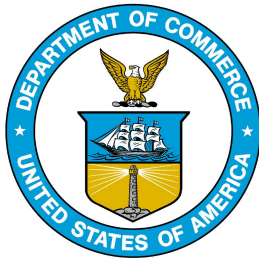# Visions 2020.2

Student Views on Transforming Education and Training Through Advanced Technologies

Visions 2020.2

Student Views on Transforming Education and Training Through Advanced Technologies

U.S. Department of Commerce
U.S. Department of Education
NetDay

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Introduction

Advances in both cognitive science and information technology have the potential to transform education and training in ways previously unimaginable. Advanced technologies under development by U.S. businesses, universities, and government could create rich and compelling learning opportunities that meet all learners' needs, and provide education and training when and where they are needed, while boosting the productivity of learning and lowering its costs. These technologies could play a major role in meeting education and training challenges in the years ahead, and help make the U.S. workforce more competitive globally. The development and deployment of these technologies involve matters related to technological innovation, a mission area of the U.S. Department of Commerce.

To lay the groundwork for Federal leadership in learning technology innovation, in September 2002, the Commerce Department published *Visions 2020: Transforming Education and Training through Advanced Technologies*. For *Visions 2020*, a number of distinguished individuals and teams from a wide range of technology and education fields were asked to look out into the future, and describe what technology-enabled learning experiences could be like. They responded with a rich collection of visions, some of which are excerpted in this report. *Visions 2020* identified potential technologies, their application for learning, and how the learning environment would need to change to take full advantage of them. With a future vision in hand, the Commerce Department convened a Summit on the Use of Advanced Technologies in Education and Training. At the Summit, stakeholder groups identified ways to encourage technology-enabled transformation in U.S. education and training.

To provide leadership, the National Science and Technology Council's (NSTC) Working Group on Advanced Technologies for Education and Training was established to foster the development, application, and deployment of advanced technologies in education and training in the United States. Among its goals related to technological innovation and market development is strengthening links between potential users of learning technologies and the researchers, technology developers, and private companies that create and provide these technologies. One way to support this goal is amplifying the voice of the user; that is, highlight market potential so that researchers and technology providers can strive to meet that market opportunity. In addition, educators who use technology for teaching may benefit from a greater understanding of how users (their students) would like to use new technologies for learning. The U.S. Departments of Commerce and Education (who co-chair the NSTC Working Group) and NetDay formed a partnership aimed at analyzing K-12 student views about technology for learning. These views are analyzed in this second report, *Visions 2020.2: Student Views on Transforming Education and Training Through Advanced Technologies*.

In October-November 2004, NetDay sponsored its "Speak-Up Day for Students" which offered online questionnaires, which asked K-12 students across the country about their use of technology. More than 160,000 students participated in answering questions; 38 percent of these students were in grades K-6, and 62 percent were students in grades 6-12. Public and private schools from both urban and rural areas participated and, in about

one-fifth of participating schools, underrepresented groups constituted the majority of the student population. Fifty-one percent of student responders were male, and 49 percent were female.

The NetDay questionnaires included an open-ended question to which students were encouraged to supply a short reply:

> *Today, you and your fellow students are important users of technology. In the future, you will be the inventors of new technologies. What would you like to see invented that you think will help kids learn in the future?*

More than 55,000 students offered a meaningful answer to this question. The Commerce Department reviewed 8,000 of these answers to probe for common themes and interests among students about how they would use technology for learning. Certain types of answers were excluded from the review. These include answers that: were too generic (e.g., I like technology), did not address learning technology-related topics (e.g., I'd invent a flying car), and did not discuss technology as a tool for students themselves to use for learning (e.g., I want a robot to do all of my homework for me).

Many answers offered views on more than one aspect of student use of technology for learning. For example, a student answer might say, "I would invent a pocket computer that all students could take home to do all of their homework." This hypothetical answer speaks to four aspects of technology for learning: a small computing device, a 1:1 ratio of computing devices to students, portability of the device, and the use of the computing device to complete all homework.

It is important to note that neither the administration of the original NetDay questionnaires nor the analysis in this paper represents a statistically valid survey. Instead, the information in this paper is an exploration of themes and interests.

Basic Themes

Visions 2020.2 begins with an exploration of how today's K-12 aged youth—the so-called New Millennials—use digital technologies. The analysis then explores four themes commonly touched on in the students' answers:

- Digital Devices
- Access to Computers and the Internet
- Intelligent Tutor/Helper
- Ways to Learn and Complete School Work Using Technology

Math and reading were often cited specifically as subjects that might benefit from the use of learning technologies.

Looking across these four broad themes and combining some of the most popular concepts in student answers paints a profile of how students may wish to use technology for learning. In this world:

> *Every student would use a small, handheld wireless computer that is voice activated. The computer would offer high-speed access to a kid-friendly Internet, populated with websites that are safe, designed specifically for use by students, with no pop-up ads. Using this device, students would complete most of their in-school work and homework, as well as take online classes both at school and at home. Students would use the small computer to play mathematics-learning games and read interactive e-textbooks. In completing their schoolwork, students would work closely and routinely with an intelligent digital tutor, and tap a knowledge utility to obtain factual answers to questions they pose. In their history studies, students could participate in 3-D virtual reality-based historic reenactments.*

For each of the four themes, selected student answers to the NetDay question are included to add richness to the themes and to give voice to the student views.[1] In addition, for each theme, excerpts from the U.S. Department of Commerce publication *Visions 2020: Transforming Education and Training Though Advanced Technologies* are included. These vignettes envision the use of advanced technologies for learning in ways that are similar to those suggested by the students.

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[1] In these quotes, errors in spelling, grammar, and punctuation have been corrected for the benefit of the reader. Also, phrases such as 'I would invent" and "We should have" have been excluded.

