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THE FUTURE IS NOW

Where today's assistive technologies will take learners tomorrow.

If the whole point of technology is to help people accomplish a wide variety of tasks, then the term "assistive technology" is essentially redundant. The term itself has only been around in education for about 15 years. What makes technology built specifically for students with special needs interesting is that it must be *purposefully* redundant, offering a host of ways for differently abled students to accomplish one goal or to use one piece of equipment to perform many different tasks. Think of the cell phone, a relatively straightforward audio-communication tool. Equipped with a video screen or a Braille keypad, cell phones are also tools for text messaging and sign language. Using built-in global positioning systems, blind students can even use a cell phone to navigate their surroundings.

"At first, much of the technology being developed was to help those with low-incidence disabilities, such as serious physical limitations," explains Greg Blalock, the director of instruction for the Research Institute for Assistive and Training Technologies at the National Association of State Directors of Special Education (RIATT@NASDSE). "Now much of it is for high-incidence disabilities like learning disabilities [LD] and attention deficit disorders [ADD]." He says as more mainstream vendors incorporate Universal Design for Learning (UDL) principles into products for the general public—building in flexible accessibility features (see "To Leave No Child Behind," page 18)—the need for specialized assistive technology will change. Additionally, the field will be shaped by pressures from above, such as laws requiring that all special-education students have access to appropriate technology, coupled with changes from below, as more people use cell phones, laptops, and other technologies in their daily lives.

We have also entered the "third wave" of computing, according to Dr. Sara de Freitas, founder of the Lab Group and research fellow at Birkbeck's School of Computer Science and Information Systems in London. De Freitas believes that wearables and mobile computing will radically alter the dynamic of interaction between learner and technology, turning our physical and virtual world into the user interface—wherever you go, you will access computer networks as part of your interaction with the world around you. To some, that means the future of assistive technology is more individualized educational environment than Individualized Education Program (IEP).

"Students may one day wear 'belt-buckle' computers that they customize for their own personal needs like cell phones," believes Bart Pisha, director of research at the Center for Applied Special Technology (CAST) for the past 19 years. "If they're ESL kids, they'll have information delivered to them in Spanish, or represented in sign if they're deaf. ADD kids will get timed reminders and technology will be able to monitor health minute by minute. The potential is limitless."

Limitless as it may be, schools are a long way from buttoning computers on special-needs students and sending them on their way. Lisa Wahl, who spent 10 years as director of the Center for Accessible Technology (CforAT) in Berkeley, Calif., and is now a consultant in the field, feels we don't really need to be designing new technology. We need to figure out what to do with what's already available first. "It's about how the kid shows us what they know," Wahl says. And that's the rub, because many students with special needs are simply unable to communicate what they know and when they know it—yet.

That's where a number of projects currently in school-based trials show real promise. Developed for children with a wide spectrum of learning differences, these technologies are also in their infancy, but may one day change the lives of us all.

WEARABLE TECHNOLOGY

Lisa Van Raepenbusch didn't know that eight-year-old Jeremy could type when she first worked with him in her special-needs classroom. The autistic boy had difficulty communicating much of anything to her, except when he was kicking and biting to show his anger. Though there was technology on the market that would have given Jeremy a computer-generated voice that might have helped, at nearly $10,000, it was too expensive for the Coventry, Ohio, school district where Van Raepenbusch worked. What's more, the technology was immobile, leaving the boy with no way to "speak" when he left the computer's side.

Lisa discussed the problem with then-fiancé Eric Van Raepenbusch, who was then a special-needs teacher and is now the technology specialist in Coventry. Eric had stock in Xybernaut, a company that supplies military troops with wearable mobile communication units, and suggested Lisa call the company. Lisa asked to borrow the unit and agreed to buy it if it worked with Jeremy, promising to share the results of her pilot.

At the time, Xybernaut made a two-pound device with either a head-mounted or flat-panel display, designed to be worn by telephone-line technicians and other field workers. Eric jury-rigged a backpack for Jeremy, which gave him the ability to carry the unit around school. Within weeks, the boy was able to tell people what he wanted by typing on the keyboard. Not surprisingly, his outbursts stopped as his communication improved. Lisa tried the unit with a child who had cerebral palsy, with similar success. Then Eric tried it with his LD class, pairing it with such software as Speaking Dynamically Pro and BoardMaker for students having trouble reading. This allowed him to create touch screens for the children to look up definitions or hear pronunciations of words as they read. "It took away the fear and the struggle for them," Eric says. "But the most exciting thing was not the academics. It was the social interaction these kids were having."

