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experiencing engineering through design

DESIGN AND DISCOVERY CURRICULUM PUTS STUDENTS IN THE ROLE OF ENGINEER

How do you go from great idea to working prototype of a new product? Developing creative solutions to real problems is what designers and engineers do every day. Now, a brand-new curriculum called *Design and Discovery* is available for free on the Intel® Innovation in Education Web site. The curriculum introduces students in the middle grades to the fundamental concepts of design and engineering.

Design and Discovery includes everything needed to organize and teach a program, including detailed lesson plans for inquiry-based, hands-on learning. The course takes students, ages 11-14, through a series of steps and learning activities, building their understanding in a sequential way.

Students start by examining the design of the simple paper clip, then quickly progress to discovering the inner workings of a bicycle. Hands-on activities teach them how to wire electrical circuits, build mechanical toys, and accomplish other targeted goals.

When it's time to create their own working prototypes, students take their ideas for new products through the same process that professionals use. They learn to keep a design notebook, recording their observations as they gather input from focus groups, put prototypes through field tests, and make design modifications.

The course is appropriate for both formal and informal learning contexts; middle school science electives, summer camps, youth groups, or after-school enrichment activities.

The *Design and Discovery* Web site includes the complete curriculum, which consists of 18 sessions, each lasting 2.5 hours. Web resources include all handouts, short readings, materials lists, and links to online resources such as the U.S. Patent Office Web site. *Design and Discovery* also explains how teachers or youth leaders can take advantage of opportunities to enlist mentors from the fields of design and engineering. Suggested field trips take students into their local communities for a fresh look at the designed and engineered world.

Design and Discovery grew out of a summer camp project called *Fair Play*. *Fair Play* was intended to increase girls' abilities and confidence in technical areas and allow them to

experience the fun and excitement of being an engineer who solves real problems. *Design and Discovery* builds on the success of *Fair Play*, expanding inquiry opportunities to all learners. It has been field-tested and specially tailored for downloading from the Web.

Students who have participated in the course have developed working prototypes for such innovative products as a sleeping bag roller, wireless Christmas lights, a remote-controlled grocery cart, and a device to help a beginning bass player with proper hand positioning. The program also makes the behind-the-scenes work of designers and engineers more visible. One student marveled at how "so much thought and time goes into something as simple as a paper clip or potato masher."

Some students may wind up developing prototypes they will want to share with a larger audience. Science and engineering fairs, such as local affiliates of the Intel International Science and Engineering Fair, offer a venue where students can share their great ideas. The *Design and Discovery* is available at www.intel.com/education/design.

what makes a good web tool?

WEB TOOLS FORUM BRINGS TOGETHER CREATIVE MINDS TO PLAN FOR THE FUTURE

In the months ahead, the Intel® Innovation in Education Web site will continue to expand with free tools and resources for teachers. Long before a new tool appears online, however, months of research and design go into resource development. Behind the scenes, a team of experienced educators, researchers, and software engineers works together to create tools for teachers to use to increase student learning.

Dr. Jim Pollard, lead researcher for the online program developers, plays a key role in shaping which new tools will make their way from raw idea to reality. A 20-year veteran of evaluation in education, specifically educational technology, he knows from experience that the classroom value of any tool is what matters most. "Education is more important than technology." he says. “We want to enhance what the teacher does in the classroom rather than replace it.”

So what makes a good Web tool for educators? And where do good ideas for teacher resources come from?

Pollard and his colleagues from the Intel Innovation in Education team recently invited a group of 50 teachers, university researchers, and software engineers to discuss those intriguing questions at the first Web Tools Forum. Four days of brainstorming and hard thinking generated a slate of new ideas for potential development. By design, all focused in some way on classroom activities that would inspire students to use higher-order thinking skills. "We were hoping to come away with four good ideas to develop, and we got at least 10," says Pollard.

FREE TO DREAM

In the loosely structured environment of the Web Tools Forum, teachers broke into smaller teams and then were encouraged to dream. "We know there are a lot of teachers out there with ideas, and we wanted to bring some of them together," Pollard says. "The best way to be creative is to be with other people who are creative."