The New Millennials: Growing-up With Digital Technology

Today's U.S. K-12 students grew-up with digital technologies. These students are not merely technology-savvy; they are approaching their lives differently as they integrate digital technologies—such as computers, the Internet, instant messaging, cell phones, and e-mail—seamlessly throughout their daily activities. Time spent using digital media by children aged 13-17 has now surpassed the time they spend watching television.[2]

Reports and surveys indicate that American students have growing access to and use of digital tools:

- In 2002, 83 percent of family households reported computer ownership, with 78 percent having Internet access. In the fall of 2002, 99 percent of public schools in the United States had access to the Internet, and had expanded Internet access into 92 percent of instructional rooms. Taking advantage of these digital tools, 90 percent of children between ages 5 and 17 use computers, and 65 percent of American children ages 2-17 use the Internet from home, school, or some other location. Internet usage is growing fast among the very young, with parents reporting that 35 percent of children ages 2-5 went on-line, growing from a usage rate of six percent just two years earlier in 2000. Seventy-eight percent of children between the ages of 12 and 17 go on-line.[3]

- Children are using these digital tools in support of their schoolwork. Students ages 6-17 who go on-line report educational activities, such as homework and research, among their top five daily uses of the Internet.[4] For example, 94 percent of children ages12-17 report that they go online to do research for school assignments. In the same survey, 71 percent of students report that they used sources found on the Internet most frequently in the last big report they wrote for school—by far the largest source of information. (In contrast, only a quarter report using books and magazines from a library).[5] Twenty percent of the children who use the Internet at home report that they go online every day for educational purposes.[6] More than half of the students have used a web site set up

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[2] Connected to the Future: A Report on Children's Internet Use, Corporation for Public Broadcasting, March 2003.

[3] Connected to the Future: A Report on Children's Internet Use, Corporation for Public Broadcasting, March 2003; Young Children's Access to Computers in the Home and at School in 1999 and 2000, National Center for Education Statistics, U.S. Department of Education, 2003; Internet Access in U.S. Public Schools and Classrooms 1994-2001, National Center for Education Statistics, September 2002; The Digital Disconnect, The Widening Gap Between Internet-Savvy Students and Their Schools, Pew Internet and American Life Project, 2002.

[4] Connected to the Future A Report on Children's Internet Use, Corporation for Public Broadcasting, March 2003.

[5] Parents, Kids, and the Internet, Princeton Research Associates for the Pew Internet in American Life Project, June 2001.

[6] Connected to the Future A Report on Children's Internet Use, Corporation for Public Broadcasting, March 2003.

by school or a class, one third have downloaded a study aid, and 17 percent have created a web page for a school project.[7]

- Despite the availability of computers and Internet access in school, the use of digital tools by students is more home-based than school-based. For example, among students ages 12-17 that go on-line from more than one location, 83 percent say they go on-line most frequently from home, and while only 11 percent say they go on-line most frequently from school.[8]

- Computers and the Internet are not the only digital technologies that children use routinely. Of those students answering the NetDay questionnaires, 81 percent in grades 6-12 had at least one e-mail address, and 38 percent in grades 3-5 and 19 percent in grades K-3 had an e-mail address. Seventy-five percent in grades 6-12 had at least one instant message screen name, as did 34 percent in grades 3-5. Sixty percent in grades 6-12 reported that they e-mailed or "instant messaged" adults such as family members, teachers or coaches on a weekly basis. Fifty-eight percent in grades 6-12 have a cell phone. In a survey for the Pew Internet in American Life Project, 41 percent of online teens say they use e-mail and instant messaging to contact teachers or classmates about schoolwork.

According to a study by the Pew Internet and American Life Project, students rely on Internet technology for school work for a number of reasons including to: complete their school work more quickly, to draw upon the latest knowledge and sourced information for papers and projects, and to better juggle school assignments and extracurricular activities. Students communicate on-line with other classmates to discuss school projects, upcoming tests and quizzes, homework shortcuts, and school assignment-pertinent websites. They also communicate on-line with teachers, tutors, and on-line study groups.[9]

The Pew Internet study reported on the metaphors students use to describe how they use the Internet for their schoolwork. These include: a virtual textbook and reference library to find source material for their school reports and projects; a virtual tutor that offers instruction; a platform for a virtual study group to collaborate with classmates on school work; a virtual guidance counselor that provides information related to their life decisions; and a virtual locker, backpack, and notebook to store and transport their school related materials, and keep track of their schedules and assignments.[10]

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[7] The Digital Disconnect, The Widening Gap Between Internet Savvy Students and Their Schools, Pew Internet and American Life Project, August 2002.

[8] Parents, Kids, and the Internet, Princeton Research Associates for the Pew Internet in American Life Project, June 2001.

[9] The Digital Disconnect, The Widening Gap Between Internet-Savvy Students and Their Schools, Pew Internet and American Life Project, August 2002.

[10] The Digital Disconnect, The Widening Gap Between Internet-Savvy Students and Their Schools, Pew Internet and American Life Project, August 2002.

<center>**Devices**</center>

Many students responding to the NetDay "what would you like to see invented" question described some sort of digital device or an attribute of a digital device:

Make It Small: Reflecting the popularity of cell phones and handheld video games (such as the often-mentioned Nintendo Gameboy), many students expressed interest in a small computer. Such a device was frequently described as being handheld or one that you could put in your pocket. Some students saw the small computer—used for homework and storage of some sort of digital textbooks—as a way to free themselves from heavy and cumbersome backpacks and paper textbooks.

Other types of computing devices students suggested include: talking computer, mind controlled computer, cell phone computer or a cell phone with Internet access, a small computer that opens up to a bigger computer, and a watch computer. Some students suggested a more affordable computer; of these, some suggested that a more affordable computer would allow more students to have one for schoolwork.

I Don't Want to Type: Many students expressed interest in voice activated computers and Internet access. Some students also expressed a desire for touch screen computers. A few students explained that these features were needed because of their inadequate keyboarding skills.

Make It Part of the Real Desk Top: Some students suggested building computers right into every classroom desk. A few students described how the desk computers would work: they would open up from inside the desk when needed, and fold back down when a flat desk surface was needed. This concept may partially reflect a desire for providing a computer for each student, in every classroom.

Make Mine Multifunctional—the Digital Swiss Army Knife: Students expressed interest in having numerous kinds of functions embodied in a single digital device. These include: CD player, DVD player, calculator, digital camera, text and instant messaging, Internet access, web address book, music player, cell phone, MP3 player, TV, iPod, CD/DVD burner, USB port, printer, dictionary, thesaurus, atlas, watch, tape recorder, games, study guides, and almanac.

