National Science Foundation
Directorate for Education and Human Resources Advisory Committee Meeting
November 2-3, 2011
Arlington, VA

Welcome and Overview

Dr. Lee T. Todd, Jr., Chair, EHR Advisory Committee (EHR AC), opened the meeting at 8:30 a.m. After welcoming remarks, he reminded the EHR AC of the report the committee wrote to Dr. Subra Suresh, Director of the National Science Foundation, following the May 2011 meeting and explained that Dr. Suresh would join the group at the end of their meeting. Dr. Todd also outlined the agenda for the day.

Dr. Joan Ferrini-Mundy, Assistant Director of EHR, welcomed the meeting's participants and asked EHR's new staff members to introduce themselves to the committee. She reminded the group that the Director and Deputy Director of the Agency will be joining the meeting tomorrow to talk about a number of interesting initiatives that are going on agency wide.

At a previous meeting, the AC formed working groups and provided EHR with material in a couple of areas of interest. Dr. Ferrini-Mundy informed the group that one of those topics, stakeholder involvement, is on the meeting agenda. She also let the committee know that EHR started to address another of the topics, developing a core research and development agenda for EHR, by holding a forum on potential core research questions and key areas that this directorate should be positioned to make progress on over time.

She continued by updating the committee about a few activities going on that are important to the functioning of the directorate going forward. This included describing the internal evaluation group working to ensure that everyone is deeply engaged in thinking about the goals of programs, how those goals interrelate, and how those goals relate to the metrics and outcomes that EHR cares about. Dr. Ferrini-Mundy also described an undergraduate education task group that works to keep EHR and NSF apprised of what is happening in undergraduate education and how NSF's activities can fit with that.

Dr. Ferrini-Mundy commented on all the hard work that all the divisions are doing on a daily basis from making grants to planning panels and asked that the EHR AC give them a hand of applause. She also thanked Dr. Todd for attending the National Science Board meeting and participating in a discussion about a strategic vision for education at NSF including better infusing education across the agency and making the science going on across the agency more central in EHR's education work. Dr. Todd added that they talked about how to get the word out about what is available, how to talk to potential partners, and how the agency could work to scale up activities that are not initiated here but could use some help in being carried out. He added that the board seemed extremely interested in how EHR is progressing. Dr. Ferrini-Mundy concluded by highlighting some of the accomplishments of the directorate of the last six months. These highlights included:

- The completion of the first phase of responding to a request from Congressman Frank Wolf that there be a report about success in K through 12 STEM education by commissioning the NRC to write the report, "Successful K-12 STEM Education." In September, a group was convened at Drexel University to have a summit focused on the study with a particular focus on successful

projects in the Philadelphia area. The event was attended by Congressman Chaka Fattah; Congressman Wolf sent remarks, and it was an overall success. Additional follow-up activities around this report are being planned including three follow-up regional workshops.

- EHR had a PECASE award winner, Tina Grotzer from Harvard, for her work on how children can learn to reason about complex causality.
- Jad Abumrad from Radiolab, which was funded through the Informal Science Education Program, was a MacArthur Fellowship winner.
- A few EHR projects appeared in *Science* including Bill Schmidt's piece on preparing future math teachers and Doug Clements' and Julie Sarama's work on early childhood mathematics intervention.
- SciGirls, funded by the Informal Science Education Program, won a Daytime Emmy.
- PhET, an interactive simulations project that has had some NSF funding, recently won a Tech Award.

Session I: Committee Business

Receipt of Committee of Visitors Reports

Dr. Bernice Anderson, a Senior Advisor, started the receipt of Committee of Visitors (COV) reports by explaining that EHR evaluates its programs every three years and that the expert review of programs by the COVs help EHR to be forward thinking and accountable. The committee received and accepted COV reports for the following programs:

- Noyce Scholars Program
- IGERT
- GK-12
- ISE
- ITEST
- ADVANCE

Potential Enhancements of the Merit Review Process

Dr. Todd introduced Dr. Steve Meacham from the Office of Integrative Activities and Dr. Candace Major from the Directorate for Geosciences to discuss NSF's merit review process and some potential changes to the process. Dr. Meacham explained that they co-chair the Merit Review Process Working Group, which was recently established by the Director. The working group was tasked with exploring the background and context for NSF's merit review process, and designing/analyzing pilot experiments to identify alternative/enhanced approaches to merit review. Dr. Meacham further explained that he and Dr. Major would give a brief presentation about the current process, impetus for change, and potential options going forward and that they would be coming back in the afternoon to get any feedback the Advisory Committee members may have on ways the working group might be able to enhance the process.

The ideas Dr. Meacham presented included:

- Shadow Panels: An independent assessment of the transformational potential of the work may help more explicitly to include it as a factor in the decision process and mitigate the tendency toward risk aversion in standard panels. A separate review panel (the "shadow panel") would be convened with the primary purpose of identifying potentially transformative research proposals. Results from both the standard and shadow panels would inform the Program Officers in making their funding decisions.

