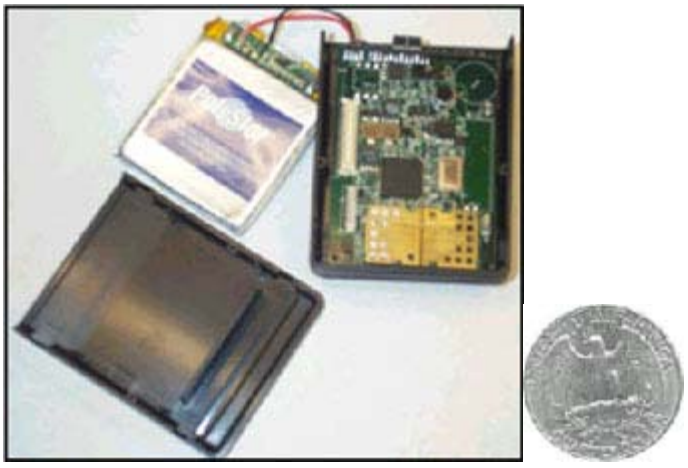
Wired Classroom Gives Educators Insight Into Child Learning

UCLA engineers and education experts are building a high-tech classroom where everyday objects, from textbooks to tabletops, are wired with sensors to measure child behavior patterns in a group setting. Researchers believe that the data they collect from their "smart kindergarten" classroom can be used to create a more interactive learning environment and allow educators to better assess teaching and learning methods.

"Children learn by exploring and interacting with objects such as toys or books, and the experience of having the environment respond to their actions is one key aspect of their development," said Mani Srivastava, project leader and electrical engineering professor from the UCLA Henry Samueli School of Engineering and Applied Science. "We can create a childhood learning environment that is tailored to each child and that allows low profile evaluation of the learning process by the teacher."

To set up a test room in his lab, Srivastava has embedded tiny sensors into objects commonly used in a classroom and strategically placed miniature cameras and microphones around the space. Specially tailored "Gilligan Island"-style hats, which will eventually be worn by students, have been fitted with sensors to track speech and movement. The books, blocks and people will be interconnected to each other and to a database that can sift through all the information that the sensors gather.



This "iBadge" is equipped with sound, localization and temperature sensors but weighs just a few ounces and is not much larger than a quarter. Researchers plan to incorporate the iBadge onto hats.

The sensors measure three particularly important features -- physical location, orientation and speech. Among other things, this allows researchers to observe how students in a group interact with each other and the teacher, where they are facing at any given time and how they behave when they or others speak.

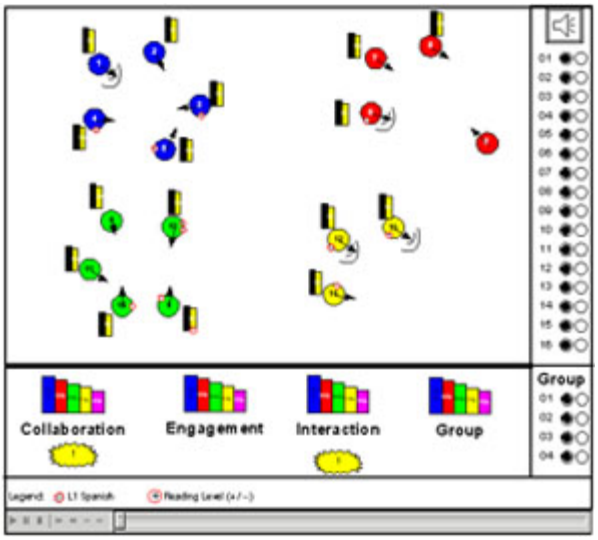
The goal, according to education experts, is to develop sensor-based assessments of student collaboration in small group settings. Using this information, teachers can identify

lessons and classroom activities that are most likely to engage young students and get them actively involved in the group learning experience.

"Engagement -- whether it's active participation or paying attention during a lesson -- is one component of group collaboration that we want to assess," said Girlie Delacruz, a research associate at the UCLA Center for the Study of Evaluation.

Computer software designed by UCLA computer science professor Richard Muntz records and archives the raw sensor data for analysis. The software, called Sylph, was developed in 2001 and has been applied in a number of projects at UCLA.

"The Sylph software that we developed raises the level of abstraction so that data can be captured and displayed more efficiently," said Muntz. "It's flexible enough to work with a variety of front-end applications that can visualize the data."



Sensors gather data on group play in the classroom and an application is used to visualize the data. Circles represent people, while arrows denote the direction each is facing. Curved lines by the arrow mean the person is speaking.

