that enable the flow of ideas among the academic, public or private sectors

IMD has made some outstanding awards. These range from projects that provide assistance in dissemination and implementation to a project that brings high school students together with research mathematicians around problems that give students a taste of mathematical research. We list some projects that exemplify this criterion below.

•NSF Award Number: 9730627

Title: Children Designing and Engineering

PI Names: Patricia Hutchinson, Dana Egreczky

The Children Designing and Engineering project is developing 12 instructional units for grades K-5. The units are based on subject matter that is both interesting to young learners and relevant to business and industrial settings, in such areas as transportation, food, safety, health, and utilities. Through its use of industry contexts (including Lucent Technologies, Six Flags Wild Safari, and Marcal Paper), the project demonstrates how real-world work settings can be introduced at the elementary school level in age-appropriate ways.

•NSF Award Number: 9730174

Title: Leadership and Assistance for Science Education Reform (LASER)

PI Name: Lapp

The Leadership and Assistance for Science Education Reform (LASER) project provides assistance in the

dissemination and implementation of high-quality K-8 science curricula. The project has partnerships with eight regional sites across the country, and each site includes academic institutions, corporations, systemic initiatives, museums, and publishers. The NSRC provides each site with materials and expertise in strategic planning, criteria for materials selection, and ideas for building administrative and community support.

•NSF Award Number: 9818736

Title: Developing Mathematical Research Skills

PI Name: Albert Cuoco,

EDC is developing a set of research problems suitable for middle school and high school mathematics students. The problems are made available on the EDC website and the project team is working with the collegiate professional mathematics organizations to engage mathematicians in becoming mentors for students and their teachers.

B.3.a Goal for Tools: Providing "broadly accessible, state-of-the-art and shared research and education tools."

Use of the Internet to make SMET information available to the NSF research or education communities

•NSF Award Number: 9720687

Title: The Worldwatcher Curriculum: Integrating Visualization into Inquiry-Based Science Learning

PI: Daniel Edelson

The Worldwatcher project (9720687) is a free software package that helps students study, visualize, and understand large sets of climate and global climate change data. It explores environmental processes from a geographic perspective, incorporating geographic data visualization and analyses as primary investigation tools. The Worldwatcher curriculum can be downloaded from the Internet or installed from a CD ROM.

NSF Award Number 9730651

Title: Performance Assessment Links in Science (PALS): An On-Line Library

PI: Edys Quellmalz

The PALS project provides web based performance assessments that address the National Science Education Standards. The PALS project has posted over 200 K-12 science assessments on the PALS web site and developed a user-friendly interface that can search for assessments tied to NSES, state, or local standards. PALS is currently developing mathematics performance assessments based on NCTM standards.

Comment on steps that the program should take to improve performance in areas of TOOLS goal.

A critical tool that is currently under development is the NSF web site describing IMD projects. Currently that site has information about IMD awards, links to project web sites, and an email link to the PI. To increase the usefulness of the web site to teachers, administrators, parents, and policy makers, we suggest that the NSF encourage the PIs to include the following information on the project web site:

• A list of states where the material has been specifically approved for adoption or is used

• A list of sample schools and districts that are using these materials, along with an email contact

• Summative field test results

• Any available assessments of the effectiveness of the program

• Teacher’s personal experiences with the program

• Sample pages of the instructional materials

• Instructions or directions for obtaining professional development for these materials

We also suggest that the NSF provide a single web page that lists the comprehensive curricula funded by IMD as shown in tab 8 of the COV reviewers’ notebooks along with links to the NSF Award web site and the program specific web site. An additional web page with a comparable listing of non-comprehensive curricula would also prove useful.

B.4 Program areas in need of improvement.

While we have pointed out areas in need of improvement previously in this report, we here reiterate those we consider to be critical.

1. Although the program officers are able to make the awards in a timely and effective manner, we are concerned that they do not have the resources needed to effectively monitor funded proposals. There are insufficient funds for site visits, which are invaluable for assessing the ongoing efficacy of the grants. Insufficient time is available for program officers to proactively follow the progress of funded projects. We would like to see NSF determine whether additional program officers and clerical assistants are needed to accomplish IMD tasks.

2. The NSF IMD has funded the development of a large number of high quality instructional materials by science and mathematics education leaders. Although formative evaluation and trial testing of the IMD-funded materials provide encouraging reports regarding their value and impact, and a few published studies show some gains in student performance, significant scientific data that answer the questions, "Is this program effective?" and "Is this program more effective than existing programs?" are often lacking. This makes wide spread use of NSF-funded materials problematic because of the complexity of instructional materials adoptions by individual schools, districts, and states. More summative evaluations and longitudinal evaluation and impact studies need to be made of the curricula developed through NSF's IMD program. In order to overcome this difficulty and to justice to Part B of the review template, more summative evaluations, longitudinal evaluations, and impact studies are needed. To meet this need, the NSF should fund a portfolio of studies and/or extend funding of existing projects. Most of the data the COV has to review involves the selection of the award, the initial plan, and beginning efforts. It is critical that performance data over a number of years be acquired to determine the effectiveness of the programs with diverse populations.