Other devices students described include: an array of digital organizers, planners, and schedulers; digital note taking devices; computer or Internet-based video phones; electronic dictionaries; and some sort of functional pencil including talking pencils, and pencils that also serve as a dictionary, cell phone, or calculator.

What would you like to see invented that you think will help kids learn in the future?
Student Views...Devices:

Make it Small:
- Cell phone that has a calculator, organizer, and a computer built in.
- Cell phone with Internet access we can use at school to help us with schoolwork.
- Handheld interactive thing that has textbooks in it, and all you do is download it from the computer and start studying!
- Small computer that can be held in your palm.
- Small computer that has the Internet and fits in your pocket.
- Small handheld computer-like things that quiz you for tests and stuff with multiple-choice answers.
- Palm Pilot that had all the school textbooks downloaded into it, with Internet access and school schedules, so you could do your homework on it and that would be all you had to carry around.
- Palm Pilot that has the Internet, and kids can use them in school instead of textbooks.
- A pocket computer would be cool.
- Pocket size computer.
- Portable computer about the size of a cell phone.
- Computer that would expand big when we need it big and then it would scrunch down to fit in our pockets.
- Minicomputers that we carry around so we can store our homework in that way, so we don't have to carry backpacks and stuff, also so we don't lose our papers and books.
- Mini palms to plug into the school system to download homework, update calendars, and interactive web.
- Computer that's smaller and could be almost as big as a textbook and it wouldn't weigh so much. A foldable keyboard would also be handy. I would make a computer with no wires or plugs, so all you would have to do is turn on the computer.
- Students should be able to have a rather small computer that can be stored in a small backpack or can be carried easily with them throughout the school day.
- Little hand held devices that can be plugged into a desk. It would write down all of your homework and notes so you wouldn't have to carry a big backpack to school.
- Laptop that could fit in your pocket, and when you use them you could just push a button and they would be their regular size and accessible to use.
- Smaller laptop computers for students. Textbooks are out of style and they put a lot of weight on a student's back. Students will grow up with a hunch on their backs and they would be slouching for the rest of their lives.
- Talking computers so they can talk and explain as you work.
- Computers that talk back to us.

I Don't Want to Type
- Talking to the computer for kids who can't type, like a disability.
- Voice activated computers. Instead of typing everything you want to say, why not just say what you want and it will search for it automatically.

Put It on The Real Desk Top:
- Desk that can flip over and become a computer.
- Computers built into our desks, so we could close them to do paper work.
- Desk that kids can sit in and when they want to use a computer, they don't have to go to the computer lab, and they would have one built right in their desks. Also, it will not get in their way because you can always flip the desk.

Make Mine Multifunctional:

- Phone/computer/camera so kids could study nature while writing and maybe call someone to tell them about what you found.
- Palm pilot/dictionary/textbook/thesaurus put altogether.
- Phone/computer/email/games device.
- Supercomputer that links a computer, a TV, a video game, a fax machine, and a GPS system.

Other:

- Pencil that will repeat what the teacher said if you forget what he or she said.
- Pencil with a built in calculator.

In the words of the Visions 2020 authors:

They (students) each place a copy of today's work file in their digital backpack, a rugged mobile personal computer and communications console "checked out" by each student at the beginning of the school year, the way textbooks used to be issued. Malia's "digipack" allows her to spend some more time on her volcanoes project later in the afternoon after walking a few blocks to her father's office.

Mailia and two of her classmates, Sahar and Osvaldo, are seated in comfortable task chairs at a multimedia production and communications station. Facing them is a high-resolution luminescent display screen, viewable from front and back, where combinations of images, text, and digital video can be summoned by voice command. "Give us our team project on volcanoes," Osvaldo asks the school's server, enabling the team to review its progress during the previous week.

Later that night at home, Malia is practicing her Chinese in the family room. She hopes to visit China one day and has been using an online language learning system to gain proficiency in basic Chinese conversation, reading, and writing. Her younger sister, Sonia, likes to look on…They both hold handheld digital devices serving as Chinese-English dictionaries for looking up words and phrases in both languages, in text and audio. They can also store their own spoken phrases.

<div align="center">Milton Chen and Stephen Arnold</div>

Alec and Arielle strolled through Harvard Yard on their way to the museum, to collect data for their class assignment. Each carried a handheld device that softly pulsed every time they walked past a building in the Yard. The vibration signaled that the building would share information about its architecture, history, purpose, and inhabitants, using interactive wireless data transfer.

<div align="center">Chris Dede</div>

In 20 years, handheld (or wearable) computers will be able to calculate 10,000 times faster than they can today, and will thus begin to rival the data processing capability of the human brain. They will be the hubs of digital assistants that could store more textual information than a human could read in 10 lifetimes. Such assistants will combine the present functions of telephones, web browsers, and recorders and players of both audio and video. Through wireless web access, they will be able to download far more video information than a human could watch in a lifetime.

<div align="center">Stan Williams</div>

ACCESS

Many students expressed ideas and views concerning their access to computers, the Internet, and telecommunications, as well as their thoughts on the qualities of that access:

A Computer for Every Student: Students registered high interest in the notion that every student should have a computer for his or her personal use in school and to take home for doing homework. Only the concept of "intelligent tutor/helper" drew more interest than the idea that all students should have a computer. A laptop was frequently cited as the type of computer that all students should have.

The Need for Speed: Perhaps reflecting lack of high-speed Internet access or an aging stock of computers, many students expressed a desire for faster computers and faster Internet access. Only the "intelligent tutor/helper" and "computer for every student" concepts drew greater interest than the need for speed.

I Want It Wireless: Many students expressed an interest in wireless technologies, especially wireless computers and Internet access. In addition, students mentioned wireless keyboards, speakers, radio, CD player, walkman, and headphones. Wireless attributes were closely linked to the mobility of computers and Internet access with a significant number of students citing a desire for mobile, portable, or any place computing and Internet access.

Make it Safe and Easy to Use: Many student responders described attributes of a kid-friendly Internet. This includes a safe Internet where there are no "bad" websites, viruses, pop-up ads, spyware, or hackers. A kid-friendly Internet was also described as one that was age-appropriate, including kid-friendly search engines and information on websites presented at a level that students can understand. Some students expressed interest in search engines that produce more fine-tuned responses to inquiries, as well as websites that did not contain factual errors.

24-7 Access: Some students expressed interest in having access to computers and the Internet at any time—day and night. This included access to school networks from home.

