Meeting the Challenge: 21st Century Cyberlearning

Summative Evaluation Report

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Abstract

The ASTA Group, LLC (ASTA) received EAGER funding (National Science Foundation (NSF) Grant No. 094077) to conduct comprehensive planning for aNational Initiative on Cyberlearning in K-12 Education. To ensure success, ASTA invited a diverse group of experts and stakeholders to participate in the planning process. Planning tasks included individual meetings and combined planning sessions. The planning process culminated with a 1 ½-day workshop to synergize the preliminary information collected. ASTA produced a Summary Report synthesizing participants' ideas and recommendations to guide the development of the national initiative. The intent of this initiative is to create a national program to transform K-12 education through increasing the scale and sustainability of technologies for education. Workshops attendees, including visionaries, educators, researchers, policy makers, and industry and government leaders from around the country, recommended solutions to the challenges of incorporating proven technology into formal and informal educational settings. To further advance the national initiative, it is recommended that a multiple-agency task force, led by NSF and the U.S. Department of Education, devise comprehensive and inter-related strategies to overcome the barriers of wide-scale implementation. It is also recommended that the task force seek and include input from experts in cyberlearning, technology, and education, as well as the myriad of stakeholders with vested interest in K-12 education.

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Background

Project Need

The National Science Foundation (NSF) and other agencies have invested in research and development of cyberlearning tools and cyber infrastructure for science, technology, engineering, and mathematics (STEM) learning. Despite supporting research on the efficacy of many of these investments, there has not yet emerged a coordinated cyberlearning focus to improve STEM education. Diverse challenges at multiple levels, from what happens in the classroom to state and federal policies that drive curriculum development, impede the progress of cyberlearning in education. Wide-scale implementation and sustainability are problems requiring a broad look across diverse institutional actors. The purpose of this project, supported through a grant from NSF,[1] is to go beyond identifying the obstacles to cyberlearning to identifying and bringing together the diverse set of stakeholders and decision-makers necessary to advance cyberlearning in American education.

Literature Review

American students' declining interest and achievement in science, technology, engineering, and mathematics (STEM) education is well-documented (Lyons, 2006; George, et al., 2001; National Academy of Sciences et al., 2007; National Science Board, 2004). The decline concerns many, including American business leaders who call for a national imperative to "improve achievement by all students in mathematics and science and attract more individuals into science, technology, engineering, and mathematics (STEM) careers" {Business Higher Education Forum (BHEF), 2007}. According to the BHEF, improving the quality of STEM education in schools is critical to the future of our national standing as a world leader in science and the global economy (BHEF, 2007, p. 4). Educational leaders similarly seek to enhance the American workforce by promoting interest in and access to continuing education (Rogers, 2006). Increasingly, they also focus on lifelong learning to advance STEM education so the American workforce can "innovate and compete in the knowledge-based, technology-driven global economy, (Ashida, 2009).

Advances in information technology (IT) or "cyberlearning" promise breakthroughs for lifelong learning and K-12 education. Today, collaborative forums provide students with the opportunity to learn outside the traditional classroom setting—learning anywhere, anytime,

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and at their own pace (Richardson, 2007). This availability can allow public schools to make better use of limited financial resources, and remove time, travel, and financial constraints for students as well as lifelong learners.

Professionals such as healthcare providers continually seek to expand or keep current their STEM related skills through continued education. Lifelong learning strategies can also address workforce retraining needs as America's workforce requirements evolve. Lifelong learners, however, face significant impediments to education access including lack of time and traveling distance for potential learners (Jukkala, Henly and Lindeke, 2008). Problems with access are also salient for other groups such as the elderly, disabled, and those of low socio-economic status. Additionally, present-day college-bound adults are provided fewer enrollment opportunities as state institutions struggle to operate with decreased funding (Tomsho, 2008). Cyberlearning has the potential to decrease these obstacles to lifelong learning by bringing education to the learner, facilitating pre- and post-service continuing education among STEM professionals as a bridge between formal and informal educational environments, and by promoting the public understanding of science (Council, 2006). Cyberlearning extends the reach of STEM education to audiences outside the classroom.

Cyberlearning technologies also have the capacity to improve schools and transform education in a positive and compelling manner. Specific and ongoing advances in cyberlearning are designed as and offer a means to promote inquiry-based STEM learning in schools. Cyberlearning enables cost-effective teaching methods not otherwise realized through traditional means (Moreno, 2006).

New and emerging technologies, including cyberlearning, hold great promise for addressing needs in STEM education both in and out of the classroom. Experience has proven, however, that technological advancement alone does not guarantee success. The complex challenge of improving both formal school-based STEM education and lifelong learning can be achieved through the collaboration of a diverse set of interested organizations, educators, scientists, industry leaders, state and federal policy makers, and government agencies.

Project Stakeholders

Discussions and solutions addressing the scalability and sustainability of cyberlearning in today's schools require inclusion of a diverse group of stakeholders:

- Education researchers
- Educators of teachers
- Educators of primary and secondary students
- Industry leaders

- Local, state, and federal education administrators
- Local, state, and federal policymakers

Discussions that bridge diverse institutional actors, guided by the common goal of advancing STEM education through cyberlearning, are necessary to frame the issues, barriers, and opportunities for sustainable improvements. These discussions should focus on developing a roadmap for action, informed by a broad understanding of the larger societal context of school based STEM education in the United States, for use by all the necessary actors. Discussions should also provide realistic assessment of the challenges for sustainable cyberlearning and clearly indicate key entry points for effective action.

