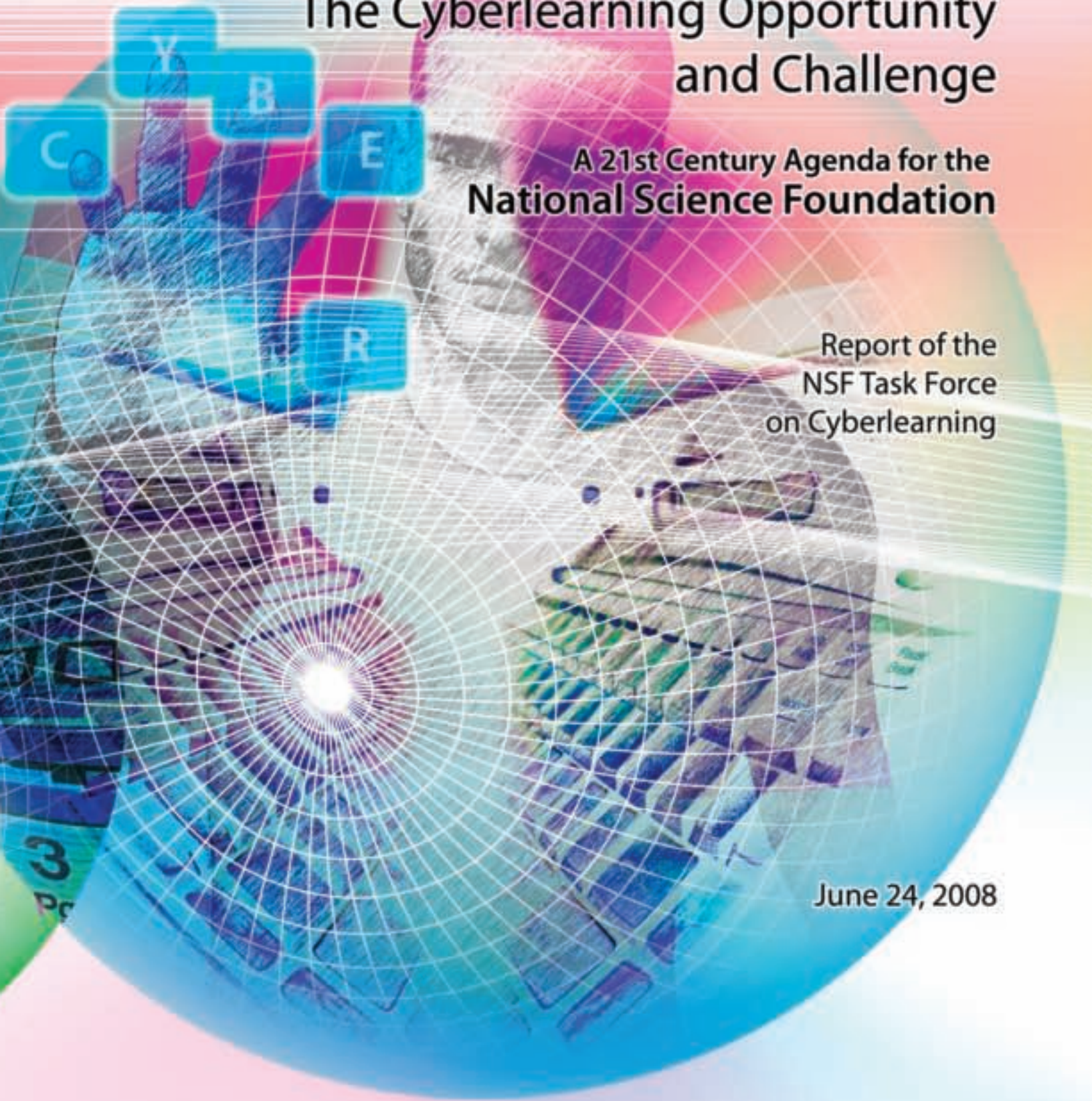
Fostering Learning in the Networked World:

The Cyberlearning Opportunity and Challenge

A 21st Century Agenda for the National Science Foundation



Report of the NSF Task Force on Cyberlearning

June 24, 2008

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"Any opinions, findings, conclusions and recommendations expressed in this report are those of the Task Force and do not necessarily reflect or represent the views of the National Science Foundation."