- Encourage Accomplishment-Based Renewals: Accomplishment-based renewals are awards to established PIs based primarily on their past productivity. Currently NSF and the research community make relatively little use of this mechanism. Program Officers could be more proactive in encouraging successful researchers to submit ABRs. This should be extended to successful collaborative groups of researchers
- Moderating Proposal Pressure: A number of suggestions have been made for strategies to reduce the number of proposals that PIs have to prepare and reviewers to review. Examples:
  (1) Ask PIs more than 10 years past PhD not to submit more than two proposals per year.
  (2) After three successive declined submissions, a PI is asked to wait xx months before submitting a new proposal.
  (3) Limit submissions from PIs that have at least two active awards with more than 12 months remaining.
- Proposal Analysis Tool: A machine learning tool based on textual analysis of NSF's corpus of past proposals and the reviewer assessments of those proposals could be used to flag incoming proposals that are likely to not fare well in merit review. Program Officers would then look at the flagged proposals to see if they agree (in which case the proposal could be declined without going out for external review) or disagree (in which case the proposal would be sent out for external review).
- Wiki-based Reviews: A set of reviewers is assigned to a proposal. Each submits an independent written review. Once a reviewer has submitted his or her review, he/she can see the other written reviews and begin a discussion of the merits of the proposal with the other reviewers on a secure Wiki site. Reviewers' identities are hidden (using labels like Reviewer 1, Reviewer 2 etc.). At the end of a set period (e.g., one or two weeks) each reviewer submits a revised version of his or her review and the Wiki site is then locked. Both the original and revised reviews are retained, along with the Wiki discussion, and provide input to the Program Officer. A variation of this would include a Wiki discussion moderator. Another variation could be structured more like a panel: the reviewers would look at a set of proposals; reviewers would be able to see each other's identities; a scribe would be assigned for each proposal and would prepare a summary of the panel's asynchronous discussion.
- Increased use of virtual panels: More proposals could be reviewed by reviewers who discuss the proposals as a panel but do so via videoconference or teleconference rather than coming together in a single physical place.

Session II: Expeditions in Education (E^2) – Partnerships with Directorates

Overview of the E^2 Concept

Dr. Ferrini-Mundy introduced the session by explaining that Dr. Tim Killeen, the Assistant Director for the Geosciences (GEO), and Myron Gutmann, the Assistant Director for the Directorate for Social, Behavioral and Economic Sciences (SBE), would be discussing the potential ways the agendas of EHR and their directorates could be intersecting. She added that Sastry Pantula, the Division Director for the Division of Mathematical Sciences (DMS) in the Math and Physical Sciences Directorate, would be sharing his comments with the group after Dr. Killeen and Dr. Gutmann were done. Finally Dr. Ferrini-Mundy informed the group that after the remarks portion concluded, she would be looking to hear the AC members' thoughts on how EHR can play a bigger, broader role in the agency.

Dr. Killeen started by responding to questions of "Why NSF?" and "Why not the Department of Education for all things education?" He pointed out that there are two things NSF can contribute. First,

it has the capability to do deep research into learning, how people learn, and how learning environments are best established. Second, NSF has the STEM dimension and that EHR in particular is embedded in a research foundation that has a wildly exciting purview of all of the rest of science, technology, math, and engineering, which is a tremendous asset that should be utilized. Dr. Killeen then presented the plan he and Dr. Ferrini-Mundy devised to bring together the dual goals of improving science and engineering research investment and engage STEM education called Expeditions in Education (E^2). He explained the three key tenets of the program:

- Engage- The importance of highlighting the relevancy of STEM materials to learning and through the engagement process.
- Empower- Empowering educators through curricular developments including looking at diversity issues and learning issues from K through life-long learning.
- Energize- Once the talent and human capital are developed people need to be energized to go out and make things happen in modern society.

The program, he elucidated, would be a way to formalize EHR's partnerships with the research directorates. This program could fund activities which would engage the talents of the research directorates, working in full partnership with EHR to engage, empower and energize. He concluded by inviting the EHR AC to engage with the Environmental Research and Education Committee, which helps to oversee the Science, Engineering and Education for Sustainability portfolio investment.

Dr. Gutmann began his portion by describing "Rebuilding the Mosaic: Fostering Research in the Social, Behavioral and Economic Sciences at the National Science Foundation in the Next Decade", a report that SBE would be releasing. He explained that the report came out of asking the community to write white papers for SBE and highlights that research in the future is going to be collaborative, interdisciplinary, data intensive, problem-oriented, and that the use of research groups will be increasing. Dr. Gutmann then emphasized the importance of integrating research and STEM education especially given the opportunity presented by the new era of connectivity and massive amounts of data that can be used to empower researchers, teachers and the public. He went on to describe the natural affinity between what goes on in the social and behavioral and economic sciences and what goes on in research related to learning and education. He continued by drawing attention to one of the findings of the Mosaic report: questions about how to build communities to engage in the practice and activities of building new data. Dr. Gutmann concluded by asking the EHR AC how to create a community that can organize itself around important questions and called for the data and infrastructure that is needed to bring together the SBE sciences and educational sciences and ways to support existing and developing communities with interests across NSF, across agencies in the government, and across national boundaries.

Dr. Pantula reiterated Dr. Gutmann's point that big data presents opportunities for mathematical and statistical scientists to collaborate with educational researchers and researchers in other areas. He continued by explaining that the NSF 2011-2016 Strategic Plan talks about new cyber tools for collecting, analyzing, communicating and storing information which will require new research, new infrastructure, and a workforce that is computationally- and quantitatively-enabled problem solvers and researchers for the future. In connecting these needs with education, he discussed a recent paper discussing educational informatics focused on collecting, mining, and analyzing large data sets about learning. Without delving into the entire paper, he explained that it brings to light ample opportunities for the EHR and SBE communities to work together with the mathematical and statistical sciences.