Project Participants

Experts and stakeholders in cyberlearning and education were selected to participate in this project. Members of the NSF Task Force on Cyberlearning (hereafter referred to as Task Force), which produced the report, *Fostering Learning in the Networked World: The Cyberlearning Opportunity and Challenge*, are experts in the broad range of cyberlearning topics. Additional experts and stakeholders were invited to a 1 ½-day meeting. These experts and stakeholders included senior leadership and representatives from the following organizations and agencies:

- Department of Defense
- Department of Energy
- NASA
- National Training and Simulation Association
- US Congress
- Department of Education
- Federal Communications Commission
- National Governors Association
- Private Foundations
- White House Office of Science and Technology Policy

Project Objectives

The objectives for this project are to:

1) Prepare for a 1 ½-day planning workshop to plan the International Conference;
2) Plan the logistics and agenda of the 1 ½-day planning workshop;
3) Host the 1 ½-day workshop to develop and identify specific recommendations for the International Conference;
4) Develop a Summary Report to guide the development of a subsequent conference grant to support the International Conference, and the planning and execution of that conference.

Project Activities

The activities for this project are to:

1) Work collaboratively with NSF leadership, Task Force members, and representatives of NTSA and DoD to identify pertinent issues related to cyberlearning and the effective use of technology in education. Participants will recommend potential conference participants, conference location and conference format. This collaborative effort will be performed through:
    a) Holding individual meetings with Task Force members, and representatives from NTSA and the DoD to collect data, initial ideas, strategies, and recommendations;
    b) Sharing working documents, prepared by the ASTA research team, which will integrate data and information obtained through the individual meetings;
    c) Conducting periodic web-conferences to update Task Force members, NTSA, and NSF leadership on the planning progress and to set the stage for the planning workshop;
    d) Hosting a 1½-day planning workshop in Washington, DC. The workshop will foster membership dialogue, brain-storming, and identification of specific recommendations for the International Conference, including objectives and research questions, participants, speakers, format, and location.
2) Prepare a Summary Report based upon preliminary work and workshop proceedings. The Summary Report will include an Action Plan with specific recommendations and plans for implementing the International Conference. The Summary Report and Action Plan will provide the basis for a subsequent proposal submission by NTSA to NSF for conference support. ASTA expects to support NTSA's subsequent grant proposal.

Resources used to implement the project

The project was conducted by The ASTA Group, LLC, a woman-owned small business, with funding support from NSF (Grant No. 0940773).

Constraints

This project was constrained by scheduling conflicts of proposed participants. Three NSF Task Force members were not interviewed due to their unavailability during the interview period. Ten workshop invitees were unable to attend the workshop due to scheduling conflicts.

Additionally, participant selection does not constitute a representative sample of experts in cyberlearning or education – participants were identified and selected based upon their expertise and perspectives, as identified by their professional writings and position. While we have made attempts to assess levels of consensus and division among participants, there was no process for achieving unanimity, nor was such a process advisable. This discussion was fractious by design, with the understanding that a plan for sustainability of cyberlearning innovation required communication across different stakeholders groups, each having an interest in and perspective on the problem. We felt that forcing stakeholders to confront other standpoints would stimulate new ideas, and it did, but it also reduced the likelihood of participants cohering around a single path forward. We have tried to indicate the main themes of the discussion without abandoning too many of the interesting side-paths. The result is exploratory and qualitative in nature.

Evaluation Study Questions

There are three fundamental evaluation questions addressed by the study:

1) What are the challenges facing scale and sustainability of cyberlearning in K-12 education?
2) What are solutions to overcome the challenges facing cyberlearning in K-12 education?
3) What stakeholders need to be involved in the further identification and implementation of solutions?

Table 1 presents the project logic model, and identifies the strategies (activities), inputs, outputs, and expected outcomes to address the study's evaluation questions.

Situation: The problem of sustaining innovations in cyberlearning is recognized but poorly defined in scope and in terms of actionable solutions.

Table 1: Project Logic Model

Strategies	Inputs	Outputs	Outcomes
1) Work collaboratively with NSF leadership, Task Force members, and representatives for NTSA and DoD to identify pertinent issues related to cyberlearning and the effective use of technology in education. 2) Prepare a Summary Report based upon preliminary work and workshop proceedings.	• Preliminary interviews with NSF Task Force members • Workshop participation and discussion by thought leaders with expertise in cyberlearning and/or education policy	• White paper outlining known issues related to cyberlearning sustainability • Analysis and report of workshop proceedings	• Better understanding of scope of challenges pertaining to scale and sustainability of cyberlearning in K-12 education • Identification of solution-oriented action entry points • Identification of areas of expert consensus • Identification of areas of expert diversity of viewpoints • Illumination of a roadmap for further action • Increased awareness among stakeholders of each other's perspectives • Increased commitment among policy makers for coordinated action

Evaluation procedures

Sample

Data for this project was collected through individual interviews and transcript analysis of the 1½-day planning workshop. Individual interviews were conducted with nine members of the NSF Task Force on Cyberlearning, an established cadre of experts in cyberlearning and education. Workshop invitees were identified through these preliminary interviews, as well as subsequent discussions with agency leaders to determine representation from identified stakeholder groups. Twenty-three agency representatives and experts in cyberlearning and/or education participated in the workshop.

Data collection

Project data consisted of Task Force member interviews and transcripts from the Washington, DC meeting. Task force member interviews were conducted between November 1, 2009 and December 15, 2009. Nine of the original twelve Task Force members were interviewed. Three individuals were not interviewed due to scheduling conflicts. The interview protocol was semi-structured, oriented to probe interviewee's unique expertise and perspective of cyberlearning in education. Each interview provided insight into cyberlearning implementation issues gleaned from each Task Force member's unique perspective. The interview notes were synthesized to identify challenges and others issues related to cyberlearning implementation. The resulting synthesis was used to frame the meeting's agenda and develop preparatory material for meeting participants.

The meeting agenda was oriented to focus participants' thoughts and contributions to identifying solutions and intermediate action steps to achieve scale and sustainability of cyberlearning in K-12 education. The meeting's goal was to foster discussion among participants, allowing the identification of the diverse perspectives, resources, and experience among them. Meeting proceedings were recorded verbatim, and subsequently analyzed for thematic content.