Fostering Learning in the Networked World: The Cyberlearning Opportunity and Challenge

A 21st Century Agenda for the National Science Foundation[1]

Report of the NSF Task Force on Cyberlearning

June 24, 2008

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Executive Summary

Imagine a high school student in the year 2015. She has grown up in a world where learning is as accessible through technologies at home as it is in the classroom, and digital content is as real to her as paper, lab equipment, or textbooks. At school, she and her classmates engage in creative problem-solving activities by manipulating simulations in a virtual laboratory or by downloading and analyzing visualizations of real-time data from remote sensors. Away from the classroom, she has seamless access to school materials and homework assignments using inexpensive mobile technologies. She continues to collaborate with her classmates in virtual environments that allow not only social interaction with each other but also rich connections with a wealth of supplementary content. Her teacher can track her progress over the course of a lesson plan and compare her performance across a lifelong "digital portfolio," making note of areas that need additional attention through personalized assignments and alerting parents to specific concerns. What makes this possible is *cyberlearning*, the use of networked computing and communications technologies to support learning. Cyberlearning has the potential to transform education throughout a lifetime, enabling customized interaction with diverse learning materials on any topic—from anthropology to biochemistry to civil engineering to zoology. Learning does not stop with K–12 or higher education; cyberlearning supports continuous education at any age.

Citizens in all fields need to understand how science and technology affect policy, business, and personal decisions. The shortage of trained scientists and engineers is a small indicator of a much larger problem: insufficient knowledge and understanding about science and technology across our population. The educational system must respond dynamically to prepare our population for the complex, evolving, global challenges of the 21st century. Advances in technology are poised to meet these educational demands. Cyberlearning offers new learning and educational approaches and the possibility of redistributing learning experiences over time and space, beyond the classroom and throughout a lifetime. We believe that cyberlearning has reached a turning point where learning payoffs can be accelerated. We also believe that this moment could be fleeting because, without deliberate efforts to coordinate cyberlearning approaches, we will miss the opportunity to provide effective support for the convergence of learning and technology. The National Science Foundation (NSF) is in a position to stimulate research and development that can enable this process.

Cyberlearning has tremendous potential right now because we have powerful new technologies, increased understanding of learning and instruction, and widespread demand for solutions to educational problems. In the last decade, the design of technologies and our understanding of how people learn have evolved together, while new approaches to research and design make the development and testing of technologies more responsive to real-world requirements and learning environments. NSF has played a key role in these advances, funding interdisciplinary programs specifically to support research and activities in the area of cyberlearning. NSF can continue to lead this revolution by leveraging its investments in the productive intersections between technology and the learning sciences.

Several factors have come together to open these opportunities for cyberlearning. Web technologies enable people to share, access, publish—and learn from—online content and software, across the globe. Content is no longer limited to the books, filmstrips, and videos associated with classroom instruction; networked content today provides a rich immersive learning environment incorporating accessible data using colorful visualizations, animated graphics, and interactive applications. Alongside these technology improvements, "open educational resources" offer learning content and software tools that support search, organization, interaction, and distribution of materials. Private companies are investing in projects to make

pervasive learning technologies more affordable and accessible. The global scope of networked educational materials, combined with "recommendation engine" software, helps individuals find special, niche content that appeals to their needs and interests.
New models of remote data and application storage combined with broadband network access allow wireless, mobile computing, not just with laptop computers but also with cellular phones. Internet-telephony, videoconferencing, screen sharing, remote collaboration technologies, and immersive graphical environments make distributed collaboration and interaction much richer and more realistic. Even though schools have not yet fully joined this vibrant, digital world, information and communication technologies are deeply entwined in the lives of young learners. Cyberlearning thus offers a receptive audience a mix of diverse content via the combined technological capabilities of the Internet, high performance computing, advanced networking, in-home electronics, and mobile communications.

The Task Force on Cyberlearning was charged jointly by the Advisory Committees to the Education and Human Resources Directorate and the Office of Cyberinfrastructure to provide guidance to NSF on the opportunities, research questions, partners, strategies, and existing resources for cyberlearning. This report identifies directions for leveraging networked computing and communications technology. It also calls for research to establish successful ways of using these technologies to enhance educational opportunities and strengthen proven methods of learning. To offer recommendations that are within the scope of NSF's charter, we focus on the STEM disciplines (science, technology, engineering, and mathematics) and the social, behavioral, and economic sciences based in the US.

