Project-based learning engages students, garners results

Students in a South Texas classroom had taken on the role of employees at CleanWater Tech, a fictional U.S. company that produces water filtration technology, and were poring over the economic indicators of various unnamed countries, trying to decide into which nation the company should expand.

When asked by Ilene Kantrov, director of the Center for Educational Resources and Outreach at the Education Development Center, what they would tell an administrator who visited the classroom during their work on the project, one student piped up, "I'd tell them they should leave, because there's learning going on and they don't want to get in the way."

Such a response is not at all unusual from students who are engaged in project-based learning, says Kantrov. The Education Development Center is a global nonprofit organization that designs, delivers, and evaluates innovative instructional programs—and many of these embrace learning through inquiry-based projects.

The California-based Buck Institute for Education, an organization committed to the use of project-based learning worldwide, defines the concept as "a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks."

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Jennifer Nastu is a freelance writer in Colorado who writes frequently on education and technology.

This eSchool News Special Report is made possible with financial support from Sebit.

Helping project-based learning take hold

The Buck Institute for Education, which focuses on professional development and materials to support project-based learning, believes that, as with most complex instructional approaches, there are many conditions that need to be met for schools to embrace project-based learning.

First, says Executive Director John Mergendoller, teachers must fully understand the concepts they are teaching. They also need to know they are not trying to force learning on the students, but instead are encouraging students to approach learning themselves.

Then, there needs to be an accountability system that ensures students are staying on track. "You can't just turn kids loose on the project," Mergendoller says. "There has to be a defined set of benchmarks, check-ins with the teacher."

The fluidity of this approach to learning also can discourage teachers from incorporating project-based learning into their curriculum, because it can be hard to ensure that all standards are being met—and tricky to recycle lessons from one year to another.

With project-based learning, students are in charge of their own learning. "So if they want to investigate the water in school to see if it contains lead, that's where you go," says Peter Rollero, associate professor of science education at Arizona State University and a consultant for Adaptive Curriculum. "Every year, the project could be different."

Starting small, and letting teachers see the excitement and learning that take place with a project, can help them become willing to incorporate more project-based learning into their instruction.

"Students go from class to class and say, 'I'm in Miss Jones' class and we're doing this really cool thing,' and then the other teachers go to Miss Jones and say, 'What are you doing with your class? The kids are so excited….'" explains Donna Gilley, career and technical education coordinator for the Metro Nashville Public Schools.

It also helps when schools have an integrated curriculum. "It's good for a teacher to teach all the subjects instead of having them compartmentalized, so you can do one project and learn math, science, social studies, writing, [and] language arts," Rollero says.

For schools that don't have an integrated curriculum, teachers from different subject areas can team up on projects.

Of course, Gilley adds, the teachers can't do it alone. To make project-based learning the best it can be, schools should coordinate with outside organizations—with industry, with museums, and with other places that will make projects come alive for students.

Teachers also should not work in a vacuum; school leaders should give them plenty of time to collaborate and plan projects.

"We entrust teachers and encourage them to design the projects themselves," explains Rob Riordan, director of instructional support for High Tech High in San Diego. "To support that, [the teachers] have lots of contacts throughout the day and in the summer, where teachers are talking to each other about their work. Teachers also come in an hour before the school day with kids begins. They spend that time working in teams, studying together, and talking about the curriculum, projects, school issues, and students."

Riordan concludes: "None of this could work without professional time for the teachers." —J.N.

Project-based learning ...

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Project-based learning is a successful approach to instruction for a variety of reasons, its proponents say. For one thing, it helps students retain the information they learn. Lecture approaches don't lead to long-term retention, says John Mergendoller, executive director of the Buck Institute. "Kids learn it for a week, then forget it," he says.

Another reason project-based learning is useful is because it engages students' interest and motivates them to learn. One of the main reasons kids drop out of school is because they're bored. With project-based learning, students are encouraged to explore their own interests and to make connections to the world beyond school.

"I can't tell you how many times I have heard, 'Why am I learning this? This is a waste of time. What's the point?' Project-based learning gives you a way of answering those questions," says Kantrov.

Project-based learning also encourages a deeper level of thinking by involving students in answering questions for themselves, making connections, and using analytical skills.

