ADVANCING PERSONALIZED EDUCATION



The Role of Basic Computing Research

Today's classrooms consist of antiquated teaching materials and approaches that fail to effectively educate many students. Artificial intelligence, mobile devices, social networks, and other computing technologies have the potential to transform the way students and teachers interact. However, cooperation and investment by academic, industrial and government stakeholders is integral to transforming our education system into an effective one that provides every student with an opportunity to succeed. | Spring 2011

What is Learning Technology?

Learning technology, sometimes called "eLearning," involves employing a variety of networking and computing technologies to improve educational practices.

Promising Tools for Learning

A number of new and emerging technologies could be extended to classrooms:

Mobile Tools

Ubiquitous wireless tools, such as smart phones and tablets, provide remote access to information that enhances learning opportunities.

User Modeling

Programs can identify a student's competencies and knowledge over time, in order to understand interests, goals and characteristics that maximize one's motivation and learning.

Social Networking Tools

Web-based tools such as social networking sites facilitate information sharing and learning with one's peers.

Educational Data Mining

Educational data based on an individual's work and behaviors can be mined to better understand learning achievements, approaches, etc.

Serious Games

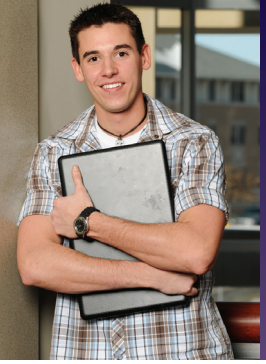
Educational games provide immersive, interactive learning environments that involve students in solving complex problems within educational scenarios and through group participation.

Intelligent Tutors and Environments

Coupled with data mining, advanced software comprising artificial intelligence, machine learning, and natural language processing provides students with customized instruction, assessment and feedback.

Rich Interfaces

Advanced sensor technologies can detect human action to better understand the value added by specific tools and approaches.



Understanding the Needs of the Student

Personalized education facilitated by computing technologies can replace the "one size fits all" teaching structure that may otherwise leave some students behind.

Personalizing Education

Technological advancements such as sensors, cameras and other advanced monitors provide students with educational instruction that is up-to-date and specialized for their learning needs. Raw data can be collected based on a student's educational background, current progress, attentiveness and emotional state during school, and mining these data in turn allows teachers to gain a better understanding of a student's strengths, weaknesses, challenges and motivation. Technological approaches for producing personalized instruction include data mining, user models, intelligent environments, gaming environments and more.

Intelligent Tutors

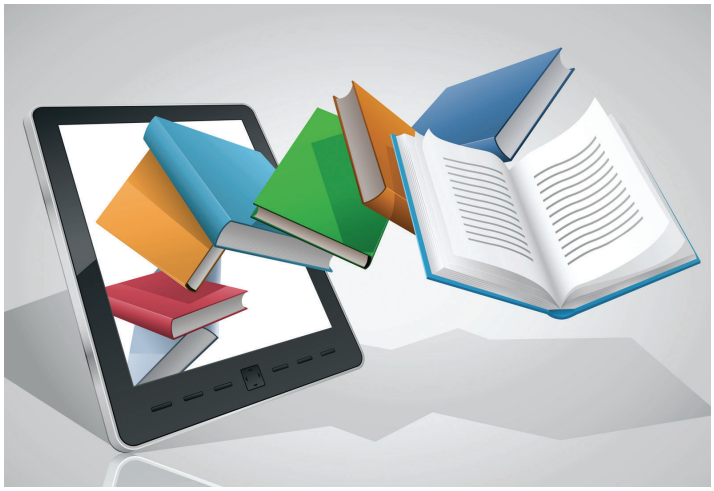
Computerized tutors, customized to meet the student's preferences, are providing private and supportive instruction, formative feedback and encouragement to students in a variety of subjects such as math and science. These tutors, which monitor a student's attentiveness, emotion and success when answering problems, can eliminate the need for constant teacher supervision, while offering hint sequences, constructive advice and elaborate instruction to boost a student's self-confidence and knowledge gained.