For example, Delacruz uses an application she helped design that connects to Sylph, retrieves the sensor data and then translates the columns of numbers into a typical classroom model, complete with icons representing children as they move about the room. Using this application, an instructor could see how engaged each student in the class appeared during a given lesson, and assess whether her lesson that day was successful. The teacher can also find ways to improve the next day's lesson.

"We expect that the measurement of meaningful behavior over time with respect to the activities children are engaged in, when they are doing them, and the context in which they are working, will allow educators to comprehensively investigate student learning processes on a scale and at a level of detail never before attempted," said Srivastava.

At least that is what Srivastava's collaborators at the Graduate School of Education and Information Studies (GSEIS) hope. They have yet to apply this technology in a real classroom setting, but they are certainly interested.

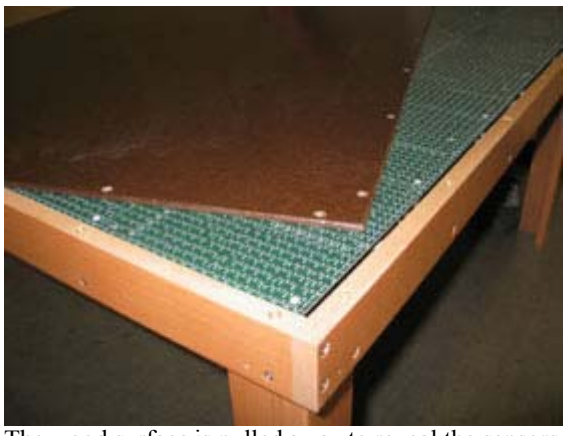
"What drew us to consider using this technology is that current research methods require a human being to do all the observing, which is both time- and labor-intensive," said Gregory Chung, a senior research associate involved in the project. "We wanted to see if measures derived from the wireless sensor data could yield inferences about student collaborative behavior that are similar to what a human observer would infer."

If such inferences can be made, researchers say, it could bring about a whole new way of observing human behavior, not only for education specialists, but anthropologists and sociologists as well.

For Srivastava and his engineering team, which includes Muntz, Abeer Alwan and Miodrag Potkonjak, the project has been a chance to explore a number of wireless networking issues. Despite progress in networking and computing technologies, the greatest advances have been in person-to-person communication, such as instant messaging or email-enabled cell phones. But that is changing, according to Srivastava.

"The marriage of tinier and cheaper processors and wireless network interfaces with emerging micro-sensors based on MEMS technology is allowing cheap sensing, processing and communication capabilities to be embedded in familiar physical objects," said Srivastava.

The result is information technology that enhances person to physical world communication, or as Srivastava describes it, "technology that adapts to us instead of the other way around."


The wood surface is pulled away to reveal the sensors of the smart table.

Srivastava's group has completed a laboratory version of their wired classroom, which includes a one square meter "smart table," with 24 square sensor tiles embedded into the surface. Multiple processors control the table's sensors, with one central processor executing the algorithms that recognize and locate objects. A thin strip of solid wood protects the sensors and hides them from view.

The research group plans to test the wireless network in a classroom setting at the Corinne A. Seeds University Elementary School, the on-campus laboratory school operated by GSEIS.

Similar research, at least in its focus on education, has been done at Georgia Tech with its Classroom 2000 project, where an instrumented classroom was designed to capture the traditional university lecture experience. Electronic notes taken by the students and the teachers were captured as pen strokes, projected on a huge computer screen for the teacher and displayed on pen tablets for the students, and augmented with audio and video recordings to produce time-stamped media-enhanced records of lectures.

The UCLA research team's focus is on the less structured playing and problem-solving oriented environment of an elementary school classroom. Making sense out of the captured information will be a greater challenge, according to researchers, and the children will be less tolerant of any obtrusive technology. The engineers also plan on capturing a greater range of information by embedding sensors in a variety of objects.

And of course, there are privacy concerns that must be considered whenever research involves young children. "The parents with children at our school on the UCLA campus know that it is an experimental setting and are aware of research projects when they happen," said Delacruz.

Srivastava believes that research into creating smart environments through the use of wireless sensor networks will have long-term applications in areas other than education, such as health care.

"If a human could be instrumented and given the power to manipulate his own environment -- controlling lights or temperature, opening doors, pointing out dangers such as a hot stove element -- then children, the elderly and the disabled could all benefit," said Srivastava. "The improvement in person to physical world interaction could be immense."

-Chris Sutton
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