Invited teachers came from across the United States. They teach in diverse classrooms; an urban high school for students in the California court system, an Alaska district that invests heavily in technology to connect students with the rest of the world, and an Idaho middle school where teachers regularly create projects that

cross disciplines. What all share, says Pollard, is that "they're known for being good teachers." And they have a track record of integrating technology into the classroom to boost student learning.

Sitting alongside these creative teachers at the Web Tools Forum were education researchers and software engineers. “They brought their own ideas and they helped make them more real,” Pollard explains. Drawing on participants' diverse backgrounds, the teams were able to express conceptual ideas for new Web tools "in terms of software and also in terms of pedagogy."

BUILDING BLOCKS

Months of development and classroom field-testing will take place before any of these new ideas will be ready to introduce on the Web site. Already, however, Pollard has a good idea of the building blocks required to make a Web tool useful for teachers and appropriate for delivery on the Intel® Innovation in Education Web site. "In general, a good tool will have little connection to content. It's something that can fit into teachers' lives regardless of what subject they're teaching."

Seeing Reason, a concept mapping tool introduced on intel.com/education last year, offers a model of all the elements that are assembled before a Web tool is ready to launch. An earlier version of the tool was developed by researchers at the Center for Innovative Learning Technologies at the Berkeley campus of the University of California. Basically, students use the tool to capture their thinking about cause-and-effect relationships by creating a series of boxes and arrows. That simplicity is the beauty of the tool. "As soon as students see how to create one factor and make one relationship, they're off. They don't need much instruction; it's all very intuitive. They are thinking about what is in their maps rather than how to use the tool; which is its absolute most important feature," Pollard says. "You're teaching about cause and effect rather than how to use the tool."

Convinced that the tool "was exactly what teachers were looking for," Pollard led the work of adapting *Seeing Reason* for the Intel site, "so that it would work on any browser, any platform." He also added supporting components intended to make *Seeing Reason* more useful to teachers. "We spent about five months on development, putting the tool in a classroom and seeing how teachers would use it. We interviewed teachers, then made modifications based on their feedback," he explains. The supporting elements transform what might seem like a simple tool into a rich professional development resource for the teacher.

So what does the "complete package" include, in addition to a great interactive teaching tool for the classroom? Pollard identifies the following elements:

- Research base: "This grounds the tool in theory and explains why it might be effective to use in the classroom."
- Teacher experiences with the tool: "What works best? What might you expect students to do? What to avoid? It's essential that we tell real teachers' stories that come from authentic experiences in the classroom. This adds credibility and lets teachers know they're learning from their colleagues."
- Quick-start examples: "These ideas will get you started using the tool right away. We provide enough content so that good teachers can see the example and apply it to something they're doing in the classroom."

- Deep example: "This is an example that shows how to use the tool from start to finish, from learning goals all the way to assessment. We show a unit in detail, so that another teacher can pick up and do the whole unit to deliver a particular piece of instruction. It's tied to standards, has a depth of content, includes all the handouts and other materials needed for teaching. It's the complete package. If the quick example shows you how a tool might work, the deep example shows you how it really does work."
- Help: "This is instruction on using the tool itself."
- Management tools for the teacher: "This is something the Web does really well: providing management tools so a teacher can set up projects for the class, set up student accounts. The teacher can then go to the Web site, review student work, and exchange comments on projects with students. It's all there in one place, and teachers and students can access it all from any computer that has Internet access."

From the *Seeing Reason* experience, Pollard says he's learned "there's a need for resources like this. Teachers have told us that having this tool available does change how they teach. And students like it. With very little instruction, they understand how to use it."

Like *Seeing Reason*, the next generation of Web tools to appear on the Intel education site will also relate to higher-order thinking. Pollard describes upcoming tools in broad strokes: "Most will be collaborative. They'll be content-free, so they can work in any subject area. And really good tools also involve layering in some way—taking knowledge in one area, overlaying it in some other area, seeing connections, building on ideas. That's appealing from the Web perspective. We can combine ideas from different geographies."