Dr. Pantula then highlighted the new DMS program, Computational and Data-Enabled Sciences and Engineering and Mathematical and Statistical Sciences, the new categories under the Graduate Fellowships related to computational mathematics, statistics and data-enabled science, and the collaboration with EHR to develop a transformative computational research experience and curricular changes to undergraduate and graduate programs. He concluded by emphasizing the importance of experimental design especially in an era where data collection has become cheaper and using good experimental design to make sure that large data sets do not mean large misuse of data.

Dr. Ferrini-Mundy then opened the floor for discussion. The thoughts raised by the AC members included:

- Conversations across the foundation. Three-way and four-way conversations between EHR and MPS and SBE and the other STEM disciplinary directorates should be encouraged because everything is interconnected and even going at it in partners isn't going to get the job done.
- Questioning what additional thought has been given to how the collaborations discussed within NSF could affect the way the work is organized in universities because some of the most compartmentalized, rigid structures exist in the academy. How might the influence power of NSF be leveraged to at least begin to look at ways of breaking down those barriers?
- Components in every directorate that seem to be trying to develop human resources. In EHR, that's an overall mandate. Is there a specific area where EHR could have maximum impact by doing assessment for some things that you're doing or some other task to support human resource development? Is there part of what everybody does that EHR could own and bring a lot of value to other directorates?
- Source of innovation. NSF plays a role in innovation but if we could get to the core of why, how do we get these innovators, how do we get more of them, and how do we put the science into STEM education?
- Potential for economies of scale. It seems there is potential for economies of scale across different divisions and directorates and where the common work is, whether it's workforce or other areas. So whether or not those particular divisions take on some of the work that EHR has traditionally done, and EHR becomes a consultant, or EHR takes on some of that work out of those areas, EHR needs to think about being smarter. EHR also needs to think about business models that are most cost effective that can help look for the cross-cutting and integration opportunities.
- Partnerships and silos. Sometimes partnerships to overcome the silos in higher education can be very artificial because the people come together but the recognition of what each community or person can contribute to the task is clouded and scientists are often asked to do things which they have no interest in nor any knowledge about. There's often a broader impacts statement required with NSF awards and a lot of little ideas are used to meet the requirement that would never amount to anything or contribute to anything on the education side. But if partnerships are encouraged between scientists and people who understand education or informal science the broader impacts activity can be something meaningful, publishable for both participants. Buy-in is also possible because the scientists would be getting help with something they might not really be interested in doing but would make the scientists look better for their next NSF grant application. So if NSF could work to encourage these types of partnerships, and somehow connect EHR's people with scientists, that could help.
    - Dr. Gutmann responded by questioning NSF's responsibilities in this process. What are the responsibilities that investigators have? What are the responsibilities that

institutions have? Requiring these partnerships creates costs and considerable thought should be given to that relationship.

- Breaking down silos. NSF can help by becoming more aware of the mechanisms that institutions of higher education are using to break down the silos, like the new academic structure being looked into at Harvard, and thinking about whether or not it wants to be a partner in producing these new structures because the biggest problem thus far is figuring out what those new structures should look like. Universities can work to break down the silos but if there is no structure that allows one to do that and you go to NSF for funding to do it and NSF doesn't support it financially then nobody is going to support you for trying new structures .
- Research Coordination Networks. Research Coordination Networks (RCNs) seem to help encourage collaboration. Taking the different smaller pieces and building communities through RCNs rather than each person doing their own thing, leads to broader impact efforts that are coordinated and are leveraging something more sustainable and more meaningful than any one researcher could do individually with a short-term grant.
- Collaborations. There have to be different ways of looking at transforming collaborations or they will die because the old guard will get the final review criteria and disregard it. If NSF can come up with a clever way to encourage these new collaborations while still keeping quality and criteria in mind but perhaps setting up a new weighting system that could be a model to the academic world perhaps the academic world will say, "If NSF does it, maybe we should think about doing it."
- Liaisons. One university hired an individual to form the connections between engineering faculty, education faculty, social science faculty, legislators, Department of Education in the state government and local K-12 school districts. This person formalized the partnership process and now everyone knows that when you write an NSF grant you go talk to this person about the broadening impacts of it. The school is trying to replicate this on a larger scale but that hasn't worked quite as well yet.
- Resources. Sometimes frustration occurs when communities that are not used to having large funding but actually can cut across fields are told to think big and when everything comes together to have a project the opportunity is not there anymore. It's not just about making the opportunity; there have to be resources put in place to make sure that it happens.
- Planning. If informal institutions can look forward to the kinds of partnerships being discussed, it can be done in a well planned, long-term way as opposed to the, "I need your help now" approach which happens all too often. When these partnerships are well planned it creates more than programming but exhibits and traveling educational outreach programs that really do inspire the kind of work and workforce development that we want to see happening.
- Thinking broadly. A lot of time is spent talking about the silos within institutions, and we need to think broadly across institutions and across sectors. It's hard within an institution, and then it's twice as hard when you try to collaborate between the sectors, K-12, community colleges, four-year institutions, museums, business communities, but these are all very important partnerships to create. How do we support the structures that are successful but not because one person is making it happen?
- Big questions. There needs to be the focus on overarching questions and themes that break through boundaries naturally because of the largeness and the breadth.
- Impact and metrics. There's an organization that has created an idea around social innovation and collective impact, and it gets to this issue of big overarching questions and issues, and the agreement on those, the common set of metrics that supersede the individual needs and yet

require that all of the individual constituencies be able to align to some common metrics of success, and they're having some impact with this.
- Persistence and longevity. It is important to ensure that after a grant is over with there is something left over structurally so that collaborations continue.

