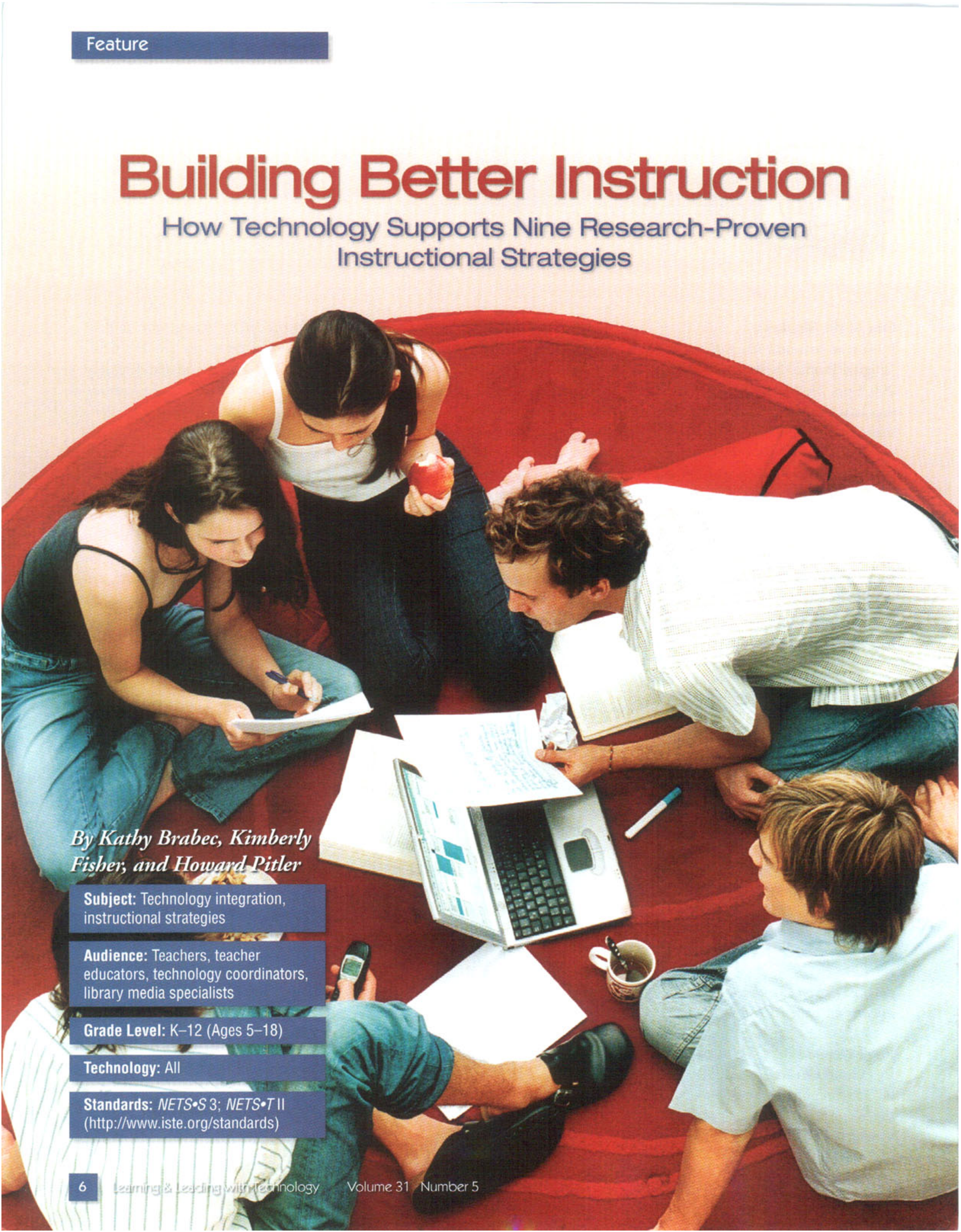


Building Better Instruction

How Technology Supports Nine Research-Proven Instructional Strategies



By Kathy Brabec, Kimberly Fisher, and Howard Pitler

Subject: Technology integration, instructional strategies

Audience: Teachers, teacher educators, technology coordinators, library media specialists

Grade Level: K-12 (Ages 5-18)

Technology: All

Standards: NETS•S 3; NETS•T II (<http://www.iste.org/standards>)

Findings from a single research study can tell us a lot, but a meta-analysis of findings from a number of studies can tell us even more. In *A Theory-Based Meta-Analysis of Research on Instruction*, Robert J. Marzano analyzed the results of more than 100 research reports on instruction, involving more than 1.2 million subjects. The goal of the analysis was to identify those instructional strategies that have a high probability of enhancing student achievement for all students in all subject areas at all grade levels. (*Editor's note:* See Resources on p. 11 for book and other information.)

