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WISE Science

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Have you ever built a house in the desert? Or helped control the spread of malaria? Project WISE creates challenging Web-based science activities that are flexible and adaptable for elementary, middle, and high school.

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How can we bridge the barrier between research innovations and their adoption in science classrooms? Too often, educational research demonstrates exciting learning gains for local students but never reaches schools outside the initial research partnership.

A partnership of classroom teachers, technologists, natural scientists, and pedagogical researchers has designed a flexible learning environment that makes teachers more effective in their classrooms and enables them to respond creatively to state standards, prior student experiences, time commitments, and available resources. New groups of teachers and schools can bridge the gap between educational research and classroom practice by using the Web-based Integrated Science Environment (WISE) project library.

Partnerships supported by the National Science Foundation and others have created a library of WISE projects. These partners have designed pilot projects, observed their use in science classrooms, and refined the projects on the basis of their observations. WISE projects can be improved by teachers, tailored to their course topics, and connected to local conditions and to state and national standards.

Schools and individual teachers can join WISE by going to the Web site (http://wise.berkeley.edu) and selecting activities for their classes from the project library. Classes—using only a Web browser and an Internet connection—can register to use WISE at school or at home. A video of teachers using WISE and a book called *Computers, Teachers, Peers* (Linn & Hsi, 2000) are also available.

The Design Framework

The WISE learning environment implements design principles to promote lifelong science learning along with language and technology literacy (Linn & Hsi, 2000). These principles reflect the scaffolded knowledge integration framework, as well as cognitive apprenticeship (Collins, Brown, & Holum, 1991), intentional learning (Scardamalia & Bereiter, 1991), and the traditions of constructivist psychology. The design framework—developed from 15 years of classroom research—helps students connect, refine, and revisit all their science ideas rather than isolate and forget the science that they have studied in school. We organize the design framework around four design strategies.

Make science accessible. WISE design partnerships seek an appropriate level of analysis for the scientific content of a project so that students can restructure, rethink, compare, critique, and develop more cohesive ideas. The WISE curriculum uses scientific models that students can easily grasp and connects these models to personally relevant problems. The WISE learning environment represents the scientific inquiry process through an inquiry map, which leads students through inquiry steps, providing cognitive and procedural guidance along the way.

Make thinking visible. WISE partnerships make scientific arguments more visible by carefully designing interactive simulations, model-building environments, and argument-representation tools. WISE projects use embedded assessments to make student thinking visible and to engage students as designers (diSessa, 2000).

Help students learn from one another. WISE projects use collaborative tools—such as online discussions, peer review, and debate—to help students take advantage of classmates' ideas. Online tools enable all students to participate in the deliberations of science, allowing equitable access to the discourse and rhetoric of science (Hoadley & Linn, in press; Hsi, 1997).

Foster lifelong learning. To help students become lifelong science learners, students critique Web sites, design arguments, or debate science controversies, such as the reasons for the observed decline in amphibian populations. Students reflect on scientific materials including Web sites (Davis & Linn, in press).

Design Studies

WISE classroom research combines the features of Japanese lesson studies (Lewis & Tsuchida,1997; Linn, Tsuchida, Lewis, & Songer, 2000) and design experiments (Brown, 1992; Collins, 1999; diSessa, 2000) in what we call *design studies* (Linn, in press). The effectiveness of a curriculum project can increase by as much as 400 percent using this approach (Linn & Hsi, 2000).

In our customization research, teachers have made WISE curriculum projects locally relevant to students in diverse geographical or demographic areas, have made projects more successful on the basis of classroom trials, and have tailored instruction to personal practices.

Houses in the Desert

In the Houses in the Desert project, students collaborate with a partner in designing a house that is comfortable for living in the desert. The project, created by physical-science experts, teachers, and educational researchers, is targeted to the middle school level. Students create a preliminary design and then critique several Internet sites advocating varied energy-efficient house designs. Next, they analyze alternate materials for designing walls, roofs, and windows, and they specialize in one housing component. Students revise their preliminary designs, perform a heat-flow analysis, and submit their design for peer review.

After reviewing peer comments, they finalize and publish their desert-house designs on a secure class Web site. In the course of this project, students gain science and language literacy by critiquing Web sites, collaborating in design, and contributing to peer review. They gain technology literacy by searching for relevant materials on the Web and using design tools.