Dr. Ferrini-Mundy closed the session by stating that the first challenge is to focus on EHR and what it is doing as a directorate, how it is investing to try to solve the most challenging issues in STEM teaching and learning, and workforce development, and broadening participation, and balancing these demands with the opportunities for collaborations that can help to continue to advance STEM education and address the challenges that NSF is best positioned to solve.

Committee Reflection on Session II

Dr. Todd introduced the session by inviting comments about the session so far. The comments shared by the AC members included:

- When partnering with the institutions, EHR should keep in mind that it's a peer-to-peer collaboration, and that EHR is a research directorate. In doing this, EHR should really think about how to leverage broader impacts.
- It's important to make it easy for PIs to have ways to really have impact. Setting up a website or creating a map that shows where the Math and Science Partnerships (MSPs) and other major projects that they can plug into would help them understand what opportunities are nearby that they could collaborate with.
- Discussion has focused on what can EHR do for others but thought should be given to learning from partnerships. Will a given partnership bring new skills, new resources, and so on to EHR?
- The single greatest criticism of a lot of educational research done in the United States is that it doesn't take into account the real substance of what is being taught.
- Consideration should be given to who is being taught and in what context. It's very difficult to make any generalization, but certainly a lay of the land, a picture that's a landscape and provides a good sense of what's going on and can inform any of the directorates and any of those outreach efforts as they begin to think seriously about participation would be beneficial.
- The directorates are probably doing some things which they feel good about, but they're not sure it works, and maybe they want somebody to come in with some educational research to learn if what they're doing works. EHR may need a kind of product list to share and make people look at it to see what EHR could do for them. That would make it easier for people to look at what EHR has to offer, and how they can follow up and act. EHR needs to figure out what it has and market it.
- The math division said that they were spending about 15 percent of their resources on education. Is it known how they're spending these funds? Some NSF projects don't have evaluations and they have no clue what's working. It might be helpful to know what they're spending their money on because they may not even know that we can help.
- One of the big problems is that people getting into these areas are very naïve about what has been done and what works, and there's no real opportunity to learn what works which may be wasting a lot of money.

Dr. Todd then asked the group if they had any thoughts about the merit review process session. The following are some of the thoughts shared by the AC members:

- Wikis and virtual panels are an excellent idea and should be pursued. Face-to-face is important too so a hybrid seems like a really good option.
- Virtual meetings have challenges of their own. Serious thought is needed about what face-to-face actually yields, and what it does in review, and right now technology isn't quite there. If NSF is going to depend on these technologies for review where nuance and other pieces are really important, then NSF should work towards perfecting it.
    - Dr. Kate Denniston, Acting Division Director for the Division of Undergraduate Education, added that there is a huge amount of community building that takes place in the halls, not necessarily just in discussing the proposals, but in meeting and coming up with ideas and collaborations. To lose this opportunity completely would be a shame.
- If accomplishment-based renewals are going to be utilized more often, what would be considered accomplishments and how would that be defined in a strictly science or engineering directorate as opposed to a directorate like EHR?
- NSF should consider which proposed revisions to the merit review process would work best early on in terms of how the community of reviewers functions now. NSF has had 50 years of getting our community to react in a certain way and set standards, and as it thinks about programs and review committees, which of these does it think would be harder to integrate into the review community?
- The shadow proposal was interesting, and it has the possibility of creating another pair of eyes, but it also has the possibility of marginalizing transformation because if it is so important to the process, then why is it a shadow? And is there a way to more fully integrate it into the process?

Session III: Interactions with External Stakeholders

CoSTEM Report

Dr. Ferrini-Mundy introduced Dr. Michael Feder from the Office of Science and Technology Policy (OSTP), which is a branch of the White House. Dr. Feder, she explained, will be speaking about a project that he is leading called CoSTEM, which is the Committee on STEM Education. She elaborated that CoSTEM is a committee of the National Science and Technology Council, chaired by Dr. Carl Wieman from OSTP and Dr. Suresh from NSF, that has been charged by Congress to undertake the work that Dr. Feder will be reporting on.

Dr. Feder began by explaining that the CoSTEM project is a really collaborative effort that was commissioned by Congress under the COMPETES Act to put together a five-year strategic plan of how every agency that's investing in STEM education should be moving forward in the future. The goals are as follows:

- To accurately characterize what the federal agencies are investing in
- To provide ways for synergy to occur across agencies
- To minimize duplication, overlap and fragmentation of programs that wasn't intentional
- To optimize those places where overlap and duplication was intentional
- To share what agencies are doing with the broader set of stakeholders that are out there
- To create a larger set of people who are part of the community that the agencies are working with and supporting

He explained that the inventory of all the federal agencies' education efforts are completed and that the information collected from that inventory will be used to inform the strategic plan and other actions

going forward. The strategic plan, he said, would be coming out with the President's Budget for FY 2013 in February. Dr. Feder acknowledged that a number of inventories were previously conducted and highlighted how this inventory was unique:

- The group was able to come up with a definition for a unit of analysis and what STEM education is and isn't which allowed for more consistent data gathering.
- The survey used in this inventory collected more detailed information.

Next he shared some preliminary findings:

- Using the GAO definition of duplication the CoSTEM inventory did not reveal any duplication of efforts except for the GLOBE program where duplication is intentional.
- It revealed that there was a little overlap and many strategic connections between programs .
- About $3.4 billion of STEM education investments focused on STEM and about $1 billion of that was for agency mission workforce focused programs. (Example: Programs mission agencies to produce individuals who can enter their workforce.)
- The majority of the investments identified STEM degrees and STEM careers as a primary program objective. There's also a significant group that identified education research and development as their primary objective.
- There has always been a concern across all reports related to STEM education about how well groups that are underserved and underrepresented are being supported. $1 billion is funding programs to support groups that are underrepresented in STEM.
- The majority of investments identified 3-4 different audiences and within those focused on K-20 learners.
- There aren't many investments specifically for math education, engineering, or technology.