Work With Me: Students cited a desire for access to digital platforms for collaborating with others on schoolwork and homework. These include chat rooms, instant messaging, and e-mail. Collaboration included peer-to-peer, student-to-teacher, and student-to-parent.

What would you like to see invented that you think will help kids learn in the future?
Student Views…Access:

A Computer for Every Student:
- I would like to have all high schools required to loan laptops to the students for four years, and place all of the textbooks and tests online so as for the sick people, they won't miss any kind of class.
- Laptop that didn't sell for much so that every student could have one on their desk.
- We already have laptops, but to see every student with an updated laptop to use with software that will aid them in their schoolwork will be nice. This could lessen the strain on students because the computers can be used to ask commonly asked questions.
- I think that everyone should have a computer beside them so, if they need to look up something right then and there, then they could look up what they need to.
- We all should have hand held computers with all of our books and notes that we took. That would be a good invention because carrying around all of those books is just a big waste of energy.
- Laptop computers should be given as a school supply to every student in the future.
- Laptop computers for each student to use while they are listening to the teacher and, that way, they can look up information if they don't understand what the teacher is teaching.
- Faster computers and a computer for everyone. It would be a laptop and it could be everything for a student—his text books, his papers, encyclopedia, and online research.
- It would be awesome if we could one day provide each and every student with a laptop computer. They could use it for taking notes, researching data, and personal tutoring.

The Need for Speed:
- Faster modems would help the kids in the future. It would make things a lot easier for them, and they wouldn't have to worry about not getting stuff done because of the time it takes for everything to load.
- We need new, faster computers.

I Want It Wireless:
- Make computers everywhere, even on the playground, so you could use them whenever you wanted, wherever you wanted.
- Wireless Internet everywhere: in the park, at home, hospitals, and everywhere else. That way there will be wireless, trouble-free Internet wherever you go. That will give the child a chance to learn wherever he is.
- Laptop computers that are built into every wall, so that you could always have technology no matter where you are.

Make It Safe and Easy to Use:
- Easier version of the Internet for the younger people.
- Something should be invented that filters out incorrect information on any website. It is very misleading and confusing to find different facts on different websites, so it would be very helpful if there were a way to filter out wrong information.
- Something that blocked all viruses/spam/pop-ups that makes it harder to get to websites.
- Better ways to use technology without all of the bad pop-ups and viruses to protect the information we have on our computers every day.
- Firewall that will not limit students to what they research. But I would like them to block out adult sites, game sites, and anything to download or buy.
- Search engine made just for kids that allows them to select sites by subjects.
- More websites that make it easier to do research by having texts in more simple language. Often, when doing research, I find it difficult to understand text that could help my cause and I'd like to see that made a bit more user-friendly.

- Separate Internet service for kids, so we can't get into anything that we aren't supposed to be in. Also, so when we get homework, we can get the information we need and not have to look in such a broad area of the Internet.
- Better search engine because, now a days, when you search just on Google you get a ton of unnecessary things that you don't need, or even want to see!

24-7 Access:
- Access your school's network from online at your own home.
- Access to the school websites and information from our houses, because it would help a lot with school projects and homework.

Work With Me:
- Internet that lets us IM people within the school so that, if we needed help on a project, we could ask a fellow student or teacher.
- Special network for all schools across the country that allows students from all different schools to talk and discuss with each other their assignments should be made.
- Computer that lets you talk to other students about work. I think we should have IM on school computers and, if a student can't get up to ask a question or talk, you can just IM someone!

In the words of the VISIONS 2020 authors:

Wireless workstations allow students into a range of virtual environments to assemble research teams, collaborate, mentor and teach each other.

Vinton Cerf and Caleb Shutz

Malia's "digipack" allows her to spend some more time on her volcanoes project later in the afternoon after walking a few blocks to her father's office. As she waits for him to finish his work, she uses it to connect to the school's library information systems and the now-widely-available wireless network.

Milton Chen and Steven Arnold

Alec and Arielle strolled through Harvard Yard on their way to the museum, to collect data for their class assignment. Each carried a handheld device (HD) that softly pulsed every time they walked past a building in the Yard. The vibration signaled that the building would share information about its architecture, history, purpose, and inhabitants, using interactive wireless data transfer. Sometimes Alec would stop and use his HD to ask questions about an interesting looking location.

Chris Dede

Eddy has a team deliverable due to be presented in his first class period. He will review the presentation with his team through his two-way video tablet on the way to school. (Riding the bus) Eddy has been in constant communication with his team going over last minute details for the presentation and they're good to go.

Randy Hinrichs

The ability to send video and audio in real time, from one place to another, means that students will develop a cultural notion of telepresence, where when something interesting is happening, a student will instantaneously broadcast it to his/her peer group. This will move the learning experience to be "anytime, anywhere," as opposed to the 8-3 M-F notion.

Randy Pausch

Mr. Parsons shows Melissa's parents how 24-hour wireless access to the technology and materials (for physics class) lets Melissa revisit concepts at a time and pace that best suit her.

John Wilson

INTELLIGENT TUTOR/HELPER

No concept drew greater interest from the student responders than some sort of an intelligent tutor/helper. Math was the most often mentioned subject for which tutoring help was needed. Many students desired such a tutor or helper for use in school and at home. In addition, there was significant interest in a single, all-knowing information resource:

Help, I Need Somebody: While many students referred generically to a tutor or helper, others were more specific, describing: a live tutor at a web site or just a tutoring web site, on-line tutor or counselor, a holographic or virtual tutor, on-line experts, and the ever popular robot tutor.

Help Me With My Homework: Some students expressed interest specifically in a device that would help them with their homework, including the homework robot, homework helper, homework help website, homework checker, and the on-line study buddy.

The Oracle: Many students expressed interest in an "answer machine," through which a student could pose a specific question and the machine would respond with an answer. Similarly, some students described a sort of knowledge utility. Through a computer or an Internet web site, students could access all of the world's knowledge from any location.