Coventry's successes with such a wide spectrum of special-needs students led Xybernaut to spin off a whole new division called XyberKids. According to Michael Binko, vice president of corporate development, ongoing studies are now looking into how the unit can be used to assist people with specific physical needs, such as an interactive map that alerts blind students to hazards as they navigate campus.

Wearables of the future will not only do the bidding of the user, they are likely to have their own agenda. "In the future, an individual localized device will sense your physiology, build profiles of human behavior, and track specific behavior patterns," according to Michael Sung, a Ph.D. candidate in MIT's Wearables Group, who studies medical applications for wearables. For instance, says Sung, a wearable might contact caregivers if an elderly

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person doesn't get out of bed at the usual time. Sung says wearables will also check galvanic skin response for stress and other physical signs of depression or fear, which could be enormously helpful with students who have emotional problems.

Wearables may even deliver "persuasive computing," Sung says, identifying the exact moments of decision-making for each individual, and taking action to persuade the wearer to make a more appropriate choice. Specialists in early education have long encouraged parents to try to catch their toddlers the instant before they bite or hit in order to train children that biting is wrong. Sung says these moments exist for all of us, even as we get older. So a child with antisocial tendencies, for instance, could be steered away from getting into a fight, cheating on a test, or acting out in the classroom.

USING BRAIN WAVES TO REPROGRAM BEHAVIOR

With so much external technology around, it's easy to forget that one of the most impressive pieces of wiring known to man is the human brain. The more we learn about it, the more assistive technology will be able to target specific areas and reprogram, strengthen, or augment their functions. That was the idea behind the development of Play Attention, a modified bicycle helmet that tracks brain waves in children with attention disorders.

When Play Attention creator Peter Freer was teaching in rural Appalachia, students who didn't pay attention were simply thought to be bad kids exhibiting bad behavior. "There was no term for attention disorders back then," Freer notes. He returned to school to study the issue, and eventually discovered research being done by NASA to help pilots stay focused during flights. Freer reasoned that if pilots could be trained to pay better attention, so could kids. "We know what the brain looks like when it's attentive and when it's thinking," Freer explains. He designed a simple bicycle helmet lined with sensors that detect when the brain is concentrating. With the help of an aide, children are asked to focus on a computer screen in order to make a fish swim or a bird fly, learning visual tracking, short-term memory sequencing, and other skills.

"The repetition creates new neural paths," Freer believes, and teacher assistant Katie Croom agrees. Croom has used Play Attention with ADD students at Old Fort Elementary School in North Carolina for the past eight years. A few years ago, the parents of a seven-year-old asked the school to put their son in the program to avoid placing him on Ritalin. "He was really fidgety, wandering around the room and only able to look at a paper for a couple of minutes," Croom explains. She worked with the boy on math and reading twice a week using the helmet, and after two years, he now is able to spend 30–45 minutes at a time on a subject without losing focus, and has not needed medication. "The kids really see for themselves the areas they need to work on," Croom says. "They can see that when they don't focus, their scores are not good."

"This is the assistive technology that seems to have the most potential," notes Wahl. She says she can imagine a day when every third-grader—and possibly every adult—has to take a course of Play Attention in order to learn to concentrate and stay on task. The product is already getting noticed outside the classroom. Freer is currently working with a U.S. Olympic team to help bolster concentration during competitions, and says the helmet is also being used with patients coping with severe head injuries and autism.

The part of the brain that controls attention isn't the only area that we'll be tapping in the future. Recently, the California Institute of Technology in Pasadena decoded the signals from brain cells that are involved in abstract thought. In the study, rhesus monkeys practiced thinking about reaching for an item. As the neural signals became stronger, researchers were able to predict the direction that the monkeys intended to reach as much as 67 percent of the time. That means scientists have decoded the signals for what we *want* to do, not what we're actually able to do. Technologies of the future will be able to analyze these thoughts and turn a person's goals and wishes into action through the use of smart machines. A host of prosthetic devices are expected to come from our growing understanding of this area of the brain, including devices that allow paralyzed people to move their limbs, give voice to the speechless, and even offer those who have trouble expressing their emotions a new way to share them.

VIRTUAL REALITY

Much has been made of the wonderful learning opportunities that virtual worlds offer students—virtual field trips, virtual relationships, and virtual lectures with experts around the globe. One of the most important features of virtual reality (VR) for special-needs students is the less-tangible idea of freedom. David C. Vinciguerra, co-director of the Virtual Reality and Education Laboratory and an instructor in VR for the College of Education at East Carolina University in Greeneville, N.C., says even low-end computing offers unheard-of independence for those with physical disabilities. Vinciguerra's aunt has severe cerebral palsy. She now uses a mouth-controlled wand to interact with others online in ways that were unthinkable earlier in her life, he says. "She has an avenue open for active participation now," he explains.