Mobile Learning

Advances in personal and mobile technologies such as smart phones and tablets allow students to explore real-world phonemona outside the classroom setting. For example, these devices together with intelligent virtual tutors help students construct graphical models of forces and motion, magnetism and electricity, landforms, and weather and climate in natural settings.

eLearning can Solve Today's Learning Challenges

- **1.2 Million** – The number of students that drop out of high school each year in the U.S.[1]
- **30** – The percentage of enrolled students in the U.S. who do not graduate from high school.[2]
- **50** – The percentage of the nation's African-American and Latino students who do not graduate on time from high school.[2]
- **40** – The percentage of dropouts in low-income schools who leave after ninth grade.[3]
- **2,000** – The number of high schools (about 12 percent of U.S. high schools) that produce more than 50 percent of the nation's dropouts.[4]



Collecting Data to Assess Learning

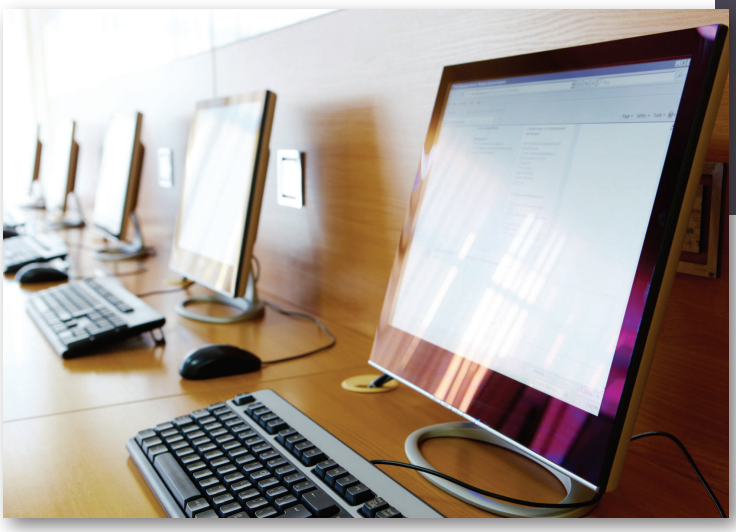
Computerized data collection of student performance provides teachers with a deeper assessment of real-time progress than current standard testing methods.

The Essence of eScience

Computational tools, instructional databases, digital libraries and educational data mining are enabling detailed and real-time assessment of students' progress in learning. These technologies are essential to providing regular student assessment that includes formative evaluation and feedback from multiple sources at multiple points throughout an academic year – not just at the end.

Continual Feedback and Learning for Stakeholders

Parents, educators and policy makers are building online teaching communities for furthering student learning and progress. These "connected" systems can serve students during after-school hours and allow parents greater access to a child's education. Digital networks allow stakeholders to manage the assessment process, analyze progress, improve educational expertise and take appropriate action to improve education in classrooms.



Deeper Assessment

Assessment systems – comprising data collection, complex analysis, and feedback – offer individually designed and interactive tasks, such as models of population density that enable students to investigate economic and social issues. Deeper assessment into the processes and contexts of learning and instruction in such problems can provide educators with evidence of a student's ability to reason, learn and apply knowledge.

eLearning can Solve Today's Learning Challenges

- **25** – The rank of U.S. students in math, among students in 30 industrialized countries.[5]
- **21** – The rank of U.S. students in science, among students in 30 industrialized countries.[5]
- **8 Million** – The number of U.S. students who cannot read at basic comprehension levels.[6]

Breaking Down Boundaries

Accelerated advances in Internet-based communications and databases are enabling an interconnected system of education tools that extends beyond classroom walls for lifelong, ubiquitous learning.

Social Networks Drive Learning and Engagement

Online collaboration tools (photo- and video-sharing, blogs, pod- and video-casts, wikis and social networks) have facilitated content sharing, allowing students to learn in new and previously unavailable environments. Students can interact in these collaborative environments and learn on computers, smart phones and tablets 24/7.

Advances in instructional software, learning communities and networking will also allow classrooms to shift from school buildings to new environments more easily.

Gaming to Promote Learning

Artificial intelligence gaming systems used for education allow students to immerse themselves in game-based narratives with 3-D characters to solve problems that include a variety of subjects. For example, microbiology classrooms use these systems to help students visualize how to trace the source of an infectious disease. The gaming systems allow students to demonstrate their knowledge and skills in real time, tracking how they think creatively, critically, and systemically.