Table 2 summarizes project evaluation questions and the approach taken to address them.

Table 2: Evaluation Questions and Data Summary

Evaluation Questions	Data Collection Approach	Respondents	Data Collection Schedule
1. What are the challenges facing scale and sustainability of cyberlearning in K-12 education?	• Individual interviews with nine members of the NSF Task Force on Cyberlearning	• Nine members of the NSF Task Force on Cyberlearning	• November 1 – December 15, 2009
2. What are solutions to overcome the challenges facing cyberlearning in K-12 education?	• 1 ½-day workshop of discussion following a structured agenda	• Twenty-three leaders and experts in cyberlearning and/or education	• February 26-27, 2010
3. What stakeholders need to be involved in the further identification and implementation of solutions?	• Individual interviews with nine members of the NSF Task Force on Cyberlearning • 1 ½-day workshop of discussion following a structured agenda	• Nine members of the NSF Task Force on Cyberlearning • Twenty-three leaders and experts in cyberlearning and/or education	• November 1 – December 15, 2009 • February 26-27, 2010

Findings

One of the most prevalent interview and literature topics was that the idea of improving education through technology is not new. The promise of technology to transform U.S. education has been discussed for more than forty years. Despite a large amount of research and successful demonstration projects, our expert informants held the view, supported by our own review of literature, that innovative technological implementation has progressed little beyond the simple presence of computers in classrooms, and not even that in all schools. Classroom computer technology can still be characterized as a useful tool utilized by a handful of teachers in some circumstances (see for example Cuban et al., 2001).

There are signs that cyberlearning can be become an integral part of instruction. Each technological advance introduces new possibilities and there are indications that wide-scale cyberlearning implementation may finally be achievable. Homes and schools across America have become "wired," and the vast majority of Americans are using technology at home and at work. Computer technology has become an integral part of our lives. We encounter it in both mundane daily activities such as paying bills, and in extraordinary life events such as undergoing cutting-edge computer assisted surgical procedures. Public education lags behind in its level of utilization compared with society at large. Leaders in education, business, and government are recognizing the need to promote cyberlearning in American schools.

What are the challenges of scaling and sustaining cyberlearning in K-12 education?

Challenges to implementing wide-scale cyberlearning are complex and multi-faceted. The diverse range of issues identified through Task Force interviews and the literature can be organized into eight broad categories:

1) Access and resources
2) Teacher training and preparation
3) Cyber-infrastructure
4) Alignment with curriculum standards and curriculum selection policies
5) Assessment
6) Determining evidence-based best practices
7) Lack of sustainable business models
8) Educational culture

Each of these challenges is discussed briefly in the following sections.

Access and Resources

One challenge to using technology in schools and classrooms is access to the technologies themselves. Access encounters barriers at multiple levels--from connectivity and availability of necessary hardware and software, to teachers' awareness of these effective learning tools and their permissiveness of student utilization. Data from the U.S. Department of Education shows that more that 80% of K-12 students used a computer at school in 2003 (DeBell and Chapman, 2006). A computer in the classroom, though, is insufficient for effective technology use in the classroom. One, two, or even three computers in a classroom of 30 students limits the potential use by students, requiring a coordination rotation of students and limiting interaction among students.

The further development of technology in education will also likewise require student in-home access for purposes of doing homework and supplementing in-class school work. A recent study by Child Trend Databank (CTD) estimates that 76% of children ages three to seventeen have access to a home computer, while 42% use the Internet at home (CTD, 2005). Being connected at home may not be enough, though, as newly developed internet resources require the transmission of large amounts of data. A recent study by the OECD estimates that only 26.7% of U.S. inhabitants have access to broadband connections (OECD, 2009), which will likely be required for wide-scale adoption of cyberlearning. Equality of access varies significantly across ethnicity/race and family income (see Figures 1 and 2).

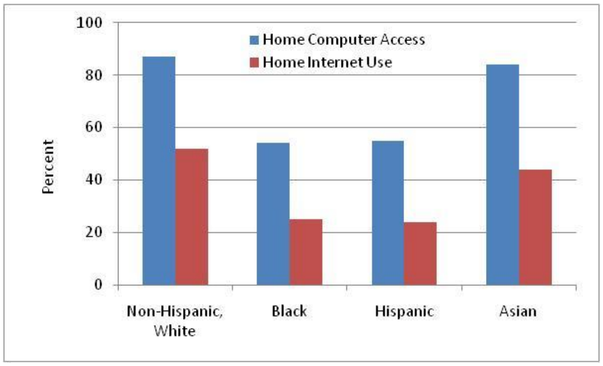

Figure 1: Percentage of Children Ages 3 to 17 Who Have Access to Computers at Home and Who Use the Internet at Home, by Race and Hispanic Origin, 2003

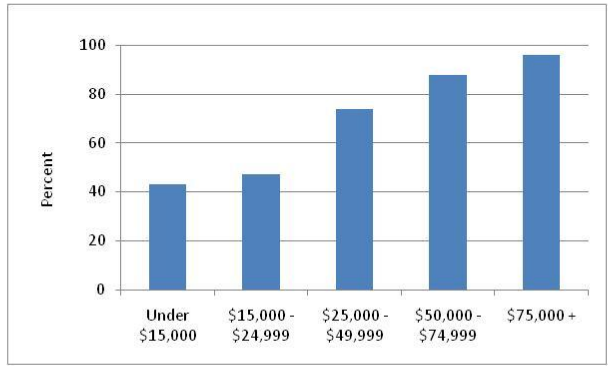

Figure 2: Percentage of Children Ages 3 to 17 Who Have Access to Computers at Home, by Income Level, 2003

Source: Day, Janus, and Davis (2005), cited at Childs Trends Databank, http://www.childtrendsdatabank.org/archivepgs/69.htm)

Other challenges related to access include identifying what tools are available, and knowing which are effective for the learning task at hand. Given the well-documented demands on today's teachers' time, it is not surprising that available cyberlearning tools are not being widely used. It is possible that teachers lack the time, and perhaps skill, to research and locate available tools. While these challenges are related to teaching training and preparation (discussed in the next section), it also requires the capability to identify and locate tools, and know what tools are effective for what learning. There are several aspects to these challenges:

- What is available? The internet represents a vast resource for STEM education, constantly enlarging and changing. The sheer volume of information means that sifting through the noise to find the right tools requires skill and time. It is not difficult to imagine an Amazon.com –like resource that house, catalogues and allows user feedback for technology-based teaching and learning resources.