What would you like to see invented that you think will help kids learn in the future?
Student Views…Tutor/Helper:

Help, I Need Somebody:
- Robots to help us to do our schoolwork.
- Talk into a speaker and say what you need help with, then it will bring up a website that tells about that subject.
- Tutoring system that can help children at home. It should be something that can adapt to a child's learning speed and that can help a child when parents are at work or when they need to be prepped for subjects at school.
- Personal computer tutors. It would be like a tape recorder that you let play during class then, from that, it would create questions to help you study based on everything talked about in that particular class.
- Robot that would live in your house and tutor the kids.
- Tutoring systems that really know how a child thinks and how he or she will best absorb the information.
- Helpers like tutors online 24-7 for your school, so that they can help you with your assignments when you need it. The tutors should be from your school so that they know what you're talking about so that they can help you get it.
- Tutoring systems that really know how a child thinks and how he or she will best absorb the information.
- Helpers like tutors online 24-7 for your school, so that they can help you with your assignments when you need it. The tutors should be from your school so that they know what you're talking about so that they can help you get it.
- Simulator after-school tutor that has the latest education knowledge that will help you with your homework, studying, and/or to help us relearn what we learned in school. Oh, and also that it is available 24/7.
- An instant tutor should be on at all times for students who need help at that exact moment.
- Website that has suggestions from Stanford students on how to get better on your worst subjects.
- Human-like robot that can study and test us over materials that we are learning.
- Robot in every house or school. They will make the kid do the work and then make the corrections so that the kid will know how to go step-by-step through every problem properly.
- Program that would enable you to talk to your teachers during the afternoon hours on the computer for help on assignments.
- Reading helper books to assist with difficult words.
- Math website that would allow you to type in any math problem, and it gives you the answer and shows you how it is done, step-by-step.
- Home hologram teacher, so you can ask it questions or re-teach a thing that you didn't get at school.
- Invention that would help kids study for tests.

Help Me With My Homework:
- Educational sites that will help students on homework lessons after school and during weekends when teachers are not available.
- Hologram of your teacher that you can access when working at home.
- Robot that can answer questions when doing homework.
- Site that could help us with our homework. Sometimes our teachers explain it to us but we still don't get it.
- Computer robot to help kids with homework and ways to get around in life.
- Device that helps kids with homework. It will help them but not give them the answer. It will help them review. It would be perfect for kids who don't see their parents a lot.
- Homework checking machine. The reason I would like a homework-checking machine is to make sure I get them right. It would help every kid in the universe.

- Homework helper, because some kids don't have parents or anyone else at home to help them and, if they don't understand it, then they deserve help.
- The Homework Helper. It will be an online website that you can go to and ask any question. It will definitely help people keep their grades up, and it will explain the answer so that they will understand it.
- Hologram that's a teacher that, when you need it, it comes out and helps the kids with homework and it's at your house so everyone can have one.
- Homework helper. If a kid is stuck on something they can ask the homework helper and it will help you.
- Homework helpers. They would be used only if students did not understand.
- Robot to help them on their homework, explaining anything if they don't get it.
- Robot to help us with our homework and give us hints about what we are learning.

The Oracle:
- Device that can help children learn by explaining answers.
- 24-hour computer that could answer oral and typed questions immediately and could teach you anything you wanted to know about. It would be kind of like a 24-hour teacher.
- Type of technology that has answers about almost anything. You can just type in a question and it gives you one simple answer.
- Website that acts as a huge encyclopedia. That would help out a lot of kids.
- Webpage with the world's information!
- Program that enables us to find whatever we want on any type of subject.
- One super site with information about everything on it.
- Program about all answers, theories, and ideas about the world. A lot of people will learn a lot. Everyone will be happy.
- Computer system that will give the answer to any question the student asks, and then give them the reason for that answer.

In the words of the Visions 2020 authors:

Each child has his or her own virtual mentor that can be accessed anytime. The mentor follows the children's activities on-line, suggesting new ideas and dialoguing interactively to understand the student's emotions and competencies. On-line content is filtered by the virtual mentor, who constantly reports noteworthy events to the parents, teachers, and other interested parties

If the student is struggling with a concept, the intelligent tutoring services turn on automatically…. If the student is having difficulty with complex processes or principles either assisted or augmented reality is initiated and the student jumps into a virtual world scenario that gives them an enhanced perspective of the problem and allows them to play the actor solving problems.

Eddy begins a dialogue with plant specialists whom he encountered over the Internet. The software recognizes that Eddy struggles with some terminology, as his interaction rate seems too low. His questions don't seem to map directly to the content. His virtual mentor immediately provides support resources and appears on his screen ready to show and tell. The virtual mentor asks Eddy some questions and explains some of the concepts that he is having trouble with.

As the team leader moves from one key concept to the next, a Q&A session appears on the screen to check to see if Sumi understands the concepts. The video session pauses as Sumi answers the questions, messaging to her co-workers for clarification. Sumi is struggling with one concept and her virtual mentor appears with more detail and a short video that was served up on the topic. The virtual mentor knows that Sumi is a visual learner and responds better to video with examples. After further explanation and follow-up questions, Sumi is still struggling with the topic, so a teaching assistant is notified and automatically schedules a meeting to help Sumi understand the material.

<div align="center">Randy Hinrichs</div>

Teachers and learners will be able to call on a variety of human tutors, counselors and experts and summon a variety of automated help systems for addressing routine questions. Learners will work face-to-face with teachers and tutors and be able to call on a worldwide network of subject-matter experts and other specialists when interesting questions arise. Sophisticated tools will help diagnose sources of confusion and suggest new learning strategies based on analysis of the experience of large numbers of learners facing similar situations.

<div align="center">Learning Federation</div>

By a combination of infinite patience and a model of what the individual student's difficulties are, the software can tailor problems and explanations of solutions to address the current conceptions (and misconceptions), much as an experienced teacher would.

<div align="center">Randy Pausch</div>

The transformation of the Internet into a system for rich experiences will bring about the creation of massive distributed on-line archives of past lectures, interactive presentations, simulations, proficiency testing, and problem presentations. This new content, designed specifically for these new technologies, will replace current textbooks and workbooks with a national resource of high-production and content quality materials, cross-indexed and customized for individuals or classes. Once created, the archives will be updated and further improved by continuous contributions and links from teachers, production groups, and authors anywhere.

<div align="center">Ulrich Neumann and Chris Kyriakakis</div>

How Students Want to Learn Using Technology

Students responding to the NetDay "what would you like to see invented" question described a wide range of uses of technology for learning. Many described some sort of hardware/software-enabled learning process, while others described certain kinds of capabilities or attributes that technology could bring to learning.