3. We want IMD staff to continue its efforts to fund high-risk projects, either because the concept may be of high risk, but potentially of high reward, or because the personnel or institutions may be lesser known in the IMD community. The COV panel is concerned that high risk programs proposed by individual investigators or small groups or first-time proposers may not be approved for funding due to their non-association with the infrastructure necessary to meet full proposal requirements. We encourage the NSF to consider a program structure similar to the Small Business Innovative Research (SBIR) program to encourage innovative and high-risk proposals from those who have limited resources and infrastructure access.

4. It is critical that engineering and technology instructional materials be developed to increase student awareness of future careers in engineering and technology. Students need experiences in the engineering

disciplines in order to develop core technology competencies and to determine potential areas of interest. With the publication of technology standards, the NSF is positioned to support the development of technology instructional materials in order to increase technology literacy for all as well as to catalyze the next generations of engineers and technologists.

5. We encourage IMD to include in its solicitations that proposers explicitly address the barriers to adoption of their proposed materials at the teacher, district, and state levels and develop strategies that districts can use to confront these barriers.

6. Greater emphasis needs to be given to the instructions for reviewers, so that they understand the meaning of Intellectual Merit vs. Broader Impacts. This will allow reviewers to consistently rate all proposals under these criteria.

B.5 Program's performance in meeting program-specific goals and objectives.

Instructional materials are at the core of education reform. The IMD program has led the development of instructional materials that address curriculum standards at the state and national level, such as the NSES and NCTM standards. The COV believes that the IMD program plays a critical role as a catalyst and supporter for the development of programs to improve SMET education for all students. Indeed IMD materials are the basis for teacher enhancement and systemic initiatives. They are the critical link upon which the NSF mission of improving SMET education is based. We applaud the efforts of IMD staff and the results obtained by the IMD program and strongly encourage their continuation and expansion.

Over the past 20 years, IMD has supported the development of comprehensive science and mathematics programs as well as supplemental materials for pre-K to 12. Some of these materials have been recognized as excellent by AAAS Project 2061 and exemplary by the US Department of Education. Now it is critical that additional resources be provided to the IMD program for the logical next stage. This should consist of the following.

- The revision of the materials that were developed 10-20 years ago to bring them into compliance with the NSES and to build on the developments of the past decade in the understanding of how people learn; the use of technology; the importance of connecting science, mathematics, and literacy; and the development of the process of curriculum design itself.

- The revision of existing materials that is necessary based on feedback from users and new information and insights.
- The development of new and innovative instructional materials.
- Long term longitudinal studies of the effectiveness of these programs that are needed to assess their effect on student learning.
- With the publication of the National Technology Standards, the development of materials to meet these standards.

B.6 COV review process, format and report template.

The COV process could be improved in two ways. First, increased time is needed for the review process. More than two days are needed to accomplish the COV goals in a reasonable way. We suggest that the COV process be extended to 2.5 – 3 days. In addition, the time to produce the final report should be increased from 2 weeks to 4 weeks after the NSF meeting. Second, the COV process could also be improved by sending

pertinent information ahead of time for review by the COV. For example, all of the materials that were added to the notebooks or requested by the COV, as shown in the first few pages of this report, should be provided to the next COV before they arrive at NSF. The notebooks should be provided to the COV at least 2 weeks prior to their meeting. In the interest of efficiency, it might also be helpful for one of the members of the COV to have participated in a previous COV so that they can effectively lead the group through the review process.

Some of the goals, review criteria, and terminology are not applicable to EHR in general and IMD in particular. Staff should review the template and review criteria to determine ways for the review guidelines to address issues that are relevant to education programs. A separate template for education programs would improve the efficiency of the COV process.

While IMD staff provided a tremendous amount of highly organized information to the COV, some additional data was needed to answer some of the questions. For example, the COV members would have liked to have been provided with the date of first contact between the program officer and the PI, as well as the ethnic background and job description, expertise, and current position of each review panel member. The COV also found that it was very difficult to determine the impact of many projects, and it was of course impossible to determine the impact of newly funded projects. For each completed project, the COV would have liked to have seen any evaluation and documentation available, such as research studies and evaluation reports. We suggest that part of the next COV review should involve looking at final reports of completed projects.