How soon might these innovative new tools be available for teachers? Look for at least two new ones by the end of this year, Pollard says. But first, there's much work to be done. It's a challenge, he admits, "but considerable fun."

institutes ready to roll

NEW COURSE CATALOG OUTLINES PROFESSIONAL DEVELOPMENT MENU FOR EDUCATORS

Connecting teachers and education leaders with resources that fit local needs for professional development is the idea behind the new Intel® Innovation in Education Institutes. Participating communities select the workshops they want from the Institutes course catalog. Then the customized sessions are presented by expert trainers who come to the local host site. And it's all free to participants and regional hosting organizations.

Institute topics focus on how educators can take advantage of free, Web-based tools to boost student learning. Most of the sessions are designed to be delivered in technology labs so that participants can engage in active, hands-on learning. For audiences who prefer an overview of a topic or tool, multimedia presentation sessions can also be arranged. Individual courses last from one to three hours, allowing for training events that fit local schedules.

The Institutes are designed to interest instructional leaders, curriculum specialists, primary and secondary classroom teachers, and others involved in using technology to support student learning. Educators should come away from a training event with a better understanding of how to use the growing number of free tools and resources available on the Intel Innovation in Education Web site (www.intel.com/education).

The Institutes catalog—available in print and online versions—outlines current course offerings and learning goals for each session topic. The catalog also explains the nuts-and-bolts of hosting a local event, including local facility needs.

Among the current course offerings:

- ***It's a Wild Ride***: Presenting a video and Web-based case study demonstrating technology-supported project learning
- ***Seeing Reason***: Introducing a Web-based tool for exploring cause-and-effect relationships
- **Ideas Worth Borrowing**: Offering a guided tour of two collections of engaging, technology-supported learning projects
- **Technology Integration Resources for School Leaders**: Providing school leaders with professional development resources to support teachers in all grade levels and subject areas
- ***Design and Discovery***: Introducing a curriculum accessible online that teaches design and engineering concepts through inquiry-based, hands-on experiences
- **Tour of Web-Based Resources**: Providing a guided, multimedia tour of what's available on the Web site to assist student learning

Regional educational organizations interested in hosting an Institute in their community may first want to observe a session in action. A calendar of upcoming Institutes is available on the Intel Innovation in Education Web site. Although Intel does not charge for providing materials or trainers, there are minimum attendance criteria. Hosts are responsible for providing facilities. The Institutes catalog provides a full listing of current course offerings, including key learning goals for each session. Copies of the catalog will be available soon (www.intel.com/education /institutes)

Q & A

INTERVIEW WITH AWARD-WINNING TEACHER SHEILA PORTER

It's science fair season—an exciting time for students and teachers alike. In communities around the world, more than a million students are busy polishing their research projects to enter in local competitions. Some 1,200 winners of regional events affiliated with the Intel International Science and Engineer Fair will come together in the U.S. in May to compete with students from every corner of the globe.

What makes these events worthwhile from a teacher's perspective? We decided to ask Sheila Porter. She teaches science at Loreto College, St. Stephen's Green, an all-girls secondary school in Dublin, Ireland, housed in an elegant Georgian building dating to 1771. Each year, she mentors and guides some 50 girls who enter projects in Ireland's national fair, the Esat BT Young Scientist and Technology Exhibition. Because of the high level of student participation she inspires, Porter has twice received the Young Scientist Teacher Award sponsored by Intel. Her swarm of students—dressed in their burgundy school uniforms and neckties—are hard to miss on the crowded exhibition floor at the Royal Dublin Society where the Young Scientist event unfolds each January.

HOW DID YOU GET STARTED WITH SCIENCE FAIRS?