To make thinking visible, the project uses animated representations of heat flow through building materials, such as wood or glass, which enables students to distinguish insulators and conductors. The project also illustrates the interaction between air and ground temperature during day and night in the desert. To make the science accessible, the project connects to real-life experiences; for example, students use the heat-flow model to compare designs for picnic coolers and to discuss how to keep a drink cold in their lunch box. To promote lifelong learning, the project helps students critique Web sites, formulate critical questions, and develop arguments to support design decisions. Finally, to help students learn from one another, the project orchestrates peer review of designs, helping students develop a set of shared criteria for evaluating house designs.

To help teachers make the project relevant to their students, the partners included a Web site where students could compare climate data in a desert to the climate in any specified location, including their own school. Students reflect on how their climate is different from that of the desert. Teachers also add Web sites that feature local house designs—for example, students in some classes explored a solar house in Maine—making the project more relevant and engaging.

Plants in Space

In the Plants in Space project, students construct a small hydroponic garden in their classroom, analyze factors responsible for plant growth (such as light, water, and soil), compare the growth of earth plants and Wisconsin Fast Plants (referred to as NASA space plants), and analyze what factors are important for plant growth in a space-station environment. NASA scientists, research biologists, teachers, educational researchers, and technology specialists designed the project. Web-based materials bring the space station to life and raise questions that are relevant to elementary students: Can we grow plants without dirt?

To make science accessible, students explore a personally relevant problem and investigate their ideas about plant growth. Students asked, Do plants eat dirt? To help make thinking visible, students represent plant growth through online graphing. To promote lifelong learning, students reflect on the Web evidence, record observations about the plants in their own minigardens, and report on their recommendations. To help students learn from one another and from experts, the project includes online discussions with NASA scientists about the challenges of growing plants in space.

Teachers can customize the hints, prompts, discussions, and even the focus of the project—for example, they can choose whether to emphasize plant-growth factors or conditions aboard the space station. After first using the Plants in Space project, one 5th grade teacher added Internet materials about photosynthesis, enhanced online discussions about light and energy, and revised the hints and prompts. The students using the second version developed a more coherent understanding of plant growth as a result (Williams, 2000).

Cycles of Malaria

In the Cycles of Malaria project, students debate three different perspectives on how to control malaria worldwide: developing an effective pesticide that targets the anopheles mosquito; developing a vaccine against the disease; and creating social programs that reduce exposure to mosquitoes, such as distributing mosquito nets or having community cleanups. Students explore evidence related to each control method and debate alternate approaches. The project is targeted at upper-middle and high school biology students and has been customized by advanced-placement biology teachers.

To make thinking visible, the project includes animations and videos of the mosquito and parasite life cycles, as well as maps showing the worldwide incidence of malaria. To make the project accessible to students, teachers draw connections to diseases in North America, such as HIV or sickle-cell anemia. The project promotes lifelong learning by helping students understand scientific viewpoints, evaluation of evidence, and policy trade-offs. To learn from others, students participate in asynchronous electronic discussions with peers and engage in class debates.

Cycles of Malaria has been customized by teachers working in a wide range of grade levels and topic areas and with diverse teaching approaches. These teachers added activities and varied their patterns of interaction with students. Middle school biology teachers included field trips to local ponds or puddles to collect mosquito larvae. Another teacher added a short story about the struggles of the family of Kofi, a young African villager with malaria. Norwegian teachers connected the material to international policies for DDT use. A high school chemistry teacher focused on the chemical compounds within the DDT pesticide and how they affect the environment.

To determine whether WISE is robust enough to support these diverse customizations while retaining the instructional framework, we contrasted the adaptations of Cycles of Malaria by three different teachers in a middle school that has implemented WISE in every science class. We found that teachers varied greatly in the frequency and duration of their interactions with students during the project. One teacher spent considerable time talking in depth with each student group, visiting groups once, at most, during a class period. Another teacher interacted for very short periods of time but visited each group several times.

Although WISE strives to enable teachers to interact deeply with their students, we were gratified that WISE accommodated even these major differences in teaching practice. Students were challenged to reflect and make connections to rich problem contexts. For example, in the post-assessment for the Cycles of Malaria project, teachers measured the improvement in students' understanding of disease vectors, vaccines, life cycles, and medical research. Students connected applications to personally relevant situations (such as traveling to a foreign country) and transferred ideas to novel situations (such as advising a small country on a pending law to clean up standing water around all rural villages). Students in all three classes showed identical, substantial learning gains. The assessments were sensitive to teaching styles as well. For example, students who had longer interactions with their teacher gave more coherent answers to complex questions. This research helps us understand how diverse teaching approaches influence outcomes and how curriculum designs can meet the needs of diverse teachers.

