National Science Foundation

Perspective on Cyber-Enabled Research and Learning Opportunities

iLab Network Visioning Workshop

Chicago, Illinois

Dr. Randy L. Phelps, Staff Associate
rphelps@nsf.gov 703-292-8040

http://www.nsf.gov/od/oia/

November 12, 2008

OFFICE OF INTEGRATIVE ACTIVITIES

The iLab Network

"Online laboratories are experimental facilities that can be accessed through the Internet, allowing students and educators to carry out experiments from anywhere at any time. Remote labs enrich science education by vastly increasing the scope of experiments that students have access to in the course of their academic careers. The ***iLab Network*** enables students to use *real instruments,* rather than simulations, via remote online laboratories using their web browser. Unlike conventional experimental facilities, iLabs can be shared and accessed widely by students and other audiences across the world that might not otherwise have the resources to purchase and operate costly or delicate lab equipment".

OFFICE OF INTEGRATIVE ACTIVITIES

Perspective of the NSF: Learning

- ***NSF supports innovative STEM education initiatives from pre-kindergarten to postdoctoral levels.***
- ***NSF supports discovery-based learning as an integral feature of formal K-12 and informal public education.***
- ***NSF understands that new practices transform education research and practice in ways that are not yet well understood.***
- ***NSF believes STEM education at all levels benefits from information, communications and other new technologies.***
- ***NSF recognizes that access to interactive data sets, simulations, and up-to-date research results, as well as interaction with researchers, is increasing in K-12 classrooms and in informal science education venues.***

NSF

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Investment Priorities: Learning

- ***Advance the fundamental knowledge base on learning, spanning a broad spectrum from animals and humans to machines.***
- ***Build strong foundations and foster innovation to improve K-12 teaching, learning and evaluation in science and mathematics.***
- ***Develop methods to effectively bridge critical junctures in STEM education pathways.***
- ***Prepare a diverse, globally engaged STEM workforce.***
- ***Integrate research with education, and build capacity.***
- ***Engage and inform the public in science and engineering through informal education.***

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Learning

"NSF Finds Out What Works"

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Learning

Division of Research on Learning in Formal and Informal Settings (DRL)

- **DRL invests in projects to improve the effectiveness of STEM learning for people of all ages.**

- **DRL promotes innovative research, development, and evaluation of learning and teaching across all STEM disciplines by advancing cutting-edge knowledge and practices in both formal and informal learning settings.**

- **DRL is a catalyst for change - advancing theory, method, measurement, development, and application in STEM education.**

- **DRL seeks to advance both early, promising innovations as well as larger-scale adoptions of proven educational innovations.**

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Learning

Division of Research on Learning in Formal and Informal Settings (DRL)

- **The Discovery Research K-12 (DR- K12) program: seeks to enable significant advances in K-12 student and teacher learning of the STEM disciplines, through research and development of innovative resources, models, and technologies for use by students, teachers, administrators and policy makers.**

- **The Research and Evaluation on Education in Science and Engineering (REESE) program: aims at advancing research at the frontiers of STEM learning, education, and evaluation, and at providing the foundation knowledge necessary to improve STEM teaching and learning at all educational levels and in all settings.**

- **The Informal Science Education (ISE) program: builds on educational research and practice and seeks to increase interest in, engagement with, and understanding of STEM by individuals of all ages and backgrounds through self-directed STEM learning experiences.**

- **The Information Technology Experiences for Students and Teachers (ITEST) program: seeks to engage students and teachers in the creative use of information technologies within the context of STEM learning experiences in school and other learning settings.**

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Learning

Division of Undergraduate Education (DUE)

Course Curriculum and Laboratory Improvement (CCLI)

- ***The CCLI Program supports the development of exemplary courses and teaching practices (including the acquisition of equipment needed to support these developments) and assessment and research efforts that build on and contribute to the pool of knowledge concerning effective approaches in STEM undergraduate education.***

- ***Funds may be requested for local adaptation and implementation projects, including instrumentation to support such projects.***

OFFICE OF INTEGRATIVE ACTIVITIES

Perspective of the NSF: Instrumentation

- ***NSF supports investments in instrumentation, facilities, cyberinfrastructure and experimental tools.***
- ***NSF promotes increased access to research instrumentation.***
- ***NSF promotes development of new capabilities, technologies, and instrumentation.***
- ***NSF supports infrastructure including multiple-use and distributed instruments and facilities, and comprehensive, next generation cyberinfrastructure.***
- ***NSF will expand access to state-of-the-art science and engineering facilities, instrumentation and equipment, databases, advanced computing resources, research networks and other infrastructure.***

NSF

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Investment Priorities: Instrumentation

- ***Fill the gaps in our ability to provide enabling research infrastructure.***
- ***Identify and support the next generation of large research facilities.***
- ***Develop a comprehensive, integrated cyberinfrastructure to drive discovery in all fields of science and engineering.***
- ***Strengthen the nation's collaborative advantage by developing unique networks and innovative partnerships.***

NSF

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Instrumentation

In the absence of new funding opportunities, there are ways to tap into existing programs…