- What is effective? There has been, and continues to be, extensive research into innovative teaching strategies and tools, but the translation of research findings into tools for teachers is slow.

A related issue is approval for cyberlearning to be integrated into the classroom curriculum. This challenge involves several areas, including local school and school district policies as well as how tools align with curricula standards. For technology resources to be used effectively, teachers need to have ready access to the right tool at the right teaching moment, which will require the required approvals and integration into the course structure. Approval and necessary access are often a consequence of policies. Local school policies are informed through local school board/district policies, which in turn are informed through state policies.

Even if a school has adequate computer resources, restrictions on time or utilization may render those resources ineffective. Principals, school board members, and other technology "gate-keepers" may be ill-informed about the potential of technology resources they limit under lock and key.

Teacher training and preparation

The development of many on-line and technology-based teaching tools is predicated on the "build it and they will come" model. The low utilization of excellent and effective tools provides evidence that this approach is insufficient. While more teachers use computers in their work settings, use appears limited to communicating via email, locating information, or preparing class materials. In other words, use sustains rather than transforms traditional educational practices (Cuban et al., 2001). In a national survey of primary and secondary school teachers, it was found that frequent computer use in pedagogy was practiced by a "small and distinct minority of teachers" (Becker, 2000).

Most experts agree that sufficient teacher training and preparation is necessary for technology to be used successfully in the classroom. A significant proportion of in-service teacher technology-training occurs when a new tool is being developed and researched, and teachers' classrooms are selected for the study. Teachers are typically trained in the tool's use for purposes of the study. Other teacher training is often the result of the teacher seeking the training through in-service training, and is dependent upon the individuals' interest and motivation and the availability training.

There are indications that pre-service teacher education is recognizing the benefits of technology in the classroom. In 2006, the U.S. Department of Education conducted a national survey of all Title IV degree-granting four-year postsecondary institutions on how teacher candidates within teacher education programs for initial licensure were being prepared to use educational technology (Kleiner, Thomas, and Lewis, 2007). The study found that about 50% of the institutions offered three- or four-credit stand-alone courses in educational technology, and included educational technology within other course types, including methods (93%), field experiences (79%), and content courses (71%). The same report also noted there were significant barriers to teaching faculty to integrate educational technology into their own classrooms, and teacher candidates encountered significant barriers to using technology during field experiences.

Teacher certification is an integral part of both pre-service and in-service teacher training. Consequently, certification requirements will need to be reconsidered in tandem with wide-scale strategic changes in teacher training to ensure training meets certification requirements.

Cyber Infrastructure

Cyber infrastructure must create a sustainable and adaptive environment for the sharing of ideas, promotion of research, learning, and collaboration, and protects the users and the environment's data. An effective cyber infrastructure cannot just be a collection of structure and processes. Cyber infrastructure must be constructed with users in mind and must consider the breadth of use. Models must be built upon effective approaches that promote interaction among peers, mentors, teachers, and researchers. Models must also be sustainable, adapting to user requirements while maintaining the integrity of necessary processes, structures, and data.

Wide-scale cyberlearning implementation can only follow adequate cyber infrastructure development. Standards and processes must be established for the transmission and storage of learning resources, as well as for the significant amount of data that will likely be collected through the use of these learning resources. Cyberlearning offers unparalleled opportunities for learning science research. These opportunities will be dependent upon accessibility and compatibility across hardware platforms. Data protection is also paramount, to maintain integrity of the data and to protect users.

Alignment with Curriculum Standards and Curriculum Selection Policies

The successful integration of cyberlearning into American classrooms will be dependent upon close alignment or cyberlearning objectives with curriculum standards. Improved consistency across state curriculum standards will facilitate the development and subsequent adoption of cyberlearning tools. Alignment is a daunting task considering that each state establishes its own standards. Additionally, local school boards typically set the curriculum for their districts' schools, and there are almost 15,000 school systems in the United States (National Center for Education Statistics, 2006). Steps are already underway, as some states have begun to adapt their curriculum standards to account for educational technologies. The push of national standards to guide state decisions may result in better uniformity across states.

A related challenge is the limited consideration of cyberlearning resources when states and/or districts select their teaching materials. Textbook selection committees have been slow to acknowledge educational technologies, relying solely upon textbooks (committee names themselves suggest an exclusive selection catalogue), or using dated selection criteria that favors textbooks. While many states are recognizing the growth of technology capabilities within their schools and among their constituents, choices still seem limited to a physical textbook versus a CD or online version. This is not entirely the fault of selection committees, as most educational technologies do not have the marketing muscle to compete with textbook publishers. Similarly, there is no functional business model for educational technologies to move them from research and development (frequently funded by NSF, U.S. Department of

Education (DOEd), or similar agencies) to widespread use. For cyberlearning to succeed, educational technologies need to gain an equal foothold among traditional teaching resources such as textbooks.