Dr. Feder described the committee's intent to use a frame of the different approaches the agencies have to support STEM education to pull together a plan that will lay out how each mission or each agency can bring their assets and fulfill their roles in a strategic way. Further, he said they are working on how to coordinate the investments, prioritize annual and long-term objectives, create common metrics to assess programs, define role of the agencies and track implementation of the plan. He added that the committee is looking for feedback from groups like the AC. He then opened the floor for feedback and questions. The following are some of the thoughts shared by the AC members with Dr. Feder's response under each comment:

- Do you know whether or not the amount of funding to support underrepresented groups is adequate?
    - The committee has looked at whether the money can be spent more effectively and efficiently but the question of putting more money towards anything right now is a difficult discussion to have given the budget situations of all the agencies.
- I cannot believe that there is no duplication and only moderate overlap.
    - The definitions of duplication and overlap were described to clarify the findings.
- Did you look at what private organizations are doing?
    - No, but the committee is trying to consider private organizations actions and figure out how best to leverage and support those assets as they write the strategic plan.
- Is this a zero sum game where we're looking at what's being spent and moving it around or is there a possibility of more resources going into this?

    - Budget questions are not decided at OSTP but STEM education is a priority of the President and if the CoSTEM group can show that it is doing something different that could lead to significant improvements, then there's a change of getting additional support.
- Is there any thought to how to influence how this limited amount of funding is being spent?
    - The Department of Education is very good at this but in other agencies there is less flexibility in how the money is spent.
- You may be able to get some different kinds of behaviors if you incentivize it and reward it, as opposed to mandating action. Are there opportunities for this?
    - Those are the kind of strategies the committee is trying to drive towards.
- Dr. Muriel Poston, Division Director for the Division of Human Resources, also inquired about the definition of underrepresented groups and whether or not a common definition was established for the inventory.
    - The agencies were permitted to use their own definitions but the committee is working on defining the term for the strategic plan.

Dr. Feder concluded by inviting anyone who has thoughts on documents he should be looking at or wishes to provide additional feedback to email him. Dr. Ladner, the Chair of the Committee on Equal Opportunity in Science and Engineering (CEOSE), invited Dr. Feder to attend the CEOSE meeting in February and offered some documents that Dr. Feder may want to consider.

Plan for Convening Stakeholders

Dr. Ferrini-Mundy introduced the session by explaining that the topic, convening stakeholders, was developed after the last meeting where members of the AC encouraged EHR to get more involved in stakeholder engagement. The tasks for the groups were as follows:

- If you were to imagine that you have a group of stakeholders that we would convene to focus on the topic of your group—so one group, the topic is research and development; the other group, the topic is undergraduate education—if you were to convene stakeholders, what goals would you have for a meeting with those stakeholders?
- Who would the stakeholders be? Who would you bring together to accomplish the goal you determined?
- What information should EHR be compiling or preparing or getting ready for such a meeting?
- What would success look like once the meeting was over?

Research and Development Group: Dr. Pearson, Dr. York, Ms. Barton, Dr. Parravano, Dr. Lopez-Freeman, and Dr. Jolly.

Undergraduate Education Group: Dr. Singer, Dr. Davis, Dr. Rankin, Dr. Renick, Dr. Blair, Dr. George, Dr. Hammonds, and Dr. Burnett.

The groups then dispersed to address the questions they were assigned. On Thursday morning, the groups presented their conclusions.

Research and Development Group:

Goals/Questions: Given all of the discussion about the criticality of STEM education and the importance of that for the workforce, why haven't we moved much farther with communities, particularly in our

public's understanding that this is a kind of an urgent need? Is there research on messaging, how can you actually change behavior?

Invitations: Educational researchers; STEM community; discipline-specific societies and associations; federal representatives; state representatives; economists; grant makers for education; specific people from K-12 and higher education

NSF Preparations for Meeting: Synthesis of existing reports including sociology, educational policy and practice, anthropology of education, etc.; staff could help identify a list of people to invite to the meeting; setting up long term cross-directorate collaborations

Measures of Success: Actually creating these living communities that would continue past the conference or workshop and work towards specific shared goals. This community could thrive and produce research and initiate change.

Undergraduate Education Group:
Goals/Questions: How can we take what NSF has, scale it, and actually get these best ideas implemented? We wanted to convene a group of stakeholders who are vested in undergraduate education that would be an opportunity to both disseminate NSF best practices and to identify common ground.

Invitations: Academic leadership; funding agencies; different business leaders that are heavily vested in the outcome of STEM undergraduate education state agencies; regional groups; publishers; research professional societies; accreditation agencies; Google, Facebook and Blackboard people; technology-focused people; Council on Competitiveness; college presidents and deans

NSF Preparations for Meeting: Pull executive summaries or synthesize some of the major reports out of EHR like the NRC Expanding Underrepresented Minority Participation study, the NRC Discipline-Based Education Research consensus study, the PCAST report; NSF-wide and EHR strategic plans

Measures of Success: End result would be that we would have everybody doing evidence-based teaching in their classroom. (Though realistically, one meeting wouldn't do that.) Beginning to get people on the same page, articulating the underlying assumptions that are driving practice and really begin to work on strategies to address the barriers, the change issue.