Cyberlearning requires a coherent, supportive infrastructure. In this report, we identify eight core strategies that NSF can pursue to effectively promote the growth of a cyberlearning infrastructure. These strategies and their associated research questions will need to be reviewed, updated, revised, and evaluated regularly. Overall, these strategies focus on promoting and leveraging new talent and new technological developments in the field of cyberlearning. The strategies encourage proactively addressing potential problems and opportunities associated with the responsible use of data, the reapplication of software tools and educational resources, and the scaling of technology for larger end-user communities. NSF should promote consideration of the ways that cyberlearning can transform STEM disciplines and K–12 education—both how technologies allow new ways of looking at and understanding content and how teachers can interact with students and their school assignments. Finally, the Task Force considers it essential to find creative means of sustaining cyberlearning innovations beyond their initial development cycle.

We also identify seven special opportunities for action that we feel have the greatest short-term payoff and long-term promise among the many that NSF might pursue. These opportunities tap into the potential of technologies to coordinate learning across multiple contexts, to connect students with remote and virtual laboratories, and to access virtual or "mixed reality" environments for interactive exchanges. The use of cyberlearning technologies also introduces specific issues that require prompt action. For example, NSF policies can play a role in guaranteeing that open educational resources are truly open and available for future use. The growing abundance of data is another key concern. Students and teachers alike need to be taught how to manage large amounts of data, whether produced through scientific research or collected as part of a student's educational history. Perhaps most importantly the NSF directorates need to recognize cyberlearning as a pervasive NSF-wide strategy by funding the development of resources that can be used for both research and education.

Recommendations

We have identified five recommendations that cut across the strategies for growth and opportunities for action detailed in the body of the report. These recommendations offer initial steps for the NSF to take while complementing existing work at NSF:

1. Help build a vibrant cyberlearning field by promoting cross-disciplinary communities of cyberlearning researchers and practitioners including technologists, educators, domain scientists, and social scientists. NSF can advance their insights through the publication of promising practices and the ongoing recruitment of diverse talents to carry the field forward.

2. Instill a "platform perspective"—shared, interoperable designs of hardware, software, and services—into NSF's cyberlearning activities. An effective platform should incorporate promising innovations from newly funded technology projects and offer fully tested and supported modules for use in classrooms. It should ensure that learning materials targeted for the platforms are widely useable and remain useable over time. The ongoing evolution of platform designs should be guided by an expert panel.

Two NSF resources merit specific attention: the National STEM Digital Library (NSDL) and the Innovative Technology Experiences for Students and Teachers (ITEST). Both resources should be reviewed in the context of recent and new developments in cyberinfrastructure and cyberlearning at NSF and with consideration of the other changing technological, social, and economic environments identified in this report.

3. Emphasize the transformative power of information and communications technology for learning, from K to grey. Technologies that allow interaction with scientific data, visualizations, remote and virtual laboratories, and human expertise offer opportunities for additional research and broad implementation, particularly among the STEM domains. New information tools that seamlessly bridge multiple learning environments and technologies likewise deserve more research attention. In addition, teachers' professional development should be supported through training programs, professional societies, and ongoing collaboration on the creation of new teaching materials.

4. Adopt programs and policies to promote open educational resources. Materials funded by NSF should be made readily available on the web with permission for unrestricted reuse and recombination. New grant proposals should make their plans clear for both the availability and the sustainability of materials produced by their funded project.

5. Take responsibility for sustaining NSF-sponsored cyberlearning innovations. Educational materials and learning innovations need to flourish beyond the funding of a grant. They can be maintained and extended across NSF divisions and through partnerships with industry, professional organizations, and other institutions.

In conclusion, widespread access to technology, increasingly sophisticated tools, and advances in understanding of how individuals learn combine to provide a stunning opportunity to transform education worldwide. We call for research, development, and proof-of-concept studies to tackle this massive challenge, to marshal energies from diverse communities, and to establish a vision for the future. Our hope is that this report stimulates the imagination and builds on the enthusiasm that we felt in preparing it.


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