- BIO: Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML): NSF 05-550
- BIO: Instrument Development for Biological Research (IDBR): NSF 08-566
- CISE/CNS: Computing Research Infrastructure (CRI): NSF 08-570
- ENG: Small Business Innovation Research and Small Business Technology Transfer Programs Phase I(SBIR/STTR): NSF 08-548
- GEO/ATM: Atmospheric Sciences Mid-Size Infrastructure Opportunity: NSF 07-602
- GEO/ATM: Graduate Student and Optical Instrumentation Support Related to the Advanced Modular Incoherent Scatter Radar (AMISR): NSF 05-564
- GEO/EAR: Earth Sciences: Instrumentation and Facilities (EAR/IF): NSF 07-553
- GEO/OCE: Oceanographic Centers and Facilities: Oceanographic Instrumentation: NSF PD 98-5410
- GEO/OCE: Oceanographic Technology and Interdisciplinary Coordination Program (OTIC): NSF PD 98-1680
- MPS/AST: Advanced Technologies and Instrumentation (ATI): No Publication Number
- MPS/CHE: Chemistry Research Instrumentation and Facilities: Departmental Multi-User Instrumentation (CRIF:MU): NSF 08-539
- MPS/CHE: Chemistry Research Instrumentation and Facilities: Instrumentation Development (CRIF:ID): NSF 04-534
- MPS/CHE: Chemistry Research Instrumentation and Facilities: Cyberinfrastructure and Research Facilities (CRIF:CRF): NSF 08-504
- MPS/DMR: Instrumentation for Materials Research: NSF 07-600
- MPS/DMR: Instrumentation for Materials Research -Major Instrumentation Projects (IMR-MIP): NSF 05-513
- MPS/DMS: Scientific Computing Research Environment for the Mathematical Sciences (SCREMS): NSF 07-502
- Crosscutting: Cyberinfrastructure for Environmental Observatories: Prototype Systems to Address Cross-Cutting Needs (CEO:P): NSF 06-505
- Crosscutting: High Performance Computing System Acquisition-Towards a Petascale Computing Environment for Science and Engineering: NSF 08-573

OFFICE OF INTEGRATIVE ACTIVITIES

NSF Funding Opportunities: Instrumentation

Major Research Instrumentation (MRI)

Goals

- Supporting the acquisition of major state-of-the-art instrumentation, improving access to, and increased use of, modern instrumentation by scientists, engineers, and students;
- Fostering the development of the next generation of instrumentation, resulting in new instruments that are more widely used, and/or open up new areas of research and research training;
- Enabling academic departments, disciplinary and cross-disciplinary units, and multi-organization collaborations to create well-equipped research environments that integrate research with education;
- Supporting the acquisition and development of instrumentation that takes advantage of new opportunities enabled by investments in cyberinfrastructure;
- Promoting substantive and meaningful partnerships for instrument development between the academic and private sectors.

http://www.nsf.gov/od/oia/programs/mri/

OFFICE OF INTEGRATIVE ACTIVITIES

Cyberinfrastructure

NSF's Cyberinfrastructure Vision for 21st Century Discovery

www.nsf.gov/pubs/2007/nsf0728/index.jsp

OFFICE OF INTEGRATIVE ACTIVITIES

NSF's Cyberinfrastructure Vision for 21st Century Discovery Learning Goals

- **To foster the broad deployment and utilization of cyberinfrastructure-enabled learning and research environments.**
- **To support the development of new skills and professions needed for full realization of cyberinfrastructure-enabled opportunities.**
- **To promote broad participation of underserved groups, communities and institutions, both as creators and users of cyberinfrastructure.**
- **To stimulate new developments and continual improvements of cyberinfrastructure-enabled learning and research environments.**
- **To facilitate cyberinfrastructure-enabled lifelong learning opportunities ranging from the enhancement of public understanding of science to meeting the needs of the workforce seeking continuing professional development.**

OFFICE OF INTEGRATIVE ACTIVITIES

NSF's Cyberinfrastructure Vision for 21st Century Discovery
Principles that Guide Learning Investments

- **Equitable and broad access to state-of-the-art networked resources is essential.**
- **To achieve widespread use of cyberinfrastructure by science and engineering researchers, educators, and learners, efficient methods must exist to find, access and use cyberinfrastructure resources, tools, and services as well as the educational materials associated with them.**
- **The privacy, social, cultural, ethical and ownership issues associated with increasing use of cyberinfrastructure for learning, research and scholarship must be addressed.**
- **Learning and workforce development opportunities contribute to cyberinfrastructure developments.**
- **Cyberinfrastructure developments will lead to new learning models necessary for lifelong learning in the distributed and networked learning environment.**
- **Leveraging cyberinfrastructure learning and workforce development activities and investments within NSF and by other agencies – national and international – are essential for enabling 21st century science and engineering.**
- **Scientists and engineers must be prepared to collaborate across disciplinary, institutional, geopolitical and cultural boundaries using cyberinfrastructure-mediated tools.**

OFFICE OF INTEGRATIVE ACTIVITIES

Linking Instrumentation with Learning (Personal Perspectives)

Q: Could we envision NSF requiring recipients of instrumentation funding to make those devices available for educational access via a mechanism like iLabs?