Merit Review Recommendations from Advisory Committee
Dr. Major started the session by asking the group to share any ideas about how the ideas described at the morning session might be relevant or used in particular situations that occur in the EHR review process. The following are some of the comments shared by the AC members:

- The reviewer workload is a concern. If shadow panels are used on all reviews there may not be enough people who can put in the appropriate amount of time to do the task well. Perhaps this type of review should be reserved for new initiatives rather than more routine reviews.
- A potential danger in creating a shadow panel is that it may become shadow panel versus the regular panel.
- Accomplishment-based panels may make it more challenging for less experienced PIs to get funding. It may be better to incentivize and support young PIs in getting additional

considerations because they potentially have more innovative ideas and are generally at a disadvantage for funding.

- One consequence of robust research projects losing funding for even a year is that they lose momentum, lose staff, and it may negatively impact that researcher's graduate students. If there is some middle ground that makes it easier to get an extension, maybe that would be best. There is a real cost to stopping a strong forward-moving program because of an idiosyncrasy of a review process.
- It is not clear how well people would react to having a computer dismiss their proposal with the program analysis tool, but the concept that not every grant has to be brought to panel, not every grant has to go out to review, seems like an excellent idea.

Dr. Major then described congressional testimony where a representative from the American Chemical Society suggested that 50 percent of proposals could be desk-rejected and not sent out for review. Although some people at the hearing disagreed, others were nodding their heads, yes. She posed the question to the AC, What are your feelings about what a right percent of desk-rejection would be? Responses followed:

- One option would be to run an experiment to track the percentage by a few program officers so that you could actually let the flow find out an ideal desk-rejection rate by looking for correlation between them and inter-reliability. Another option would be if you needed to reduce the workload by 20 percent then make the rate 20 percent. Alternatively you could bring a program officer's outcomes to a panel and assess the accuracy of the program officer. Regardless, it would be much better to have a strategy that recognizes the intelligence and experience of the program officers than a computer-generated system that could be gamed.

Next Dr. Major asked if anyone had any thoughts about remote participation, the Wiki-based reviews and the virtual panels. Responses followed:

- One AC member supported the idea of exploring these ideas with the understanding, too, that the technology needs to be worked out so that no one is disadvantaged in the process. Young people don't seem to want to do face-to-face. They are more into virtual interactions. The importance of the face-to-face part of it was acknowledged as well. Maybe a hybrid is really important not to lose the value of face-to-face interactions.
- The blended model and allowing for both, especially for those who are fully dealing with the generational issue around this, would probably be helpful. There was a sense that a mix of virtual and physical presences is rarely as effective and so mixing the two at the same time I think is less effective.
- If a principle investigator has a five-year grant, and has really invested a lot of time in it, it would be nice to have follow-on grants, and the accomplishment-based investigator approach might help that.
- Similarly in the situation just described, NSF will have made a significant investment in the research program that is lost or partially lost anyway without it.
- Wiki-based reviews for other kinds of reviews have worked very well. It makes people write out their arguments rather than just argue from the force of personality, which is often kind of a problem in panels where a very dominant person can really carry the day just because of the personality rather than the argument.

Setting the stage for the joint session with Mathematical and Physical Sciences (MPS) Advisory Committee and meeting with Dr. Suresh and Dr. Marrett tomorrow

Dr. Ferrini-Mundy explained that Dr. Suresh and Dr. Marrett would be looking to hear the AC's observations and specific guidance for the directorate or the agency. The following are some of the comments the AC agreed should be shared with Dr. Suresh and Dr. Marrett:

- It would be really interesting if NSF really did capture some of the costs of the education initiatives taking place throughout the agency.
- It might be interesting to get the advisory groups together because I think there would be additional valuable perspective offered by advisory group members to each other, in addition to the program officers' insights.
- In the context of talking about OneNSF, there seems to be an emphasis on the integration of research and education. What's happening at the broader level and how do conversations at the directorate level fit in with that?
- One of the issues that came up was the kind of vertical integration of representation, starting with the National Science Board, that with the new administration coming in, the idea was to really look at how that works. There doesn't seem to be too much diversity at the National Science Board, so with the new administration, the question is kind of how much advocacy for increasing diversity on the Board is occurring and will the composition of that group change?
- It appeared in part from the conversation following Dr. Feder's presentation that there's a lot of material and a log of reviews and documents already in existence that address some of those issues that need to be folded into the report as background, at least, as well as deepening what he presented.
- It all seems to be about scaling the effectiveness and the impact of NSF, and it would be really interesting to talk briefly about some of the things that EHR is thinking about and participating, and that could further scale the value of the work that comes out and the importance of that.
- It would be interesting to learn about what the Director is thinking about in terms of incentivizing collaboration, not just form EHR, but across the agency and into other sectors.
- What is the time frame for the final product for the merit review criteria?
- There is a need to build the literature base about teaching and learning at community colleges and with adult learning, and how EHR can promote that and help train faculty. It's complicated further at the two-year colleges because research is not really their mission, and it's not always valued by the college's administration.
- How would the Director view an effort to create partnerships with business and philanthropic foundations and so on around some key education initiatives or issues?
- NSF over the years has focused on producing the numbers, but the quality of the people produced to be competitive in the marketplace may not be the level we would like. So there's a lot of pressure for a program to turn out the numbers, but it doesn't mean the people participating in the program are going to be competitive in an open market.