Assessment

Assessment is frequently cited as a barrier to successful cyberlearning implementation. The pressure of high-stakes, state-wide student assessment tests, used to evaluate students, teachers, and schools, gives teachers little incentive to try new instructional methods, whether they involve technology or not. Similarly, the scope of preparation material needing to be covered for testing leaves teachers with little time to identify and select appropriate tools to match lesson objectives.

There are also concerns about whether the current assessment model is appropriate for cyberlearning instruction. There is general consensus that important potential benefits of cyberlearning, such as promoting inquiry-based learning and teaching critical thinking, do not align with the content measured through current standardized assessment formats. For example, a virtual environment may be successful at teaching aspects of the scientific method, such as hypothesis testing, but will lack the required rote memorization of scientific facts that is necessary to succeed in high-stakes testing.

Determining evidence-based best practices

The National Science Foundation has been instrumental in the development and research of educational technologies, including cyberlearning innovations, for use in schools and classrooms. NSF's support for education research exceeded 900 million dollars in 2009 (NSF 2010), representing only the most recent round of a longstanding commitment to advancing STEM education. Support for cyberlearning innovations benefits from the same rigorous merit review process afforded to other NSF grant making activities. The products of such efforts are generally efficacious, and always evaluated.

When and if cyberlearning innovations move outside the government supported arena and are supported by private for-profit and not-for-profit organizations, rigorous impartial review may not be guaranteed. The means to evaluate the effectiveness of any innovation or determine best practices will be unclear.

Lack of Sustainable Business Models

For educational technologies to become integrated into standard education practice, steps must be taken to make them self-sustaining after the research and development (R&D) funding runs out. Federal and state research dollars are often used to support the initiative, development, and evaluation of innovative cyberlearning tools. Funding is not ear-marked to finance continued project maintenance and support. Promising projects, with research demonstrating effectiveness, are often set aside when researchers continue their research program with new developments. Even if the program is left to open-access, there are usually no resources left for continued teacher training. There is a gap between R&D funding and moving the innovation into the marketplace (e.g. classrooms).

The development of business models suitable for educational technological resources has been suggested. There is debate about whether educational technologies developed with government funding should later be sold for profit. Without a sustained revenue stream, there are no resources for training, maintenance, and further development.

Open source resources have also been identified as a solution for sustaining and scaling-up educational technologies. The open source discussion has been growing, in part due to the increasing costs of textbooks. It began in higher education, where the cost of textbooks may be impacting the ability of some students to attend college. The discussion is beginning to move downward into K-12 education where cash-strapped states are looking for ways to reduce their textbook budgets. Some states and districts have implemented parent fees for K-12 textbooks, which will likely increase the volume of the open source discussion.

Educational culture

Teaching in today's classrooms remains, in many ways, the same as it was in one-room schoolhouses of yesterday. The decision to use technology in the classroom often depends on the teachers themselves and the beliefs they hold about technology (Ertmer, 2005). There are limitless examples of teachers needing to rely upon their own initiative to bring technology and technology-based resources into their classrooms. Even then, teaching innovation is often met with skepticism and resistance by school administration and teaching peers. Any system-wide cyberlearning initiative will require education for stakeholders, including students and their parents, teachers, and principals, regarding its benefits and uses.

What are solutions to overcome the challenges of cyberlearning in K-12 education?

There was general consensus of the challenges facing cyberlearning in K-12 education among workshop participants. Initial discussions were oriented on whether a national plan was appropriate, or whether a strategy of "hybridization" is better suited for K-12 education. The idea that top-down action (i.e. national standards or a single platform) is desirable was challenged. In other words, cyberlearning should be built upon the existing K-12 infrastructure in an incremental fashion, rather than attempting to reconstruct that infrastructure wholesale. The difficulties of transforming K-12 education were noted and offered as reasons why other areas, especially higher education and vocational and military training, appeared further along in terms of cyberlearning implementation. There was also some discussion as to whether the disproportionate success of cyberlearning in higher education is a sort of incrementalism, an expectation that higher education transformation would trickle down to K-12 education. It was noted that cyberlearning expansion into K-12 would be facilitated by focusing on overcoming the complicated social environment that surrounds K-12 schooling. An example of an incremental approach is broad support for a multitude of small scale implementation projects, which would be tailored to the needs of individual consumers, schools, districts. These small projects would then form a marketplace where superior products would scale up through demand rather than be pushed down through a coordinated strategy pre-selected at a national level.

There was also discussion about who is responsible to accomplish cyberlearning implementation in the K-12 arena. Participants were directed to the NSF Cyberlearning Task Force report, and the recommendation that NSF build a community not only of researchers but also of teachers and education faculty for the purpose of developing platforms for cyberlearning (the platform theme became the subject of later discussion). The question was raised that since NSF has not enacted this recommendation, who would? And to whom should recommendations be made? The issue of leadership for cyberlearning in K-12 education became another theme for later discussion: who needs to be involved and what institutions have the capacity and will to effect a transformation in K-12 practice?

Emphasizing the platform theme, one participant called for a focus on assessment and evaluation (tools for teachers and schools to facilitate the use of cyberlearning innovations in the classroom). However, another suggested a “ground up rebuild” of the K-12 system would be required to replace the current “19^{th} century” educational system. Her suggestion spoke to the problematic nature of layering technology over the existing K-12 infrastructure without addressing the underlying goals of K-12 education. This point seems pertinent. For example, a longstanding goal for NSF regarding STEM education has been to encourage inquiry methods over direct instruction. Cyberlearning media can be designed to facilitate inquiry methods. Cyberlearning will not be valued as an educational tool, however, until inquiry methods are prioritized and valued by the educational community. A question for cyberlearning implementation, then, is should the affordances provided by cyberlearning be part of the transformation strategy, or should cyberlearning innovations be designed to facilitate direct instruction and thereby a more palatable incremental addition to the dominant direct instruction method for STEM education?