Three Literacies

WISE promotes lifelong learning by addressing three mutually reinforcing literacies: technology, science, and language.

Technology Literacy. We base our definition of technology literacy on the National Academy of Sciences report on what everyone should know about information technology (Snyder et al., 1999). The WISE curriculum interweaves technology with science instruction, targeting three complementary aspects of technology literacy. First, students learn to use technology in complex, sustained problem solving—identifying unanticipated consequences, searching for relevant information, communicating, collaborating, and critiquing. Second, students learn contemporary skills, such as using e-mail, the Internet, word processing, and spreadsheets. Third, students learn the concepts of technology, such as modeling, simulations, and the societal impacts of technology.

WISE helps students develop technology literacy in school instead of relying on inequitable home access (American Association of University Women, 2000). More students are developing fluency with information technology at home. They join chat rooms, play networked versions of games, do homework on word processors, and use graphics and drawing tools. These experiences prepare many students to use technology in the classroom, but they also divide students along economic lines.

WISE remedies these inequalities by incorporating technologies for tomorrow's workforce in the classroom. In many schools, students come with a good understanding of digital media, only to find that their teachers employ an old-fashioned, low-tech presentation of science and other topics. Schools often relegate computers to a lab space where they are used for "skills training" or extracurricular project work rather than for universal technology literacy. This disconnect between technology in the home and technology in the classroom contributes to the increasing sense of irrelevance and disinterest that students feel about science instruction.

Science Literacy. Science literacy requires reconsidering scientific ideas and seeking a more coherent understanding of them. To respond to rapid increases in science knowledge, frequent job changes, and consequential policy debates, citizens must constantly update their science knowledge. Nutritional decisions (Is butter or margarine more healthy?), environmental decisions (Should I choose paper or plastic?), and political or economic issues require citizens to revisit their ideas as well as critique contradictory, persuasive messages in the popular press and on the Internet. Schools can no longer cover all the science topics that students will use in their lives, so we must motivate students to continue to learn. WISE projects connect to relevant issues—such as space exploration, environmental stewardship, and wilderness survival—to set students on a path toward lifelong learning.

Language Literacy. Lifelong science learning depends on a critical reading of science material, effective communication about science issues, and clear writing about science topics (Heath, 1983). In WISE, students communicate about scientific topics, evaluate scientific texts, ask questions about science policies, participate in debates about contemporary controversies, and create and critique arguments.

WISE Conclusions

Students need opportunities to independently explore complex problems, to flounder, to learn from their peers, to reflect on their experiences, and to become responsible stewards of their own learning. This linked, coherent learning only arises when science instruction presents students with theories and principles that they can connect to personal experiences, interests, and past instruction.

The process of thinking about science, reorganizing ideas, incorporating new information, and remaining skeptical of evidence is both difficult and exhilarating. If we convert the science curriculum to a lifelong learning enterprise, we can capture that exhilaration. This approach can amplify the rewards that teachers feel when they teach students about science and can also increase the opportunities for researchers to make science instruction effective and successful.

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We invite those concerned about science education to visit the WISE Web site (http://wise.berkeley.edu) for more details.

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The WiSE program is a groundbreaking effort to increase the representation and success of women in science and engineering at USC through a series of creative programs that enable women to thrive at every stage of their careers. Committed to developing fresh approaches to policies and to building a supportive environment for both women and men, the WiSE program is driving USC to the leading edge of diversity in science and engineering. Learn more about WiSE. Our Programs. The World Islamic Sciences and Education (WISE) University and the Turkish Ibn Haldun University signed a memorandum of understanding (MoU) to promote academic ties and encourage researchers from both universities to conduct joint projects and studies. The memorandum was signed by President of WISE University Professor Salman Al Bdour and President of the Ibn Haldun ... WISE Membership gives you access to the Ten Steps, a unique and evidence-based consultancy-led program proven to improve diversity & inclusion at all levels.Â Diversity & Inclusion Changemakers Since 1984. Let WISE support you with your Diversity & Inclusion journey. WISE is a Community Interest Company which provides Business to Business (B2B) services to get more women into all levels of science, technology, engineering and maths (STEM) roles. Project WISE creates challenging Web-based science activities that are flexible and adaptable for elementary, middle, and high school. Discover the world's research. 20+ million members.Â In our review of software tools, we identified several systems with features designed to support learners by providing ways to help them keep track of where they were in an overall plan.