I started teaching 30 years ago. Being young and enthusiastic, I encouraged my students to enter the science fair. It was a fantastic experience for me and the girls. Then I took a break from teaching. I've been back in the classroom now about 12 years. It's been like starting teaching all over again, and I'm refreshed and enthusiastic again. I started entering students again in the fair in 1995. We had two students that year, and they were successful. The next year, we had nine. And from that it's grown, so over the last three years we've had over 50 students and over 20 projects each year. I teach biology and general science, but my students enter all disciplines—physics, chemistry, biology, mathematics, social/behavioral science, technology, whatever they like to do themselves.

WHAT DO STUDENTS GAIN FROM THE EXPERIENCE?

With project work, particularly when students pick the project themselves, it's something they want to do. They become the experts. Eventually they know more about their topic than I do. So it's a great way of learning. They're interested, and they're doing it for themselves. It's very rewarding to see a student come into her own with a project of her own choosing.

HOW DO YOU RECRUIT STUDENTS TO PARTICIPATE?

I never turn a student away. I encourage everybody to come and have a try at it. First I announce it and have a meeting, and maybe seventy students attend. I show a video of past fairs. Also, after the fair, when we go back to school we have an exhibition of all the projects. We leave them up for a week. The other teachers will come and ask the girls about their projects and admire them. So we have great excitement, and that sort of sets the ball rolling. It's become a culture at our school.

BEFORE THEY START WORKING ON SCIENCE FAIR PROJECTS, DO YOUR STUDENTS GET A FOUNDATION OF SCIENTIFIC RESEARCH SKILLS IN THE CLASSROOM?

In Ireland, students have the opportunity to do a transition year that includes a science module. This comes after their third year [Irish secondary school is typically a six-year program, for ages 12-18]. This is a year where teachers get to devise the syllabus, allowing them to be more creative in their approach and course content. It's an ideal opportunity to teach something like scientific research and the process of science. So I introduce that as a sort of formal model in transition year class. In that way, students learn how to go about doing research, and I encourage them to enter projects in the Young Scientist Exhibition. This school has a great tradition of having a strong science program. All of the science teachers do practical work—laboratory experiments—as much as we can.

WHAT'S THE ATMOSPHERE LIKE AT YOUR SCHOOL AS THE YOUNG SCIENTIST DEADLINE APPROACHES?

It's a great atmosphere of work and learning and helping one another. Right before the exhibition, the girls are getting their projects finished, and they'll come to the school for a couple of days during the Christmas holidays when nobody else is there. The older ones will help the younger ones. On the teams—most of my girls enter team projects—everybody has a different role to play. They learn to work together, and that's very important. It's such a lovely atmosphere. Students become so engrossed in their work that we don't even stop for lunch and send out for food! It's an air of everybody working together and everybody learning.

BECAUSE OF YOUR TEACHING AWARDS AND OTHER INVITATIONS, YOU'VE NOW ATTENDED FOUR ISEF EVENTS IN THE UNITED STATES. WHAT HAS YOUR INVOLVEMENT IN THE INTERNATIONAL FAIR MEANT TO YOU AS A TEACHER?

The first year I won, I didn't even know there was an award. I just could not believe it when they told me I had won, and I'd be coming to America. Then two years later, I won it again. And I've been invited to attend two other ISEF events as a group leader for other teachers. This has added a new dimension for me as a teacher. I've learned so much from attending the events, seeing students' projects, and getting the chance to meet other teachers from around the world. We've exchanged a lot of ideas, and we've stayed in contact. It's great to hear things from another point of view. As a teacher, you should be learning new things all the time. You need to get out of your own classroom and meet one another. In science, particularly, there is so much to learn.

WHAT'S THE BEST PART OF SCIENCE FAIRS?

A lot of people say to me, why do you bother? You're giving up your free time to do this. And I say, I do it because I want to do it. I get as much pleasure from it as the students get. That's my reward: to see how happy they are. They grow so much in self-confidence. As a teacher, you just have a lovely relationship with your students. And they do learn—most of them know more about their topic than I do now. And that's OK. I'm only there to guide them. They might go on to become doctors or get their Ph.D., but when they meet me again years from now, they will always say, "Remember when we did the Young Scientist?"