Going to Class Online

Middle and high schools have taken homework and courses in math, science, English, and other subjects online. Through a combination of complex algorithms and educational data mining, online educational systems provide students the freedom to learn at their own pace with personalized assistance, while also providing teachers with formative assessment in real-time.

eLearning can Solve Today's Learning Challenges

- **25** – The number of years from birth until the average individual becomes sufficiently proficient to serve as an educator.[7]
- **$319 Billion** – The amount in lost wages, taxes and productivity due to school dropouts from the class of 2008 over the course of their lifetimes.[8]
- **$192 Billion** – The amount of income and tax revenue combined that is lost to each group of 18-year-olds who never complete high school.[9]
- **$7 Billion** – The cost per year for districts and states to recruit, hire and retain new teachers.[10]

Facilitating eLearning through Federal Investment

Continued forward progress in computing research is essential to promoting advances in education – and to sustaining a broad spectrum of Federal agencies' missions. This progress requires sustained and long-term investment that fosters close partnerships between computer scientists, educators, and other disciplinary researchers.

National Science Foundation (NSF)

- The NSF recently formed a Cyberlearning program to harness the transformative potential of advanced learning technologies across the education enterprise. This program should continue to be funded at the levels originally envisioned by the NSF. This funding level would support research into creating educational experiences that connect users with content, mentors, imaginary worlds, invisible phenomena and more. These elements are vital to engaging learners and helping them improve over time.

Federal Investment Must Support:

- Fundamental research that advances eLearning
- Federal support for distributing technologies into classrooms
- Data sharing through incentive-based funding opportunities
- Highly collaborative, multi-disciplinary groups of researchers
- Communication through workshops and conferences

U.S. Department of Education (ED)

- ED should provide $90 million in funding for the Advanced Research Projects Agency-Education (ARPA-ED) initiative, as recently announced by the Administration as part of its budget request for FY 2012. ARPA-ED would pursue breakthrough developments in education technology and learning systems, support systems for educators, and other tools that improve educational outcomes.

Other Agencies

- Agencies like National Institutes of Health (NIH) and Department of Defense (DoD) invest significant resources in training. For example, NIH currently provides $824 million for clinical training and postdoctoral research fellowships, while DoD spends billions to maintain tactical readiness, enhance special operations, and strengthen intelligence and security gathering. These agencies should establish programs analogous to NSF's Cyberlearning initiative or ARPA-ED to bring together leading computer scientists, social scientists, and domain experts to identify new technology-based innovations and strategies for instructing the next generation of clinicians, researchers, patients, war fighters, etc.

The Need for Computing Research

Computing research has led to breakthrough technologies that have solved many of the world's biggest challenges. Most of the revolutionary technological advances of the last 50 years were pioneered at U.S. universities through Federal research grants. We have a unique opportunity to benefit society through additional Federal support in key areas of computer science and information technology.

Economic Development – Every billion-dollar sub-sector of the IT industry bears the stamp of Federal support for basic research. U.S. preeminence in science and technology has long been the engine of job creation and the source of global economic leadership.

Scientific Advancement – Innovations in networking and information technologies have led researchers to develop new tools that expand the breadth of many scientific disciplines – ranging from the mapping of the human brain to understanding issues of climate change to analyzing massive amounts of astronomical data to better understand our universe.

Improve Daily Life – Computing research is improving areas as diverse as healthcare, transportation, energy and education. The development and distribution of these technologies will allow people to live safer lives, conserve natural resources, receive personalized education and beyond.

Technologies Developed from Government-Funded Computing Research

- The Internet
- Google
- Global Positioning Systems (GPS)
- Smart Phones
- Home Security Systems
- Doppler Weather Radar
- Health Monitoring Devices

CITATIONS

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FOR MORE INFORMATION

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The Computing Community Consortium (CCC) is a standing committee of the Computing Research Association (CRA) funded through a cooperative agreement between CRA and the U.S. National Science Foundation. The CCC seeks to mobilize the computing research community to debate and articulate long-term research challenges.