

External Research Digital Inclusion Program

The Classroom of Tomorrow, Built with Today's Technology

Computers can be instrumental in transforming education in underserved communities, but not if they are simply used to facilitate memorization and test-taking. A team of researchers in Chile is exploring affordable and innovative uses of computers in the classroom that promote collaborative learning and nurture intellectual creativity.

Many educators want to move beyond traditional "skill and drill" learning methods—in which teachers lecture to passive students—and toward collaborative learning in which teachers guide students in exploring ideas and solving problems. While traditional methods can be effective for teaching literacy, numeracy and other basic skills, new approaches can better nurture creativity, flexibility, teamwork and other valuable traits.

Computers can help by putting children in control of their own learning. But they also introduce new challenges. For example, students often learn better when they work in groups, but desktop and laptop PCs are designed for individual use. How does the learning dynamic change when teams of students work collaboratively using small devices, such as mobile phones? What happens when several children gather around a single computer, each with their own mouse, collaborating to solve problems?

For Dr. Miguel Nussbaum, a computer science professor at the Catholic University of Chile, handheld devices, mobile phones and shared PCs with multiple mice are promising learning tools because they give children direct access to technology while also enabling richer interaction with their peers.

"It is essential that the technological network support the social network—the students should be able to collaborate seamlessly," Nussbaum says. "The students' face-to-face interaction should be the final aim, and the technology should be a transparent driving force."

With support from the Microsoft Research Digital Inclusion Program, Nussbaum and



Mobile phones encourage collaboration among students in a Chilean classroom.

Fast Facts

Project: Wi-Fi Enabled Phones for Bridging the Cognitive Divide and Transforming the Classroom Experience

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Profile:
 Researchers at the Catholic University of Chile are exploring how mobile phones and other low-cost portable devices can be used to encourage collaborative learning and 21st-century skills development, particularly in low-income communities that cannot afford expensive technology investments.

Digital Inclusion Program

The Microsoft Research Digital Inclusion Program provided US\$1.2 million in research funding in 2006 to empower academic researchers worldwide to tackle technological challenges that could positively affect health, education and socioeconomic conditions. The 17 recipients, selected from among 162 proposals from 34 countries, received technology resources as well as project funding.

The Digital Inclusion Program is administered by the External Research group within Microsoft Research and is part of the group's ongoing commitment to investing deeply in innovative research. The External Research group collaborates with the world's foremost researchers in academia, industry and government to move research in new directions across nearly every field of computer science, engineering and general science.

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a team of teachers, psychologists, designers and engineers are exploring new implementations of technology in the classroom that can effectively support collaborative learning. In particular, they are focusing on approaches that are affordable and easy to build for schools in underserved communities, which stand to benefit the most from dramatic improvements in learning outcomes.

Mobile phones are already commonplace in most of the world, with nearly 2 billion users—including two-thirds of Chile's 15 million residents. However, the current generation of handsets can support only text messaging and rudimentary e-mail functionality, making them cumbersome and difficult to use in the classroom. Today's handsets are also dependent on phone company networks, and frequent use can incur significant charges. However, as richer functionality and Wi-Fi networking capabilities make their way into inexpensive handsets, these barriers could disappear.

Nussbaum and his team don't want to wait for technology to catch up with their ideas, so they're already working to explore how future generations of mobile phones and other portable devices can support collaborative learning. By adapting existing educational software, building networks of devices and testing them in real-world classrooms, they are exploring the technological and pedagogical issues around mobile learning so future technologies can be put to use quickly and effectively.

They have developed a wireless mesh network that enables groups of phones or other mobile devices to run educational applications without relying on a server PC or using a costly phone company network. They have also developed educational software for this network that encourages collaborative learning among small groups of students and makes the best possible use of the small screen and limited input capabilities of the mobile phone.

They have found that they can encourage face-to-face interaction, discussion and problem solving by focusing on a series of multiple-choice questions sent to each student's phone. Working in groups of three, the students discuss possible answers and enter their responses. If the answer is correct, they can move on to the next question. If it is not, they can continue working until they get it right.

In this scenario, the teacher can monitor and guide the students' work on a separate mobile phone or Pocket PC that provides real-time feedback in the form of a grid showing each group's progress. The teacher can then focus on specific groups that are having trouble or work with the entire class when a subject area is problematic for everyone.

In their early trials at a school in Santiago, Chile, the researchers found this approach to be effective and engaging for teachers and students alike. Having students work on individual phones requires them to take personal responsibility for their learning. The phones also encourage students to work in close physical proximity, creating more opportu-

nities for interaction and collaboration. They also help make difficult subjects, such as physics, become more accessible and fun.

Nussbaum and his team also studied the classroom use of single-display groupware, which allows three children to work together at a single PC, each with a separate mouse. They found that for students 8 years old or younger, it is easier to perform collaborative work when the information they're working with is all on one screen, as when they share a PC, than when they must construct a mental model of the problem they're working with from sequential pieces of information, as students would be required to do when they work on portable devices with small screens.

The team's approach to computing in the classroom balances the use of appropriate, affordable technology with a deep understanding of pedagogy—the science of teaching. Key to their approach in these trials is the decision to have the students work in groups of three. By working in such small groups, the students are engaged in active learning: they formulate their own questions and then collaborate, discuss, analyze, debate and brainstorm. When supported by the right technology—in this case, mobile phones and single-display groupware—this kind of learning can have a powerful, immediate impact.

Building on these findings, the team is expanding its trials to additional schools and adapting its work to create a series of educational games that can further enhance teamwork and collaborative problem solving. They also want to conduct further experiments that combine wirelessly connected mobile phones, Pocket PCs and low-cost education devices such as Intel's Classmate PC to explore how a diverse range of devices can work together to improve learning outcomes.

Their work to bring the benefits of computing to emerging countries is driven in part by the belief that although technology can make a substantial difference in children's development, the digital divide has produced a "cognitive divide" between those who use technology in their everyday lives and those who do not. Some research has shown that people without access to technology don't perform as well on standard tests of memory and attention. Exposing students to appropriate technology early in life can help to close this gap.

"Computers and software are important cognitive devices that can help people nurture higher-order thinking skills," Nussbaum says. "Cost shouldn't be a barrier to that kind of mental development."