Following the incremental theme, discussion approached the question of an action entry point by drawing attention to the media already in place in schools, predominantly textbooks, which (in one participant’s opinion) reduce funding for cyberlearning. This theme, revisited later in the discussion, identifies the challenge that there is no room for cyberlearning innovations because traditional educational materials are in place and supported by an active industry. One identified solution is a strategy of working with, competing, challenging, or changing the structure and process schools use to adopt instructional materials. This implies an entry point at the state level—where textbook adoption occurs—possibly including Governors as change makers, and appealing to Governors' need to control educational costs.[2]

As an example of how this challenge could be addressed, a participant reported on NASA's successful project to change curriculum standards in the Virginia school system to include methods and content related to engineering, which necessitated a transformation to adopt cyberlearning materials. In Virginia, NASA assembled a broad coalition of educators, researchers, and stakeholder groups in the aerospace industry (which supports NASA) to lobby for change. NASA provided leadership, conducting a 3-year project that included a gap analysis, draft standards, and assistance with the identification of suitable materials (Virginia adopted Flexbooks, a paperless hypermedia enabled alternative to standard textbooks). Notable in this effort was that classroom practice was changed, not by appealing directly to teachers, but by changing the incentive structure that teachers must follow. Another noted approvingly that the NASA example is one of creating "market channels" in which the regulatory system (in this case state curriculum standards) creates an incentive structure that encourages innovation without dictating its form.

One participant wondered if anyone had done a study to show how States can save money with cyberlearning. This question was not answered directly, but another participant noted that it's not necessarily in the State Education Directors' interests to introduce cost savings that might result in shrinkage to their overall budgets. However, Governors and State Legislators might see this differently. If Governor's and or state legislators can be shown the potential cost savings of cyberlearning, this might be a viable entry point for action.

A participant reported that the National Governor's Association (NGA) is in the process of developing a core set of curriculum standards across States. This reform process may be an opportunity to build standards that encourage cyberlearning. She encouraged the meeting participants, as a group, to develop concise recommendations to the NGA.[3]

[2] Beyond curriculum standards that favor existing players, a participant suggested other potential barriers include copyright standards (i.e. what's the revenue mechanism for open-source content or content developed through public support? And how is that competitive?).

[3] NGA has released a draft set of standards available at http://www.corestandards.org.

Other meeting participants approached the action entry point as a problem of getting more and better tools in the hands of more teachers through awareness, and or the promotion of modular learning products. One said that from his perspective, sorting through all the materials available to find the right application for a need was an ongoing problem, prompting another participant to suggest the need for a clearinghouse or database or search tool of available materials. This approach, as another noted, has a “20 year history of failure,” as such tools have been developed but not used, and quickly become obsolete through that disuse.

A participant suggested instead there was a need to make existing tools easier for teachers to use by developing platforms in which assessment is modular in the sense that it is also tied to general assessment standards. In other words, assessments should be designed as part of a multi-use package of design standards that would exist independently of a particular instructional material. He distinguished this idea from the notion of “learning modules” that were supposed to contain the building blocks for lesson and course development (another failed idea in his estimation).

A “platform” as some use the term is probably closer to the idea of a computer operating system like Microsoft Windows or a computer language like HTML or Java. Platforms support the development of any number of applications that benefit and are constrained by platform design. In this thinking, assessment-within-platform would not dictate content but would regulate the types and format of data collected, for interoperability across curricula and tracking performance over time. A platform, in addition to assessment regulation, should be developed to address and overcome the problems faced by teachers of how a cyberlearning innovation can be incorporated into their practice; in other words, geared toward facilitating course design from A to Z. This perspective of cyberlearning development is distinctly different from most educational research, which is focused on isolated and often idiosyncratic learning outcomes, in response to funding opportunities provided by NSF and other funding organizations.

The utility of a platform approach was picked up by one participant, who remarked that as a funder she sees a lot of projects but they are not linked in any meaningful way. She also sees an overall lack of attention to classroom social practices in cyberlearning innovation research. Another participant said this is a problem the DOEd is aware of and DOEd is encouraging researchers to incorporate an “ethnographic understanding” of teacher practices into materials design.

This participant suggested NSF would be a natural home for platform development. The problem she sees is that NSF relies on a research process derived from medical research that is too slow and cumbersome to support the rapid development and dissemination of an evolving cyberlearning content base. This was a problem the Department of Defense might be in a position to assist with their expertise in “Rapid Prototyping.”

Several participants noted the duplication and waste of effort across agencies in developing new innovations and promoting best practices. This returned the discussion to the question of leadership, and specifically who needs to be involved. Participants made several references to federal initiatives that impact or potentially impact cyberlearning’s spread to K-12 sector. These initiatives include the I3 program at DOEd, E-Rate and the National Broadband Plan at the FCC, ITEST (and other NSF research solicitations), and efforts to draft common State curriculum standards (led by the National Governor’s Association). Participants agreed that there were substantial opportunities for coordination across these and other programs, as well as the opportunity to instill an explicit cyberlearning focus within each. It seems clear that at a minimum, the DOEd, FCC, NSF, and NGA should be involved based on their existing interests and/or investments in education and technology. No consensus of meeting participants emerged as far as the agency or program that would be the obvious leader for this effort.

The discussion of agency leadership and collaboration raised the practical issues that collaboration across agencies requires Congressional and/or Office of Management and Budget (OMB) support. This support is necessary to ensure mechanisms for transferring money across agencies to support common initiatives. In response to this issue, it was asserted that OMB has enabled collaboration within the I3 competition. It was also suggested the Commerce Department should have a leadership role in promoting business that market cyberlearning innovations. It was also noted that National Center for Research in Advanced Information and Digital Technologies (or “Digital Promise”[4]), housed within the DOEd, may be well positioned to serve as a champion for cyberlearning sustainability across agencies and other stakeholders. It was suggested that Digital Promise could serve as the lead organization for cyberlearning initiatives with other agencies’ support.