Based on this meta-analysis, Marzano, Debra Pickering, and Jane Pollock identified and subsequently reviewed nine categories of instructional strategies that are most likely to lead to enhanced student achievement in their book, *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement*. Many teachers are using these strategies, and they are asking how technology can be integrated with these strategies to improve student learning. In this article, we review the research-based instructional strategies and give concrete examples of readily available technology that support them.

Nine Strategies

1. Identifying Similarities and Differences. Classroom practices associated with identifying similarities and differences include comparison tasks, classifying tasks, and the use of metaphors and analogies. For example, you might ask students to compare ideas or objects, classify or group items into categories, or use a metaphor or analogy to see how seemingly dissimilar things are related.

2. Summarizing and Note Taking. These strategies are clustered as part of the same instructional category because both require students to distill information. Summarizing requires students to analyze information at a fairly deep level, thus strengthening their understanding.

Students can summarize information in different ways, including deleting information that isn't critical to the overall meaning of the text, substituting some information, and keeping some information.

Note taking is similar to summarizing because students must first determine what is most important and then state that information succinctly.

3. Reinforcing Effort and Providing Recognition. These strategies deal with students' attitudes and beliefs. Students who believe the amount of effort they put into a task increases their achievement actually do better, according to Marzano, Pickering, and Pollock. Many students aren't aware of the importance of believing that their level of effort is related to their achievement. But you can explicitly teach this and share examples with students. You can help students understand the role of effort and how important it is in their learning by asking them to track their effort and achievement using rubrics or charts.

It is equally important to reward students for achieving specific goals. Though there are many ways to tell a student he or she has done well, recognition is most effective when it is abstract (e.g., praise) or symbolic (e.g., tokens such as coupons or stickers) and contingent on students' attaining specific performance goals.

4. Homework and Practice. Homework and practice are considered

together because both provide opportunities for students to deepen their understanding and strengthen their skills. In terms of homework, one vital point to consider is the importance of establishing a homework policy and being sure students and parents understand it. Similarly, it's important to ensure that the purpose of assignments is clear.

Mastering any skill takes lots of practice. In fact, research referenced in Marzano, Pickering, and Pollock's book indicated students need to practice a skill 24 times to reach 80% competency, with the first four practices yielding the greatest effect.

5. Nonlinguistic Representations. The primary way teachers present new knowledge to students is through speaking and reading. But psychologists theorize that humans store knowledge in two forms: linguistic and nonlinguistic—words and images.

Nonlinguistic representations of knowledge can take a variety of forms, including graphic representations, physical models, mental pictures, drawings, and kinesthetic classroom activities. A number of studies indicate that each of these types of activities helps students to develop nonlinguistic representations that enhance their understanding of content (see *Classroom Instruction That Works*, pp. 73–74, for a list).

6. Cooperative Learning. Grouping students for cooperative learning activities can be a very powerful instructional strategy. Informal, ad hoc groupings may last only a few minutes or an entire class period. More formal groupings for cooperative learning may last a few days or weeks, as defined by a unit of study. Coop-

erative groups designed for support, sometimes called “base” groups, may last the entire semester or school year. See the Cooperative Learning Center at the University of Minnesota Web site for more on cooperative learning.

7. *Setting Objectives and Providing Feedback.* Setting objectives establishes a direction for learning. Once students understand the parameters of an objective, they should brainstorm to determine what they know and what they want to learn. Specific, timely, and regular feedback to students enhances their learning. Also, feedback should include an explanation of why an item is correct or incorrect and be criterion referenced. In other words, students should understand where they stand relative to a specific target of knowledge or skill.

8. *Generating and Testing Hypotheses.* The strategy of generating and testing hypotheses is effective because it requires students to apply their knowledge and thus deepens their understanding. Several processes encourage students to generate and test hypotheses, including systems analysis, invention, experimental inquiry, decision making, and problem solving. Within this strategy, students plan and conduct simple investigations (e.g., formulate a testable question, make systematic observations, and develop logical conclusions).

9. *Cues, Questions, and Advance Organizers.* These tools give students a preview of what they are about to learn or experience and thus help activate students’ prior knowledge. Cues and questions should focus on what is central and important, as opposed to what is unusual. Higher-level questions can deepen students’ learning, because they require students to restructure information or apply knowledge. Advance organizers are most useful with information not easily presented in a well-

organized manner. For example, creating an advance organizer for a field trip can provide students with information about what they are about to see and do.

Note in the table on p. 9 how strongly these can affect student achievement. Translating effect sizes into percentile gains makes the potential benefits of a given instructional strategy clearer and more dramatic.

Supportive Technologies

Technology should always be viewed as a tool, rather than an end in itself. However, many times, a single technology application or process will help address a number of different instructional strategies. This section explores examples of such technology.