"When I'm doing project-based learning, I'm looking at taking the 'whole' apart and looking at the pieces. That's problem-solving, the ability to analyze information by putting it together in a new way to solve the problem," explains Pat Walkington, vice president of sales and marketing for Sebit LLC, which produces an online learning solution called Adaptive Curriculum.

Adaptive Curriculum is an interactive, web-based software product that allows students to conduct scientific experiments, in realistically rendered surroundings, that are substitutes for actual experiments when these might be dangerous in real life or when they require costly equipment. The virtual experiments help students develop standards-based scientific inquiry skills.

"In project-based learning, instead of answers being provided to students, [students] have to do experiments to come up with the solutions," Walkington says.

What's more, project-based learning can help students develop the same kinds of 21st-century skills—such as problem solving, critical thinking, communication, collaboration, and creativity—that today's employers covet. Tackling long-term, student-led projects can help students build real-world skills and knowledge.

Examples of project-based learning

At the High Tech High charter high school in San Diego, a group of 10th-grade students collaborated on a multidisciplinary project called Beyond the Border. Because one of the most-crossed borders in the world is just 12 miles from the school, the students wanted to discover what was on the other side, and why conditions were so different there.

They decided to look at several elements, including medical care, water quality, immigration, and travel across the border. Then, working in groups of two or three, they created video clips about their findings and posted these on YouTube. They also presented their findings in an evening exhibition. Visitors could watch the students' videos on a bank of laptops and headphones arranged around a table.

The project cut across several courses and disciplines, including English, science, and social studies, while teaching students in a way that allowed for multiple entry points into the core curriculum content.

"Our teachers, when they sit to plan their projects, think about the things they're passionate about, things they think are important to cover in their discipline. Then they think about state standards, and what they can cover in the projects they want to do," says Rob Riordan, so-called "emperor of rigor" for High Tech High (basically, he's the director of instructional support). The teachers also consider the elements of their discipline they will be unable to cover through the planned projects, and pinpoint the areas they'll have to cover through other, perhaps more traditional, means.

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Advocates of project-based learning say it encourages higher-level thinking skills.

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“***Kendra Moreno, Asst. Principal***
“Adaptive Curriculum has really brought a lot of enthusiasm for science into our school.”
“I think for our language learners, Adaptive Curriculum had been very strong because of the amount of interaction that is required.

Hunter, 5th Grader
“It's easier to remember about it when it's fun to do”

Rene Castaneda, Technology Director
“It’s had a very positive impact because we have seen some teachers excited about learning more about the content they sometimes don’t understand very well through the online access that we now have with Adaptive Curriculum on the Internet.”
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A sample project-planning form

1. Begin with the end in mind.

Summarize the theme for the project. Why do this project? Identify the content standards that students will learn in this project. Identify key skills that students will learn in this project. Identify the habits of mind that students will practice in this project.

2. Craft the driving question.

State the essential question or problem statement for the project. The statement should encompass all project content and outcomes, and it should provide a central focus for student inquiry.

3. Plan the assessment, part 1.

Define the products for the project. What will you assess—early in the project, during the project, and at the end of the project?

4. Plan the assessment, part 2.

State the criteria for exemplary performance of each product.

5. Map the project, part 1.

What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills? Look at one major product for the project and analyze the tasks necessary to produce a high-quality product. (List the knowledge and skills that students will need: already learned, taught before the project, and taught during the project.)

6. Map the project, part 2.

List key dates and important milestones for this project. What challenges or problems might arise?

7. Manage the process.

List the preparations necessary to address needs for differentiated instruction for ESL students, special-needs students, or students with diverse learning styles. Ask: How will you and your students reflect on and evaluate the project? (Class discussion, student-facilitated formal debrief, teacher-led formal debrief, individual evaluations, group evaluations, or other.)

(Source: Buck Institute for Education, http://pbl-online.org/pathway2.html)

Project-based learning ...

continued from page 22

The most successful project-based learning takes place when the teachers let go of control, says Kantrov.

"The students say, 'We'll figure this out together. What do we want to find out?' Teachers don't need to know every detail and every fact," she explains. "Their skills have to be in understanding where students are and helping them move from where they are to the next step in the learning."

The Education Development Center, together with the Ford Motor Company Fund, created the Ford Partnership for Advanced Studies (Ford PAS), a project-based curriculum that helps students develop the content knowledge and skills necessary for future success in such areas as business, economics, engineering, and technology.