The role of industry was also discussed. Several participants noted that while the Defense Industry has incentive to promote domestic educational reforms (i.e. many jobs require security clearances that only US citizens can get), other industries would also benefit from a technologically literate or STEM competent workforce. The concern was raised, however, that many industries have moved overseas or recruit resident aliens, rather than invest in the US education system. Two participants agreed that it seemed “too late” to engage the high tech and manufacturing industry in a meaningful way because too many have already made the move overseas.

[4] http://www.digitalpromise.org/

A participant reminded the group that the Task Force has already charged the NSF to assume a leadership role in developing a sustainability plan. He outlined the following strategy:

1) NSF picks five successful innovations "game changers" it has sponsored
2) These are turned over to DOEd for implementation
3) DOEd assembles industry support for commercialization and scale-up

This plan drew the comment that "researchers are ill-suited to deal with sustainability issues," a view which was endorsed and opposed by various participants. The comment speaks to the difficulty NSF has already experienced in their attempts to design "scale-up" solicitations that produce transformative results. But it may also be true that the problem of dislodging existing players in the instructional materials industry has received insufficient attention at NSF. Even if a superior product is marketed correctly, earlier entries crowd the field and have the advantage of consumers' sunk costs (note Microsoft vs. Apple, or Microsoft vs. Linux, or Microsoft vs. anything). A participant referenced a "seven year rule," that is, many states expect investments in new materials infrequently and expect the materials to serve multiple years, this is a barrier to innovation and favors materials with established performance.

At this point participants agreed with an earlier assessment that cracking the textbook industry's stronghold over the market is key to the sustainability of cyberlearning innovations. One noted that all the publishers are actively seeking the next generation of "IT-enhanced materials," but doing so without much guidance in the form of standards or requirements from the government. Another expressed skepticism that the textbook publishing industry can be trusted to "carry the ball" absent regulatory guidance. Another suggested that the industry seems to want to keep the printed textbook with IT add-ons—which will in his opinion, not address the rising cost problem.

There was also a considerable amount of discussion over the viability and advisability of developing a new cyberlearning "showcase" product to directly challenge the textbook industry. Several (but not everyone) agreed this was worthwhile, but there was less agreement over what form it would take or what market niche it would broach. Some thought it should be a core course (e.g. High School Algebra I) for use in the K-12 system. Others saw more promise in developing materials for dropout prevention programs, Community colleges or vocational settings—areas with less intense competition. Still others thought that material development was a distraction from the sustainability or scale-up question; that quality cyberlearning materials were extant but unused. One advocated that NSF should make a "ten-year" commitment to sustaining its already proven innovations.

Key recommendations from small group discussions

The second day of the workshop was oriented on small group discussions of specific recommendations for achieving scale and sustainability for K-12 cyberlearning. Discussions and recommendations were oriented around three topic areas:

1) Research agenda / advanced technologies
2) Improve product development
3) Infrastructure

The following three sections list the key recommendations that emerged from those discussions.

Research agenda/ advanced technologies

1) We need platforms that enable assessment and tracking.
2) Innovation design should take into account student engagement.
3) Adoption of innovation will be facilitated by recruiting “supernodes” as early adopters.
4) NSF should partner with the Department of Commerce or DOEd to pursue markets for cyberlearning innovations rather than attempt this in-house.

Better product development

1) Replace monolithic “smokestack” thinking as exemplified by textbooks with more flexible approaches. The drivers for this are cost, quality, policy/regulation, integration with teaching practices, student engagement and viral marketing. Barriers include teacher certification misalignment, regulatory barriers to virtual schools, curriculum standards misalignment, and visibility/awareness.
2) Design for interoperability (e.g. platform).
3) Issue competitions with prizes for innovations that succeed, in addition to targeted research solicitations.
4) Hold investment conferences to attract venture capital to innovators.
5) Focus on creating demand for rather than increasing supply of innovations.

Infrastructure

1) Keep communications happening between agencies (like this meeting) to resolve infrastructural issues and explore opportunities for collaboration.
2) Do a periodic assessment of technology use in the classroom.
3) Audit e-rate funds.
4) Conduct a study of NSF supported cyberlearning innovations in the marketplace to identify obstacles to adoption.

What stakeholders need to be involved in the further identification and implementation of solutions?

All interviewees and workshop participants agreed that the breadth and complexity of issues pertaining to K-12 cyberlearning require the input and participation of all stakeholders to implementation solutions. Recommendations for stakeholders to be included in future planning include:

- Cyber-infrastructure business leaders
- Department of Commerce
- Department of Education
- Educational Professional Organizations
- Educators
- Industry
- National Governors Association
- National Training and Simulation Association
- Textbook Suppliers
- US Congress
- Cyber-infrastructure researchers
- Department of Defense
- Department of Energy
- Educational Researchers
- Federal Communications Commission
- NASA
- National Science Foundation
- Private Foundations
- Teacher Educators/Programs
- White House Office of Science and Technology Policy

Conclusions

The call for an International Conference to promote K-12 cyberlearning is premature. The problem of increasing the scale and establishing sustainability of cyberlearning in K-12 education is complex. Multiple challenges face users, designers, and policy-makers at every level. These challenges involve providing the necessary tools to local students and teachers; teacher training in effective use; identifying effective tools and strategies quickly, and disseminating that information meaningfully to users; establishing platforms and infrastructure that promote collaboration and interoperability; and developing standards and policies that promote the use of cyberlearning in classrooms.