Active participation and independence for the deaf students at Lake Sybelia Elementary School in Maitland, Fla., was exactly what resource teacher Patti Schofield had in mind back in 1997. That's when she approached Veridian (now General Dynamics Advanced Information Systems, or GD-AIS) to design a groundbreaking VR program for the school. GD-AIS makes VR scenarios for the military. Schofield, now the Virtual Reality Education for Assisted Living (VREAL) project coordinator, felt that using similar scenarios could help her students get over their concerns about not being able to communicate in the physical world.

The first VREAL scenario taught children basic life skills, such as stranger danger and how to get help in an emergency. Today, there are 64 educational scenarios, including a farm and a virtual town where kids can learn how to shop, order food, and even see snow for the first time. Holly Caulfield works with the school's multiple-handicap students, and says the repetition possible in the VR scenario is particularly helpful for her young learners. "My children need to acquire basic

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built-in assistive technology, such as features in a word processor or Web browser that enlarge text automatically, or the feature in an operating system that replaces error beeps with a flashing screen for users who cannot hear the beeps. "These are the true 'electronic curb cuts,' the simple features that everyone uses and people with disabilities can't do without," says Larry Goldberg, director of media access at WGBH and director of NCAM.

In the realm of educational materials, as states increasingly move to comply with federal Section 508 accessibility requirements, publishers will experience the demand for such materials. "There are at least five or six states with accessibility policies for K–12 educational materials," Rothberg says. "Right now, those policies can't be interpreted strictly because there simply aren't enough products on the market to meet the need, but as the benefit from providing instructional materials in those states becomes clear, I think publishers are going to begin to add more of those accessibility features."

In a world where accessibility features are built into operating systems and universal design is built into educational software because it is good instructional design, perhaps the terms "assistive technology" and "universal design" will become obsolete. It will all be about one and the same thing: educational tools that enhance performance and achievement.

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life skills," she notes. "Virtual reality gives them real skills because they can redo the same thing, over and over."

Because deaf students can't see their teachers when they're wearing head-mounted VR displays, a special pop-up window was designed for teachers to sign to their students live while in VR. The teacher signs in front of a video camera and the video is transmitted to the window inside the display. Bob Edge, program manager for training, analysis, and acquisitions programs at GD-AIS, notes that in the future, these windows will give developers the ability to layer information for students, perhaps using live or video signing clips of specific things the children are seeing and experiencing or, as kids are able to read, words and phrases placed throughout. "It could be as rich as TV is today, with many different visual cues like scores or news stories running across the bottom of the scene," Edge notes—though all agree that too much input would be a problem.

Still, such layering could offer real benefits in the development of vocabulary. Gail Rosenberg, an educational audiologist and product manager for My iCommunicator, says the importance of VREAL is that it allows deaf children to pick up incidental language cues that they usually miss. A full-hearing child walking down a street hears snippets of conversations, for instance, that enrich his vocabulary. "The language of a hearing-impaired child is not as rich because they are not constantly overhearing people speaking, or music lyrics in the background," Rosenberg explains. "The virtual setting provides another input for children, especially when there are written words in the scenario and other language cues. It adds another dimension to their language acquisition."

Schofield thinks there's a range of special needs that VREAL could address going forward, such as English as a second language and acclimating children with emotional problems to new situations. Jan Beck, Schofield's colleague at Lake Sybelia, says, "VREAL will only lose its potency if teachers ever run out of things to teach. I wouldn't want to be the driver's-ed teacher giving a deaf kid her first driving lesson—but I could see doing it in virtual reality!" she laughs. According to the VREAL team, basically any scenario that helps make lessons concrete, such as getting change at a store or measuring milk in a container, has applications for all children.

ANYTIME, ANYWHERE, ANY ABILITY?

Is education of the future going to include miniaturized classrooms, clothing that scolds, and jolts to various parts of the brain? Probably not anytime soon. The best that can be said is that as the costs decrease and adoption increases, there will be many more opportunities to experiment with new models than in the past.

Meanwhile, there's already a ton of very cool applicable technology out there, ready to be tried with special-needs students. Blalock says it's interesting that in all three of the programs above, people from the classroom thought out of the box and came up with creative approaches for using existing technology with students. And that brings up the most important piece of the puzzle. Is anyone putting the same amount of time and energy into training teachers to think out of the box in order to meet every student's special needs? That's an area of the brain that really bears looking into.