Now in use in 26 states, the curriculum offers a series of modules that link the learning of traditional academic subjects with the challenges students will face in post-secondary education and with the expectations of the workplace they will face as adults.

Community-wide, collaborative efforts and innovative partnerships link Ford PAS local high schools with colleges, universities, and businesses. Through coordinated, real-world projects that start in the classroom, Ford PAS offers experiences to help students make decisions about their future education and careers.

"If you're going to build skills like critical thinking, problem solving, teamwork, and communication, you actually have to engage students in processes where they have to think critically, work in teams, and communicate with a variety of audiences," says Kantrov.

Kantrov describes such a project, one that focuses on the economics principle of comparative advantage: "The project has students working to publish a yearbook. Each student might have a particularly strong skill: One is better at doing layout, another is better at writing. The students were challenged to discover how much time they should devote to different tasks to get the yearbook done quickly. They learned what they needed to know about comparative advantage in order to figure out the problem."

Skills are taught within the context of solving the problem, and professionals from the business world come in to model particular skills throughout the process. Community involvement is important, Kantrov says, because students don't learn just in schools. They eventually head out into workplaces, labs, and communities to continue learning and to begin their professional life.

In the economics project the South Texas students were working on—a Ford PAS module called "The Wealth of Nations"—students look at several different economic indicators (such as gross domestic product, inflation rate, employment rate, literacy rate, and infant mortality rate) for various countries to predict the presence of a skilled workforce in each country. The indicators for each of the countries are posted around the room, and students work in teams to consider the implications of these indicators as they are revealed.

Students eventually get to see color photographs of families from these countries, taken from the book The Material World, and they read a brief story about each family. At the end of the activity, they learn the names of the countries. "It's a wonderful activity and really impresses on kids the meaning and significance of the various economic indicators," Kantrov says.

Later in the module, students come up with their own indicator of a country's economic well-being, which they then apply—along with the traditional indicators—to their decision about where CleanWater Tech should expand.

Where technology fits in

Students can use technology as a tool for gathering information and completing projects, just as professionals in a given field would do. As they work on inquiry-based tasks, students are learning important information-age skills (such as internet research, data collection, and analysis) along with the core curriculum content.

Gary Bitter, professor of educational technology at Arizona State University and founder of ASU's Technology Based Learning and Research, believes technology is an integral part of project-based learning.

"In most cases, students will use technology to [apply] some type of meaningful problem-solving approach where they can experiment with numbers, say, in math, or experiment with … the simulation of an activity," says Bitter, who is in charge of mathematics content for Adaptive Curriculum.

Developed by Sebit in conjunction with Bitter and other ASU educators, Adaptive Curriculum is intended to make often-difficult math and science concepts easier to teach and more enjoyable to learn. Math and science "activity objects," as they are called, are designed to teach concepts by having students consider a real-life problem, make a plan to solve the problem, carry out the plan and check results, and draw a conclusion.

"When kids are more in charge of their own learning, the information is retained a lot longer and you're using higher-level thinking skills, engaging the learners, and letting them take more responsibility for their own learning. The teacher's role has changed, from one of having all the knowledge to encouraging kids to learn and get that information on their own," Walkington says.

For example, one activity object on mutualism has students watch a bird eating decaying food from the mouth of a crocodile. The students must form a hypothesis: If the bird didn't perform that function, what would happen? Would the bird be OK, but the crocodile would suffer? Would the crocodile be OK, but the bird would suffer? Would they both suffer? The students look at a simulation of what would happen, then go back to their hypothesis to see if they were right.

Another activity object has students conduct virtual experiments on photosynthesis, while a third activity object looks at how planets orbit each other and allows students to take one planet and orbit it around another.

"They have to understand something about gravity and how it works, the trajectory of the object in order to maximize the orbit, the speed and mass of the object. In the experiment, they can manipulate all of this to see if they can get an orbit," Walkington explains. "If the variables aren't correct, they see what happens—[such as] one planet crashing into the other."

The product is mapped to state standards for grades 5-8. However, it's a useful product for younger, gifted students as well, Walkington says. There are currently 99 activity objects in math and 115 in science. The activity objects can be used as part of a larger project, but they can also stand alone: Most of them run 40 minutes long—the average length of a class.

Adaptive Curriculum gets the less-interested students motivated, says Bitter, who adds: "If you have a student [who is] deficient in mathematics, teachers can bring him up to a level to work with. They can assign an object to him, leave him on his own with the concept he's not understanding, and get him adapted to the mainstream."