Make it a Game: Many students expressed interest in learning games, with some commenting that these games would make learning fun, or reduce boredom at school. Math, especially, and science were identified as subjects that might be easier to learn by using learning games.

Take Me There: Many students said that a time machine or some sort of virtual world should be invented. The time machine would allow students to witness and experience historic events first-hand. In a similar notion, the teleporter or transporter would take students to other places, for example, to study a foreign culture or land.

On-line Classes: Many students expressed an interest in taking on-line or computer classes, and many expressed interest in taking on-line or virtual classes from their homes. Some mentioned that this would be a way to keep up or go to class when sick. A few described a virtual classroom where students would come together virtually rather than physically, or an individual cyber classroom that would come to you.

Working Digitally: Strong interest was expressed in doing school work on the computer or on-line. This includes, generically, doing some or all work at school on the computer or on-line, as well as doing homework on a computer, on-line, or at a web site. Specific work or functions singled-out for computer or on-line performance include: taking notes using a computer; using on-line tests, quizzes, and worksheets; taking on-line practice tests, and quizzes; as well as having access to on-going assessment of student learning performance. Some students expressed a desire for a web site specifically related to the work they are doing, or the subjects and textbooks they are studying in school. Others proposed on-line study tools and guides, and project guides. Some students had interest in using e-mail or instant messaging as a way to receive school assignments, to get help from the teacher, or to turn in homework. Some students saw instant messaging and chat groups as tools for collaborating on schoolwork and homework. A few students were interested in a personal web-based work site for scheduling, and for following their assignments and grades on-line.

A Different Kind of Teacher: Some students expressed interest in some sort of a digital teacher. Descriptions include: on-line teacher, computer/virtual/electronic teacher, robot teacher, and holographic teacher. A few students wanted a robot or holographic teacher for the home.

A Different Kind of Book: Many students expressed interest in using some sort of e-book or on-line textbook. A few students expressed interest in talking books and books one could interact with. Some students cited benefits of these e-books such as freedom from carrying heavy backpacks and never having to worry about losing your textbook.

Attributes of the Learning Process: Some students suggested that learning be personalized based on how an individual learns best. Tailored learning was also suggested as being beneficial for those students with disabilities. Using virtual reality, 3-D, or some kind of visualization was suggested as a way to present material in a way that some students could better understand. Some students suggested that simulations or a simulated laboratory would aid in learning. Interactivity was cited as an attribute needed in learning, as was the need for digital tools to provide step-by-step instruction or problem-solving, even repeatedly in case the student didn't master the material in the first few attempts.

Give It To Me Straight Up: A significant number of students described physical interfaces with some device, product, or process or some thing that would automatically transfer knowledge directly into the brain. These include: hat, helmet, pill, brain transplant or implant, chewing gum, port or plug in one's head for downloading information to the brain, injection, implanted microchip, laser beam, eye patch, mask, thinking cap, holographic projection into brain, baseball cap with learning waves, some sort of transmission while sleeping, brainwaves sent from robot, virtual reality headset, and transfer from teacher via a helmet.

What would you like to see invented that you think will help kids learn in the future?
Student Views…How We Want to Learn Using Technology:

Make It A Game:
- A way kids could have fun doing their homework. Someone could invent videogame homework. I don't really like homework so that would be a good idea.
- Something disguised to be a game so they don't know they're learning. But they really are!
- Better computer games to help students learn more.
- Animal learning games, sorting games, and more math and reading games.
- Video games that help us have fun and help us learn at the same time
- Video games that reenact historic events or scientific experiments. People love video games, and what better way to learn than through telling the story, while being able to reenact it.

Take Me There:
- Time machine so we can go back into the past so we can do our colonist projects easier.
- Teleport machine that would let kids go to the dark, depths of the ocean, or maybe rain forests to study.
- Transporter so you can go into the past and meet all the other presidents, and people like Albert Einstein.
- New simulations on historic battles where you see the battle where generals wish they had the view.
- I would like a more interactive type of learning. Maybe you could put on a helmet and it would transfer you to a holographic place that you need to learn about.
- How about a time machine. It would help to learn if you could see it first hand.
- Things like virtual reality careers we could do. We would be able to work in an environment in which we would have to work in the future without actually being there, but still be able to explore and see what it would be like.
- 3-D simulators would help kids learn about stuff. For example, I think kids would remember the crossing of the Delaware River if they actually experienced it through 3-D software!
- Time machines would help us because we can experience history first-hand.
- TIME TRAVEL ALL THE WAY, BABY!!! Then, students could meet the people they always studied. Then, social studies wouldn't be so BORING! Students could give the person they give a report on a face, a character, a real live human being, not just a painting.
- 3-D simulators to reenact historic events.
- Computer that has a virtual tour on it so, when looking up a country, you can go onto the computer and get a tour of it.
- Virtual reality textbooks which you place the disk in the goggles and then you learn by actually being in the lesson.
- Virtual reality classrooms where if you are studying the moon, you can make it seem as though you are on the moon, and if you are studying an important historical event, you can make it seem as though you are in that event.

On-Line Classes:
- Computer with a built in school system so you can learn at home without going to school.
- If I was sick there would be a camera and I could push a button and connect to the school.
- Computers that talk back to us. When you are sick, you can get online and your teacher is online so it is like you are at school.
- Virtual class room, where kids can stay at home and learn. The teacher could be on the computer or on a T.V. screen with a video camera or a web cam. This way, no one would have to miss a day of school if they were sick.
- Special place to go to school. I think that every new home should have a room in it with a robot teacher. That would be their own individual school.

- Being able to be at school yet in your house, and be able to look at the computer and see the classroom filled with people, yet nobody is in the classroom. Everybody is at home like you are. You could learn at your own pace.
- Hologram teacher so when the student is sick he or she would still learn the same thing he or she would learn in class and not fall behind.