Session IV: Joint Session with the MPS Advisory Committee

Minutes provided by the Mathematical and Physical Sciences Directorate:

Notes from Lisa Hunter's discussion session

- Inquiry based learning involves the "how people learn" framework
- Findings of the work show that students get excited about their activities and involvements in the projects --- we need to ensure that they spend time on their original path working toward their research degree
- Partnership with the Institute for Inquiry at the Exploratorium strengthens our projects

Notes from John Cherniavsky's discussion session

- Expeditions in Education effort with CISE, SBE, and OCI
    - Treats education data mining as a field within past four years using publicly available data
- Examples of projects include
    - ITEST-Pulsar search collaborative where 60 high school teachers and 90 students work with astronomers to search for pulsars
    - IDEAS-Inquiry based dynamic earth applications using supercomputers
        - Improving the use of computer data analysis skills in undergraduate meteorology
    - CITEAM- Enabling interactive visual exploration and remote collaboration for the geosciences and physical sciences (involves visualization methods and collaboration tools)
- Citizen science challenges --- gaming team solved protein structure related to HIV online
- Need shift in thinking on big data sets
- Need more collaboration between education and the various science disciplines
- Can we trust/have faith in the accuracy of large data sets ---students are often too trusting of numerical data…need to ensure students understand limits/error bars
- Lack of access to stored data ---- how do you find it? Need improved database searching for better access to deep data

Suggestions for collaboration between MPS and EHR

- Systematic work to prepare PhDs today for teaching
- Study impact of PhDs educational preparation for teaching, i.e. look at students of "your PhD students"
- Use big data as resource for curriculum
- Cognitive tutors
- Networking among different types of NSF centers (STCs, SLCs, CCIs, etc. via meetings with center directors and outreach staff)
- Determine how to connect students authentically to scientists who produce the data (e.g. Green Pea)

Session V: Moving Forward

Advising the Director: Conversation with Dr. Suresh and Dr. Marrett

Dr. Suresh started the session by explaining that, due to the uncertainties about future NSF budgets and given that the goal of doubling isn't going to happen in the next couple of years, he and other senior

leadership have had discussions about how to organize activities within NSF. He continued by explaining that they decided to organize NSF's activities in the following ways:

- Focusing on human capital development, and education is a very important part of the human capital development. So things like supporting graduate students, post-doctoral associates, and broader educational activities very much fall into that.
- There are many things NSF can do no matter what the budget situation is.
- Given the huge fiscal crisis facing the country, and perhaps many parts of the world, how does NSF use this opportunity for positive outcome? The foundation can look at things that it does, that it has done, and how improvements can be made, and how new things can be tried?

He went on to emphasize the enormity of the leveraging power that NSF has, especially via the OneNSF concept. Dr. Suresh added that in the context of EHR and its educational activities, the potential for moving the needle agency-wide in the educational arena is enormous by working with the research directorates. He concluded by commenting that he and Dr. Marrett would be very interested in the AC's thoughts and ideas on how to take things that EHR does and things that the research directorates do and integrate them in a seamless manner so that the net impact is much greater than the sum of the parts.

Dr. Marrett then thanked the AC for the letter they wrote to Dr. Suresh following the May 2011 meeting. She highlighted the importance of the AC writing about using its convening authority to initiate stakeholder conversations because it says that the AC isn't just waiting for EHR to do it all and is really taking initiative to interact with stakeholders to get input.

Dr. Todd thanked Dr. Suresh and Dr. Marrett for their comments and opened the floor to discussion. The following are some of the comments by the AC members and responses from Dr. Suresh and/or Dr. Marrett:

- Yesterday representatives from the other directorates visited and one of the associate directors said that 15 percent of his budget goes toward education. Is there an accounting method that shows how education expenditures are done throughout the OneNSF? Is there a way EHR can influence how that money is spent by providing its research and products to the other directorates?
    - Response (Dr. Suresh): One of the things that has happened quite a bit more in the last few months is the very fact that there are so many conversations going on about education between EHR and the research directorates has elevated the significance in both directions. The idea is not to make EHR a service organization within NSF, but to be a key player in the activities of the research directorates. The CoSTEM inventory has been a useful exercise, and I'm hopeful that both of these internal to NSF and external to NSF will put education on even a more prominent footing than it has been so far among science agencies and science funding agencies.
- Might there be connections with some of the agendas for major foundations, philanthropists with NSF, EHR?
    - Response (Dr. Suresh): There are three connection opportunities. The first is working towards stronger connections with other federal agencies. The second category is private-public partnerships, and I personally feel that there is significant room for that. There is enormous opportunity for public-private partnership, and legally we don't have a barrier to engage in that way. We have to be very careful about not mixing federal

dollars with private dollars and so forth. But there are clear ways of doing it. The third is tapping into previously underutilized groups like the large numbers of outstanding teachers in the country, who have energy, interest and talent, who currently are not engaged in this conversation.