Key Curriculum Press is another company that offers technology to support project-based learning. The company's Engineering the Future science course, developed with the Museum of Science in Boston, includes a unit in which students are asked to build a paper boat. By lighting a candle, setting it in the vessel, and directing its heat into the water, students learn about propulsion, thermodynamic properties, and other concepts.

"What we find by engaging them in this hands-on activity is that those experiences, and therefore the con-

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Project-based learning ...

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cepts they learn, stay with the students much longer than if they had just been taught an algorithm [that] they memorized and then applied," says Jim Ryan, vice president of marketing for Key Curriculum Press.

Engineering the Future poses questions to students at the beginning of projects. The students then discover the answers to these questions as they go along.

PASCO Scientific's computer interfaces and sensors (probes), bundled with computer-based activities for chemistry, biology, physics, and general science, are another way for schools to bring technology into a project-based learning environment.

"More and more, we're trying to give kids an idea of what real science is," says Wayne Grant, chief education officer for PASCO. "It's about asking questions that have meaning to you and going out to answer those questions. It's like detective work."

For example, he says, a project that took place in the Pacific Northwest had students examining the viability of salmon spawning streams. They took water quality measurements along the length of the river to determine the deterioration of the environment and its effects on salmon. Then, they looked for factors that were affecting the river.

One detrimental factor they discovered was logging; however, logging is a major industry in that area. "So then science is not just about lab coats. It influences social policy. The measurements you take are not just disconnected measurements of things like pH," explains Grant.

The students followed up by looking at the economics of logging. "It changes the perception of what science can be about," Grant says.

School challenges—and successes

The relatively new Adaptive Curriculum was used with great success recently during a pilot program at the Isaac School District in Phoenix, Ariz. Kendra Moreno, assistant principal at Isaac Middle School, met with the sixth, seventh, and eighth grade teachers, as well as with the designers of the program and its activity objects, to discuss bringing Adaptive Curriculum into classrooms.

"We went through our state standards to see which activity objects would best align. Then I had to promise teachers that they would not fall off their timeline. They are reluctant to do things that would put them back. It had to be seamless [and] support their instruction," Moreno says. Only after they started using the activity objects did teachers begin to see how the activities served as building blocks for understanding.

Moreno developed a calendar for the school's laptop cart; teachers got the cart, which contained one laptop for every two students, every other week.

"About 80 percent of [our students] come from homes where English is not the primary language, so we have huge numbers of second-language learners," she says. One of the things she likes about Adaptive Curriculum is its repetition of vocabulary words and visuals; kids were using key content vocabulary from the lessons and having very academic discussions as they completed the activities. "They hear the same words over and over, and that's important, because if you don't 'get' the word, you're not going to get the concept," she explains.

Another huge benefit of Adaptive Curriculum, Moreno says, is that she saw a significant increase not only in students interacting with each other, but in teachers interacting with students.

"When you have 15 laptops going, you can't go to your desk to check eMail, you can't step out into the hall to have conversations with colleagues," she says. "[Teachers were] walking around monitoring things [and] answering questions. These were high-level concepts."

Moreno mentions the mutualism activity with the crocodile and bird as something that captivated students in particular. "With middle school kids, keeping them interested in participating is a science," she points out. "If I'm a seventh grader, I'm thinking, 'This is so cool.' It's much cooler to look at it on a screen than read about it. Kids loved it." Students were visibly excited on laptop day, she says, and English-language learners and students who'd typically give teachers the hardest time were the ones who were most excited and willing to learn.

Teacher growth also was apparent. "They learned their subject much better," Moreno says. "They also learned classroom-management techniques and looked at how their students learned. They asked themselves, 'When Adaptive Curriculum and the laptops are gone, how am I going to keep students engaged?'"

The program's assessment feature revealed how much students had learned, and it suggested to teachers where the lesson should go next. Teachers loved the curriculum's support pages, which helped them navigate through the material and understand how much time it would take to give students the requisite knowledge they needed.

The Metro Nashville Public Schools are using Ford PAS. One of the projects Metro Nashville uses has students create a business plan for an imaginary rock band that starts in a garage.

Students look at how to market the band and how to

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Another benefit of project-based learning is that it helps students learn to collaborate and solve problems in a team environment.

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Project-based learning ...