Working Digitally:
- Hologram Homework Helmet. Instead of carrying three or more textbooks and dozens of folders with you in your backpack, just take a HHH (Hologram Homework Helmet). It's lightweight and easy to carry. Just put it on and, presto!, your homework is right in front of you.
- Talking computers so they can talk and explain as you work.
- IM on school computers and, if a student can't get up to ask a question or talk, you can just IM someone!
- Website with different subjects and teachers there to teach students different subjects. That way, we can go to school anytime we want and we wouldn't have to wake up so early in the morning to catch the bus.
- Site for every school with all the homework and a description of the assignment each day would be great.
- Before the marking period closes, students can see their grades online to see what work and assignments they're missing or if they failed on an assignment they can improve it.
- Homework website where you can go there and get information on a report, and get ideas on how to start.
- Something that looks like a GPS but has world maps on it, globes, and other things that teachers would ask students to get out in the middle of the day.
- CDs that have every word from in your textbooks and all the assignments that would be taken home by the students.

A Different Kind of Teacher:
- Hologram of your teacher that you can access when working at home.
- Very good software where we can just talk to a teacher online because after school we might have a question that your mom or dad can't answer.
- Computer that is like a personal teacher that has a lot of patience and that can speak.
- Teacher for every student, but not real teachers. They should be holograms and they should know everything possible
- Holographic teacher to take home so it could help you.
- Private interactive teachers online would help kids learning in the future
- Real teachers online
- Robotic teachers so we could learn more stuff and not get yelled at as often.
- Every kid should get their own teacher robot.
- Kids should have a holograph teacher for their own. They could always be able to help the kids.
- Robot teacher.
- Holographic teachers that can give you a three dimensional image of whatever you are learning about.
- On-line teacher than can talk to you and answer your questions in an easy, simple way.
- Personal AI teacher for every student.

A Different Kind of Book:
- Every time you have trouble with a word the book would tell you the word.
- All of our textbooks on CD or DVD.
- We could invent reading helper books to assist with difficult words.
- Electronic books would be cool. Maybe have books that you can read but, if you click parts that you don't understand, it explains it more.

- All our textbooks on laptops. That way, we don't have to worry about forgetting any thing.
- Digital books that read the lesson to you, and teach you specific things. The thing would be voice-sensitive so you could read, and it would correct your reading.
- Dictionary that talks. So when kids find a word they can't pronounce, they listen to the dictionary pronounce it for them.
- Basic books should be made online with visuals, demonstrations, and also with text to help people who learn differently still be able to learn at the same rate as other students.
- Electronic books that not only have words to read in it but, in the back, it has a screen with little demonstrations for all different types of learners.

Attributes of the Learning Process:
- Talking computer so that the computer could help to teach students one on one.
- Computers that can produce realistic images of any subject. For example, the operation of machines or human organs.
- It would be helpful, since I'm an auditory learner, if we had special kinds of notebooks that we could write notes in, and we could have a little recorder in it so we could record the lesson and play it back to help us learn and understand our lesson!
- Type of personal computer to help many different people on different learning levels without rushing them.
- Personal computer (or program) that would adapt to the knowledge of the user. With the knowledge the computer has about the user's strengths and weaknesses in a certain area, it will be able to know what techniques to use to teach.
- 3-D simulations in classes such as science because often materials needed are not safe or available.
- Piece of technology that was set to the kid's specific needs (i.e., it would help this person with 10th grade math while another person with 5th grade math; same for all subjects).
- Advancements in simulation technology, which would be useful for teaching anything complicated.

Give It To Me Straight Up
- Mind helmets—helmets that will transmit information directly to the student's brain.
- I would like to see all technological learning to be in a shot form that you get when you turn 5. Then POOF!!, you know everything you need to know for school.

In the words of the Visions 2020 authors:

The most advanced and most desirable technology is the creation of a teleimmersive environment for teaching and learning. This is a three dimensional virtual space, which mimics the real space visually, aurally, and tactually. It is one in which both the student/apprentice and teacher/master can meet and interact. This technology does not exist yet but it is very feasible from what we know today. The advantages of such as environment are many. First, the students and teachers do not have to be physically co-located. Secondly, the teacher can advise/coach several students and yet the student would feel that he/she is the only one getting the teacher's full attention.

Ruzena Bajcsy

Asynchronous learning, or self-paced online learning now allows students to do most of their work outside of a standard, shortened lecture or presentation. Once equipped and capable to use core math and science principles, students were free to explore their world. This allows me to spend more time interacting with students individually to cover particular strengths and weaknesses.

Vinton Cerf and Caleb Schutz

Yesterday, donning special virtual reality headgear, they had gone on a simulated trip to the lava fields, giving them an on-the-ground sensation of hiking across acres of older lava formations to arrive at a scene of bright orange lava flowing towards the sea. "How cool was that," Malia grins. "You could hear the lava crackling." Last night, from their homes, they had brainstormed some questions in preparation for an interview with a volcano expert, scheduled for today.

Milton Chen and Stephen Arnold

Alec's favorite exhibits were those augmented by virtual environments. For example, at a panorama showing the bones found at a tar pit, Alec's HD (handheld device) depicted a virtual reconstruction of the dinosaurs that were trapped at that prehistoric location. In the virtual environment, he could assume the perspective of each species and walk or fly or swim through its typical habitat. Other types of exhibit-linked virtual environments enabled "time travel" to show how a particular spot on the earth's surface had changed over the eons. For each epoch, Alec used virtual probes on his HD to collect data about temperature, air pressure, elevation, and pollutants.

Chris Dede

Alicia likes animals a great deal and the group is going to experience how elephant families are similar to their own. Upon entering the virtual safari, she immediately experiences the size and weight of the elephants as they are presented in a 3-D environment where she feels as if she could reach out and touch them. During the safari, the virtual mentor points out how elephants are similar to our families and how important the mother is to the survival of the babies.

Students work in sophisticated visual environments deconstructing and constructing objects on the screen allowing them to question why things work the way they do. Imagine students using intelligent reusable visual components to build a plane that flies, a bridge that spans a ravine, or an electronic device that can actually be built by another team. As students work in simulated environments with smart objects, they begin to understand the underlying scientific principles...

Today in science, Eddy is completing his personalized learning project. This project was designed especially for Eddy's learning style and allows him to use an observation-based instructional process. While outside, Eddy works on the effects of light on plants, using his virtual biosphere to experiment.