A: No - NSF should not overly constrain the creativity of the community – broader impact allows for this, but it should not be a requirement

OFFICE OF INTEGRATIVE ACTIVITIES

Linking Instrumentation with Learning (Personal Perspectives)

Q: Could new kinds of partnerships be enabled for acquiring and sharing lab devices / equipment, to make high end resources more broadly available from researchers, to teachers, students, museums, etc.

A: Yes! This obviously serves as a broader impact of any research / instrumentation proposal.

OFFICE OF INTEGRATIVE ACTIVITIES

Linking Instrumentation with Learning (Personal Perspectives)

Q: Should NSF facilitate these types of partnerships?

A: Sure, by catalyzing creativity and promoting flexibility

Q: Should NSF require these types of partnerships?

Q: Should NSF develop a program for this type of activity?

A: No and Maybe. NSF is a community driven organization and should not be overly prescriptive – programs with impact should be supported

OFFICE OF INTEGRATIVE ACTIVITIES

Linking Instrumentation with Learning (Personal Reflection)

How is cyberinfrastructure changing the way science is being done, and what are the implications for science education both formal and informal?

How do we get students to learn how to use cyberinfrastructure in their science education?

How should we be preparing the future science workforce - and everyone else - to work in a cyber-enabled workplace?

What new ideas and visions exist and/or are needed for leveraging NSF investment in instrumentation to benefit education using remote lab technologies?

OFFICE OF INTEGRATIVE ACTIVITIES

Personal Reflection as an Astronomer

Remote Telescopes

Las Cumbres Observatory:

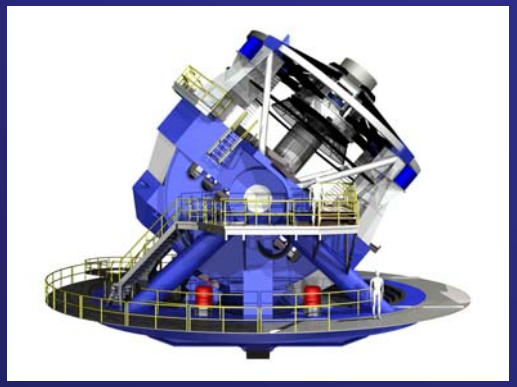
Global Telescope Network

Science and Education

What will we be missing?

Who will build the next generation instruments?

New "haves" and "have nots" wrt instruments?



Large Synoptic Survey Telescope

Forefront Science w/ Enormous Opportunities in Education

Mt. Wilson:

Telescopes in Education

New opportunities for broadening participation

New opportunities to engage students and the public

Hard to separate reality from simulation

Students are increasingly cyber-savvy

NSF

OFFICE OF INTEGRATIVE ACTIVITIES

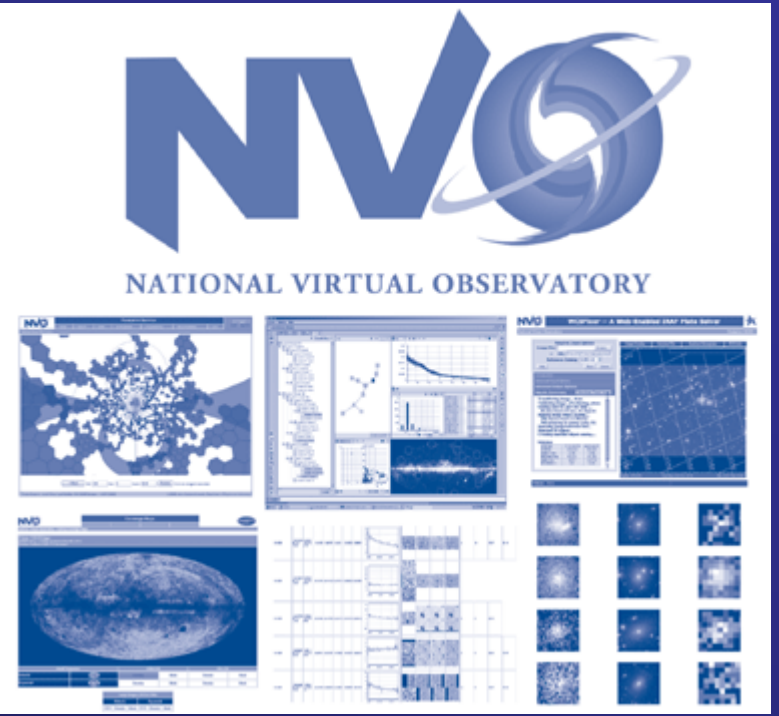
Personal Reflection as an Astronomer

Virtual Astronomy Observatory

- **Science**
- **Education**

“find, retrieve, and analyze astronomical data from ground- and space-based telescopes worldwide”

http://www.virtualobservatory.org/



NSF OFFICE OF INTEGRATIVE ACTIVITIES

Cyberinfrastructure and Instrumentation Investments Enable New Opportunities to Integrate Research and Education

Tell Us What Is Possible, How Effective It Is, And How Flexiblity Can Assist!

OFFICE OF INTEGRATIVE ACTIVITIES