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hire personnel. They also write a business plan. Later, students must write a business plan for starting a small community business like a barber shop, and they build on the skills they learned in the first project.

Another project has ninth graders looking at a company that is bringing Japanese food to the fast-food market. Students work on advertising and communication models for the company, then write a business plan and present it to bankers from the community. Such projects tie in the elements of critical thinking, problem solving, teamwork, and communication that form the basis of Ford PAS.

Students respond much better to the projects than teachers, says Donna Gilley, career and technical education coordinator and a Ford PAS trainer for the Metro Nashville schools. Students are "resilient, they're used to change," she explains. And "younger teachers respond better. It's the more experienced teachers who are used to teaching from a book and giving a test on Friday" who are hardest to convince.

Getting buy-in from the teachers is not a cinch, at least initially. "It's a cultural change, a shift for some teachers," Gilley says. To facilitate the shift, the district conducts three-day Ford PAS training sessions, with a goal of teaching broader strategies. "We're not trying to train 400 Ford PAS teachers. We're trying to train our teachers to be more project-based, inquiry-based," she explains.

Over the course of three days during the summer, the program brings teachers through the Ford PAS activities they will be teaching. Then, teachers are taken on industry visits.

"We've gone to Dell and others, and I ask [industry executives] to talk to teachers about what it takes to get and keep a job in their industry. They always say team building, communication, critical thinking.... That's when teachers begin to believe what we say. It has been the most successful part of the training," Gilley says. "Teachers are just like kids: You tell them something, and they don't believe it, but bring in someone from the industry to say it, and they say, 'Oh, it must be true.'"

The epitome of project-based learning

High Tech High began in 2000 as a single charter high school launched by a coalition of San Diego business leaders and educators. It has since evolved into a school development organization with a growing portfolio of schools spanning grades K-12. High Tech High focuses on a personalized, project-based learning environment in the hopes of combating the twin problems of student disengagement and low academic achievement.

"We want to closely connect what we do with what's happening outside the school," says High Tech High's Riordan. "We try to develop a way of looking at curriculum and language that cuts across courses and applies to all courses and all kids."

Project-based learning facilitates interaction between adults and students. "With project-based learning, you have teachers designing the projects and putting themselves in a position of co-inquirer. The students and teachers are doing real work beside each other," Riordan says.

Technology is an important feature of the school's environment, but it is not the main subject of the school. Rather, students use a variety of technical and technological tools to design and create products in math, humanities, and science.

One ninth-grade physics project, called "So You Want to Be a Millionaire," had pairs of students designing a product that uses electricity. At the same time, students were studying 21st-century media and looking at advertising and public-relations campaigns. They used the knowledge they were learning about media to create a business plan with a target audience and a marketing plan for their product. Students then exhibited their products, and five of them were chosen for presentation in front of a panel of venture capitalists. One of those products is now in production with a local company.

"We don't want our students to tell you that they had math first period and chemistry second period," says Riordan. "We want them to talk about a piece of work they're doing that they're invested in. We encourage kids to pursue their interests; we aspire to have kids explore interests through projects as a way to make connections to the world beyond school." eSN

LINKS:

Adaptive Curriculum
http://adaptivecurriculum.com

Buck Institute for Education
http://www.bie.org

Education Development Center
http://main.edc.org

Ford Partnership for Advanced Studies (Ford PAS)
http://www.edutopia.org/project-based-learning-research

High Tech High
http://www.hightechhigh.org

Isaac Middle School
http://www.isaacschools.org/ims/programs.htm

Key Curriculum Press
http://www.keypress.com

Metro Nashville Public Schools
http://www.mnps.org

PASCO Scientific
http://www.pasco.com

Project-Based Learning
http://pbl-online.org

Technology Based Learning and Research at ASU
http://tblr.ed.asu.edu

'This all sounds great ... but does it work?'

That's the question that John Mergendoller, executive director of the Buck Institute, hears often. His response is a resounding "yes." But measuring project-based learning can be a challenge. If an English teacher and a math teacher both do a project, and one lasts a week while the other lasts a month, those projects will look very different, Mergendoller points out.

Anecdotal evidence suggests that teachers believe project-based learning helps students develop higher-level thinking skills. Students also become more actively engaged in the learning process.

"Because project-based learning focuses on real things, an aspect of life that you can analyze, it's motivating and it grabs students," says Peter Rillero, associate professor of science education at Arizona State University. Students learn and retain more knowledge, teachers say—knowledge that is applicable to the real world.