Randy Hinrichs

Coursework could include being turned loose in a virtual representation of Renaissance Venice and asked to find the secret behind the legendary blue coloring of their glass, engineering and building a (virtual) bridge over a (virtual) Mississippi River, navigating the interior of a (virtual) pancreatic cell to determine why signals reaching it do not stimulate insulin, or being given a broken (virtual) avionics system from a Boeing 777 and asked to repair it.

A combination of automated monitoring tools, tutors and other specialists will make it possible to continuously adjust the pace, nature and style of the learning process to ensure a learning experience optimized for each learner. Instead of being forced to move all learners forward at a uniform rate, teachers will be able to move each individual forward at a rate consistent with his or her measured performance in each area. No one will be forced forward before demonstrating comfort and confidence in the concepts being learned.

<div align="center">Learning Federation</div>

Imagine a group of students from around the nation in the science classroom of the future as they embark on a mission of exploration. The room is transformed into a fully immersive aural and visual environment that makes them feel like they are really in the same place together.... Together they begin to travel through a human cell. As they move through this beautiful yet unfamiliar landscape of curious objects, the immersive environment entices them to ask questions of each other and their teacher, to explore fundamental principles, and to form robust models of complex processes.

The term interactivity will be transformed from mouse-clicking and instant messaging to realistic, life-sized representations of teachers and classmates sitting next to you and talking. Imagine students interacting with avatars of James Watson and Francis Crick tutoring and guiding them on the discovery of the DNA structure. Imagine students immersed in a role playing experience at the Continental Congress during the Revolutionary War era.

<div align="center">Ulrich Neumann and Chris Kyriakakis</div>

Ms. Fuentes and Mr. Jackson are debriefing her students on their virtual participation in historical events. In Ms. Fuentes' class, Joshua and Alice have just finished participating in the Founding Fathers' debate over the approach to states' rights in the founding of the Constitution. The opportunity to question Jefferson and Hamilton has given them much to contemplate on how to develop national unity and which decisions are best made at the state versus the national level.

Ms. Alfonso is spending her daily two hours of planning time reviewing the regular digital diagnostic assessment from each of her student's work and crafting approaches to help each of them. Her feedback tools indicate that a new approach is helping Darren understand multiplication better, but exponents still seem to be a problem. Ms. Alfonso is working with colleagues to identify the best way to help Darren with this lingering problem. The feedback also shows that the program allowing students to virtually build and touch three-dimensional objects appears to be helping Jennifer's understanding of geometry, and allowing her to study solid geometry at a relatively young age.

Mr. Monopolis is finishing up a conversation with Jessica's mother. He has noticed that Jessica appears distracted in class and her work shows a lack of concentration. Jessica's grandmother is ill, and the family may have to travel to a neighboring state to see her. Jessica is worried about her grandmother, as well as about falling behind in schoolwork and not seeing her friends. Mr. Monopolis is outlining for Jessica's mom how she can attend school through wireless video conferencing while she is away, and even visit with her classmates during lunch break. The materials already online describe what the class is studying this semester, and Jessica's parents plan to review it in more depth so they can monitor Jessica's work while they are out of town. They also plan to communicate regularly with her teachers.

<div align="center">John Wilson</div>

As she clicks through the footnotes she comes across a website showing the evolution of ship design through the centuries. She is immediately taken with the style and design of the Viking long ship. A footnote there brings her to a game where she gets to control a Viking colony. After playing the game for a while she decides to order a book, a fictional account of Viking culture that was noted during part of the game.

Will Wright

Their research using the Global Learning Network has led them to the Hawaii Volcanoes National Park website, where they have witnessed several hours of video footage of volcanic eruptions, observed volcanologists at work tracking and measuring lava flows, and watched interviews with them. The site included a 3-D time-lapse hologram of the 1983 Mount Kilauea eruption on the Big Island. Through the time compression of time-lapse photography, they were able to witness lava flows over the past 40 years.

Malia asks, "A few weeks ago, we had a small earthquake here. We felt it but it didn't damage anything. How are earthquakes related to volcanoes?" On another screen, Ranger Levitt calls up a simulation of plate tectonics and shows them cross-sections of the Earth, as well as aerial satellite photos from different elevations, with overlaid graphics indicating earthquake fault zones in the Bay Area and then San Francisco."

Milton Chen and Stephen Arnold

As students work on building a motor, large screen displays coordinate visualizations for them to work together. They see visual designs on their devices and they build the motor from graphical components that simulate what they'll be doing in the laboratory. All their notes, their conversations with other students, their workflow, their graphics and video captured during their research period are all recorded and stored for student review.

So many automated processes have been built in for them: inquiry style, learning style, personalized activity selection, multimedia preferences, physical requirements, and favorite hardware devices. If the student is in research mode, natural dialogue inquiry and social filtering tools configure a working environment for asking questions and validating hypotheses. If students like rich multimedia and are working in astronomy, they automatically are connected to the Sky Server which accesses all the telescopic pictures of the stars, introduces an on-line expert talking about the individual constellations, and pulls up a chatting environment with other students who are looking at the same environment.

Randy Hinrichs

In 20 years, we'll have eyeglass displays that will be able to project virtual or recorded images that the wearer will perceive as immersive three-dimensional reality. Such glasses will be able to overlay or blend telemetry, virtual images and the real world almost seamlessly. A person will be able to see someone seated across a table, and—in the next "seat"—another person physically located halfway around the globe.

Stan Williams

Visions 2020 Authors Cited:

Ruzena Bajcsy
Director
Center for Information Technology Research in the Interest of Society
University of California at Berkeley

Vinton Cert
Vice President for Internet Architecture and Technology
WorldCom

Caleb Schutz
President, Marco Polo Foundation
President, WorldCom Foundation
Vice President, WorldCom

Milton Chen, Executive Director
Stephen D. Arnold, Vice Chair
George Lucas Foundation

Chris Dede
Wirth Professor of Learning Technologies
Harvard Graduate School of Education

Randy Hinrichs
Research Manager for Learning Science and Technology
Microsoft Research Group

The Learning Federation

Ulrich Neumann
Chris Kyriakakis
Integrated Media Systems Center
University of Southern California

Randy Pausch
Co-Director
Entertainment Technology Center
Carnegie Mellon University

R. Stanley Williams
H-P Fellow
Hewlett-Packard Laboratories

John I. Wilson, Executive Director
National Education Association

Will Wright
Chief-Designer and Co-Founder
Maxis

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