Incremental change can, and is slowly happening. A national agenda, however is necessary to guide policy decisions and implementation strategies. A national strategy would be capable of leveraging and coordinating resources, activities, and accomplishments that are currently emerging in isolated pockets. Diverse challenges call for diverse solutions that account for the multiple needs and expectations of involved stakeholders. The complex and varied (at times conflicting) needs of stakeholders call for a collective effort. The collective effort, however, must have a leader. It is unclear at this time which agency or organization is willing or able to assume a leadership role to establish and promote a national agenda for K-12 cyberlearning. DOEd and NSF seem well situated to assume such a role, though the effort will require committed resources. The lead agency must also act in concert with other agencies and stakeholders at a level uncommon for government agency action.

Through the data collected from experts and policy makers in the course of this project, we were able to develop a comprehensive picture of systemic challenges facing cyberlearning sustainability and scale-up in the K-12 education sector, and identify several promising opportunities for action. Through interviews and open group discussion, our experts revealed a complex and nuanced problem, with many interlocking parts that look different depending on the standpoint of the observer, and many partial solutions. However there is no consensus for a single solution or action entry point that will remove barriers to cyberlearning's promised transformation of K-12 education, nor did a champion emerge in the form of a federal agency, private organization, or other entity with both the authority and interest to push for change. Some favor incremental changes, some advocate whole-sale restructuring of the public schools. Yet others insist that traditional education will soon be rendered obsolete by technology, and can be ignored altogether. This disunity is partly a result of who was at the table. We wanted to bring together a range of stakeholders to deliberately encourage cross-fertilization and emergent opportunities for collaboration across organizations. This effort was partly successful and worth continuing with more resources and a more modest set of goals.

Recommendation

There should be a national agenda specific to cyberlearning: while NSF has led the research effort to research and develop cyberlearning innovations, especially in the area of STEM education, DOEd also has a substantial role in developing educational innovations (e.g. the current I3 solicitation), and the FCC leads efforts to build infrastructure required for wide-scale adoption of cyberlearning in the K-12 sector. Add to this, the National Governors Association's leadership in reforming curriculum standards, NASA's commitment to 21st century engineering education, and DOD's experience in modeling and simulation. All these and other efforts are potentially synergistic, and would benefit from better coordination.

It is recommended that a multi-agency task force be established, led by NSF and DOEd, linking involved national organizations and agencies. This task force should be tasked to establish a national agenda for K-12 cyberlearning. The task force should be comprised of subcommittees, organized according to challenge areas, drawing in stakeholder and expert opinion as necessary. Subcommittees should work collaboratively to allow cross-pollination of ideas and ensure that strategies are developed to support each other. A culminating event, a national or international conference on cyberlearning, should then be held to introduce the national imitative, and demonstrate support by all stakeholder organizations involved in its development.

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APPENDIX – Meeting Agenda

Meeting Purpose:

This meeting is the first step to bring together agencies, public and private organizations, academia and industry to collaborate in an initiative to ignite the nation's commitment to successful and sustainable change in K-12 formal and informal education through cyberlearning. The focus is to establish a collaborative framework and next steps plan to lead to a set of integrated recommendations to be seized by all through the context of a larger, international event.

Friday, February 26

9:00 Welcome and Introductions

9:15 The Time is Ours

9:30 So, Why the Hurry?

I. Given the importance of a strong educated workforce to our nation's security and viability, what are the issues and challenges of selecting best practices that are "shovel ready" for wide-scale implementation in formal and informal learning settings?

II. What national goals/initiatives are in place to support the acceptance and viability of widespread use of technologies in formal and informal K-12 education? Considerations include: National Technology Plan, National Broadband Plan, etc.

III. With the President set to sign "Pay Go" legislation and his announced freeze on discretionary spending, where is support for a dedicated, national cyberlearning program?

12:30 Working Lunch – Summary of Morning's Outcomes

1:45 So What Do We Do? (Agencies to be represented across groups)

Group I-A: What is the shape of a national action plan, given the issues and barriers identified in the selection of scalable, sustainable existing and emerging tools and practices?
Facilitator: Dr. Clifford Lynch
Proposed Agency Representation:

- White House Office of Science & Technology Policy
- Department of Education
- FCC
- Congressional Representation
- National Governor's Association

Group I-B: *How can cyberlearning address the requirements for assessment and evaluation of performance of "shovel-ready" formal and informal learning programs, given new emphasis on achievement-based teaching?*

Facilitator: Dr. Eva Baker
Proposed Agency Representation:

- Dept. of Education
- Department of Defense
- Private Foundations

Group II: *What needs to be done at a national level to obtain public support and buy-in (to include educational culture, administrators, parents)?*

Facilitator: Dr. Marcia Linn
Proposed Agency Representation:

- Industry
- Private Foundations
- National Governor's Association
- Congress

Group III: *What current efforts and financial/business models could inform further work on developing a consolidated, collaborative action plan for using cyberlearning tools and technologies on a broad scale in formal and informal settings?*

Facilitator: Dr. Hal Abelson
Proposed Agency Representation:

- NASA
- Dept of Energy
- Industry
- Private Foundations
- Department of Defense

4:00 Out-Brief to Committee of Whole

5:00 Plan for Saturday

5:15 Adjourn

Saturday, February 27

9:00 Where Do We Go From Here?

What are the Next Steps to Continue the Dialogue to Establish a Collaborative, Cooperative, Focused National Plan?

Group 1: Policy Perspectives

- White House Office of Science & Technology Policy
- Department of Education
- Congressional Representation
- FCC

Group 2: Agency Perspectives

- NASA
- Department of Energy
- Department of Defense

Group 3: Private/Public Perspectives

- Industry (NTSA)
- Foundations
- National Governor's Association

Group 4: Academic, R&D Perspective

- Task Force Members and Others Representing R&D/Academia
- CRESST

11:00 Sharing of Thoughts

Noon Working Lunch

12:30 Collaboration Commitment

Group Discussion on:
How to Organize Next Steps Discussion
How to Support Next Steps Planning
How to Share the Planning and Commitment (larger conference)

2:00 Adjourn