Hard data also show that project-based learning can be effective. Research suggests that students who engage in hands-on activities at least once a week score significantly higher on standardized tests of science achievement than students who don't. To apply this concept to virtual experiences, Sebit LLC, developer of Adaptive Curriculum, executed a pilot program to explore the effects of hands-on learning through Adaptive Curriculum on sixth-grade students' science knowledge.

The study, which focused on 71 students who used Adaptive Curriculum and 46 who did not, found that students in the Adaptive Curriculum group had a 49.5-percent increase in their science assessment scores from pretest to post-test. (Students in the control group had negligible gains.)

Another study, conducted in 1997, showed that students at a project-based British secondary school performed better on math problems requiring analytical or conceptual thought than students at a school that used more traditional, direct instruction.

Technology, too, has been found to play a valuable role in project-based learning. In a five-year study of students involved in the Challenge 2000 Multimedia Project—which had students complete interdisciplinary, multimedia projects that integrated real-world issues and practices—students using technology to create presentations aimed at a particular audience outperformed their peers who did not use technology in areas such as communication, teamwork, and problem solving. —J.N.

LINK:
Challenge 2000 Multimedia Project
http://www.ed.gov/pubs/edtechprograms/multimediaproject.html

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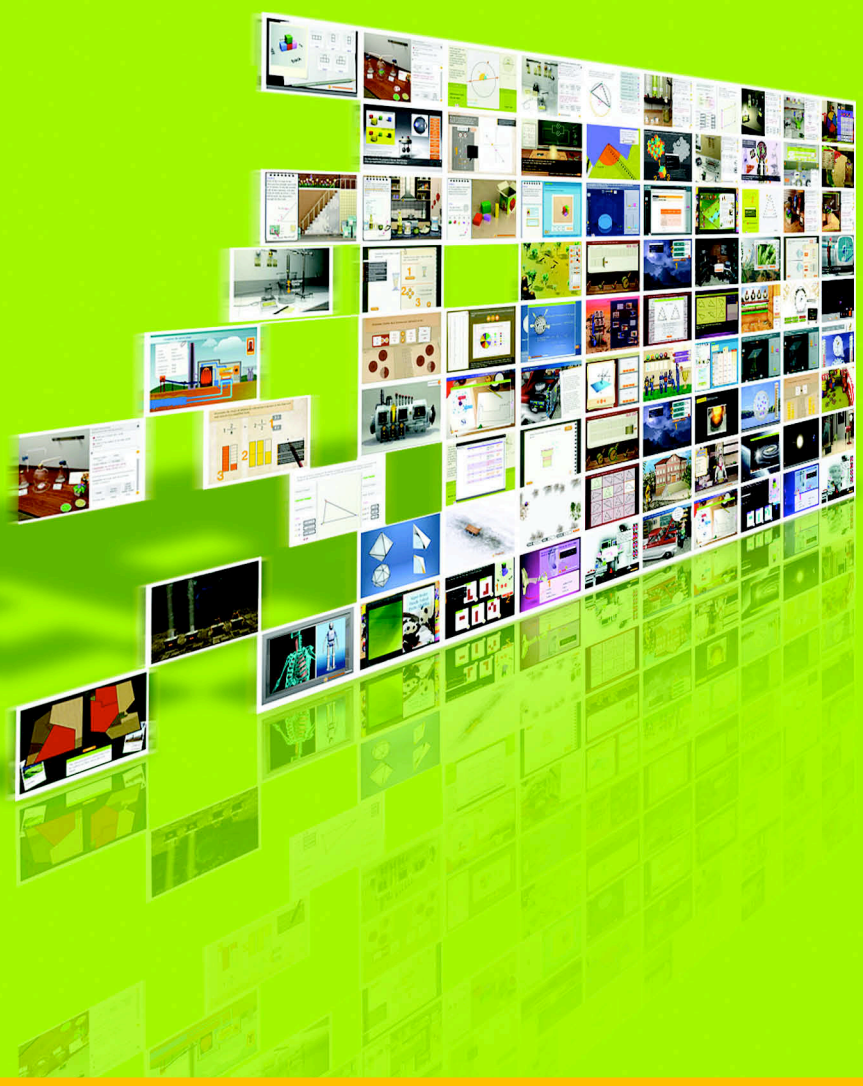

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