- There seems to be discussions going on about looking at shadow reviews, Wiki reviews and accomplishment-based proposals. Are major changes coming down the pike in the review system?
    - Response (Dr. Suresh): I just want to clarify there are two things we're talking about. One is the merit review criterion; the other is the mechanics of how we do the merit review. Those are separate. I think you're referring to the mechanics of merit review. After looking at the numbers it's clear that we are really on an unsustainable path with respect to handling the proposals. It has many, many implications. One, we waste so much time of the community. We want to be fair. We want to be transparent. We want to be equitable, especially to younger people, but fairness cuts both ways. What is fair? Let's at least have a conversation. So this committee has been meeting for several months, and, in fact, we have a town hall meeting tomorrow at NSF with this group of all program officers. That's where we are with that.
- At the institutional and faculty levels, how is training provided so that the classroom research into teaching and learning at the community college can be done to try to assess all these things that are going on? In other words, the faculty are picking up pieces and parts of the different programs, and innovating into their classroom, but then they don't really have the training in research, educational research, that they need because they're mathematicians. What is the role then of NSF in all this, and how can NSF help the community sort of sort some of this out? It's all good, and yet it's challenging and yet it's confusing.
    - Response (Dr. Suresh): It is a very complicated thing. So one of the conversations I've had with a few leaders from community colleges, but also from university presidents, and especially in many of the EPSCoR states in the U.S., is what are new opportunities for community colleges to engage with local institutions, larger institutions? And both are funded by NSF in some cases, but in many cases, there may not be enough of a conversation among them as there should be. Are there ways in which NSF can facilitate this conversation through some coordination? And I think it's eventually up to the individuals involved to engage in this conversation, but that's one possibility that, in fact, in my conversations with a few groups, this they thought would help address at least partially some of the issues that you raise.
    - Response (Dr. Marrett): I was just going to suggest that I think we would find it helpful from an advisory committee like this to help us determine priorities because we can't do everything, and this becomes--there are other places that might be much better prepared to help classroom teachers figure out how to continue to expand the knowledge. We really always need help on trying to keep things within boundaries enough so that we don't take what are really limited resources--we've got limited funding resources, limited staffing resources--that they're not spread so thinly that we don't end up being most effective. So I understand the question at the classroom level is one that's very important, but I'm not sure that we can give you an answer. We need your engagement in that kind of conversation.
- What is the thinking in the Director's office on the merit review process?
    - Response (Dr. Suresh): As you know, a National Science Board Task Force was set up some time ago to reexamine the merit review criteria, but unfortunately, when the America COMPETES Reauthorization Act was passed the Task Force was chronologically

out of synch with the Act based on the deadlines. In an effort to synchronize them, at my request, the National Science Board Task Force came up with a preliminary set of recommendations. They were sent out for comment from the community, and the sheer volume of the response was enormous. All the data has been gathered, collated, prioritized, and it was presented to the Board during the summer. The task force will meet at the December Board meeting and will finalize that set, and they will also be in conversations going on with Congress and the community taking all their input. We would take that task force recommendation, examine it, and look at how best to implement it. One of the tricky things about the second criterion or the additional criterion, the broader impacts, is that how do you quantify the impact of broader impact, not in one year, two years, but over a long period of time? That's always a challenge. We need to have some quantitative correlation between what goes into it and what comes out of it and it's invariably a very long-term effort. So we've had internal conversations on how best to set up an infrastructure internally at NSF that will address that over a long period of time. With respect to timeline, you can expect something from the Board probably early in the new year, and then a response from NSF sometime during the course of spring of next year or so.

- NSF has had a long and distinguished career addressing the country's issues around diversity and inclusion and broadening impact. Can the Office of the Director influence the composition of the National Science Board to try to get that Board a little more representative of what the country looks like?
    - Response (Dr. Marrett): First, we're not surprised that this would be a recommendation, but let me suggest that there's a way in which this committee can help influence the agenda of the Board. There is the Committee on Education and Human Resources, and that committee is often looking for what ought it to undertake, and I've said before we've got an extremely busy staff here, and I think they would really appreciate ideas about how one could use that committee far more effectively for discussion of topics that might not be as obvious now. So there is one matter of thinking about composition, but there's another matter of agenda setting, and that's where I said we would certainly welcome your input on how the committee, how the Board, in general, and that committee, in particular, might set its agenda.
- OneNSF is fascinating, and what is even more fascinating is that people seem to get it and are actually energized by it. Have any structures been changed because of OneNSF? Have you had to change any structures in order to facilitate that, or is it inspiring enough for people to kind of get it?
    - Response (Dr. Suresh): This is not envisioned as a way to change the organizational structure. Nor is it envisioned as a vehicle to say that everybody should do the same thing, and I've said this before, you know, theoretical mathematics is not the same as experimental physics, right, or biology, bench biology. They are very different cultures, and we want to cherish those differences. So OneNSF doesn't mean they should all end up doing the same thing. What it means is I think you can elevate things that are near and dear to everybody rather than having different missions that are almost aligned but not perfectly aligned, but given the large numbers, increase the entropy to--NSF has only one mission. It doesn't matter whether you work in EHR or whether you work in MPS. There is only one NSF mission, and what OneNSF tries to do is to elevate it.
- Is there a process to identify OneNSF projects, or they just kind of bubble up?
    - Response (Dr. Suresh): It's both. In the case of some of these, there are core principles of NSF; right? International engagement. These are in our Strategic Plan so we took

three things from the Strategic Plan, which was released a year ago: broadening participation; encouraging more women to stay in academia; helping women of color stay in academia in greater numbers; international engagement. So these are activities that are very much aligned with our core principles. So that's how it started. So we actually will have--so there are two mechanisms to do this. One of the things we've been talking about is to have an organized process to have input to create this at the grassroots level. The other one is things that bubble up, ideas that bubble up, and then it has to have traction in different corners of NSF. In many of these cases, in the case of Career-Life Balance, it was a committee, a working group that was set up with representation from all across NSF, that met once a week for six months and wrote a report. That's how that came about.

Dr. Todd closed the session by thanking the AC members for their energy and thoughts throughout the meeting and thanking Dr. Suresh and Dr. Marrett for their time and wise counsel.