Word Processing. Almost all teachers have access to a word processing program. The rubric on p. 9 was created using Microsoft Word’s Table feature. Students might use a rubric like this to rate their effort and achievement on particular assignments and keep track of these ratings over time. They might then use Word’s Graph Chart feature to better see the relationship between their effort and achievement.

An English teacher might use an advance organizer to facilitate the writing process. You could first use the organizer to help students select a writing topic. Students would identify five possible topics, which they would add in the circles; they would then identify at least three facts about each topic, which they would add in the squares. Using an organizer like this can help students make better topic choices. After students select a topic to write about (e.g., endangered animals), they can use the same advance organizer to develop the introduction, three supporting paragraphs, and the conclusion.

Word processors can be excellent tools for summarizing. One approach frequently used is to delete informa-

tion that isn’t critical to the overall meaning of the text, substitute some information, and keep some information. Using the Track Changes tool in Word, students can easily delete words and phrases, view the revised text, and make changes as needed.

Technology can also be a helpful tool for analogies. You could create an analogy task template using the drawing tools in a word processing program. Once the template is created, you or your students can easily change the text.

Using the annotation feature in Word allows for peer editing and helps facilitate an ongoing dialogue between teacher and student, providing timely feedback.

Microsoft Word and PowerPoint also can be used to create graphic organizers. You can use the Organization Chart feature to illustrate two common structures for organizing information.

Web Resources. The High Plains Regional Technology in Education Consortium (HPR*TEC) has a range of excellent online tools for teachers. NoteStar, for example, allows teachers to create online research projects for their students. Students can then use NoteStar’s features to take notes from online sources and organize their notes by topic or subtopic. NoteStar automatically embeds the Web site annotation into each note. NoteStar also enables students to summarize easily. Students can copy and paste directly from a Web site and add their own information, making sure to note which information is quoted and from where.

Another HPR*TEC resource is RubiStar. This online resource provides generic rubrics that can be printed as is or customized. Rubrics can be excellent tools in setting objectives and providing feedback. Find a great rubrics library online at Discovery School.

To help students understand the roles and responsibilities involved in cooperative grouping, you might encourage them to create a rubric to assess their group's effectiveness in working together. Find rubrics related to cooperative learning skills on the University of Northern Iowa's professional development Web site. These rubrics can serve as references for students as they construct their own rubrics.

You might find it helpful to study the Web sites of textbook publishers, which often include statements of general concepts, organized by chapter and unit. Suggested activities can provide cues for students to activate prior knowledge and anticipate new content; unit and chapter outlines available on these sites also can serve as advance organizers. Some great examples include Glencoe, Harcourt, and Macmillan/McGraw-Hill. Many education publishers have Web sites that support their texts. Don't overlook these valuable resources.

A unit strategy that promotes cooperative learning and generating and testing hypotheses is the Web-Quest. Not to be confused with a Web scavenger hunt, a WebQuest is an organized activity following a specific model. Visit Bernie Dodge's WebQuest Page for an overview of this model and hundreds of Web-Quests, organized by grade level and discipline.

Homework policies and daily assignments can be posted on a school's Web site for easy access. Also, for a fee, several companies host school and teacher Web pages (e.g., eBoard.com, Myclass, and Blackboard).

Organizing and Brainstorming Software. Software for these activities can be integrated into a number of the instructional strategies. For example, Kidspiration, Inspiration, and Kid Pix offer great graphic organizers for identifying similarities and differences. These applications come with

Effectiveness of Nine Strategies		
Category	Average Effect Size	Associated Percentile Gain
Identifying similarities and differences	1.61	45
Summarizing and note taking	1.00	34
Reinforcing effort and providing recognition	.80	29
Homework and practice	.77	28
Nonlinguistic representation	.75	27
Cooperative learning	.73	27
Setting goals and providing feedback	.61	23
Generating and testing hypotheses	.61	23
Cues, questions, and advance organizers	.59	22

When conducting a meta-analysis, the results of a given study are translated into a unit of measurement referred to as an *effect size*. An effect size is a measure in standard deviation units of the increase or decrease in achievement of the experimental group. An effect size can also be translated into percentile gains. Table is adapted from *Classroom Instruction That Works* (p. 7), by R. J. Marzano, D. J. Pickering, & J. E. Pollock.

Effort		Achievement	
4	I worked on the task until it was completed. I pushed myself to continue working on the task even when difficulties arose or a solution was not immediately evident. I viewed difficulties as opportunities to strengthen my understanding.	4	I exceeded the objectives of the task or lesson.
3	I worked on the task until it was completed. I pushed myself to continue working on the task even when difficulties arose or a solution was not immediately evident.	3	I met the objectives of the task or lesson.
2	I put some effort into the task, but I stopped working when difficulties arose.	2	I met a few of the objectives of the task or lesson but did not meet others.
1	I put very little effort into the task.	1	I did not meet the objectives of the task or lesson.

Scale: 4 = excellent 3 = good 2 = needs improvement 1 = unacceptable

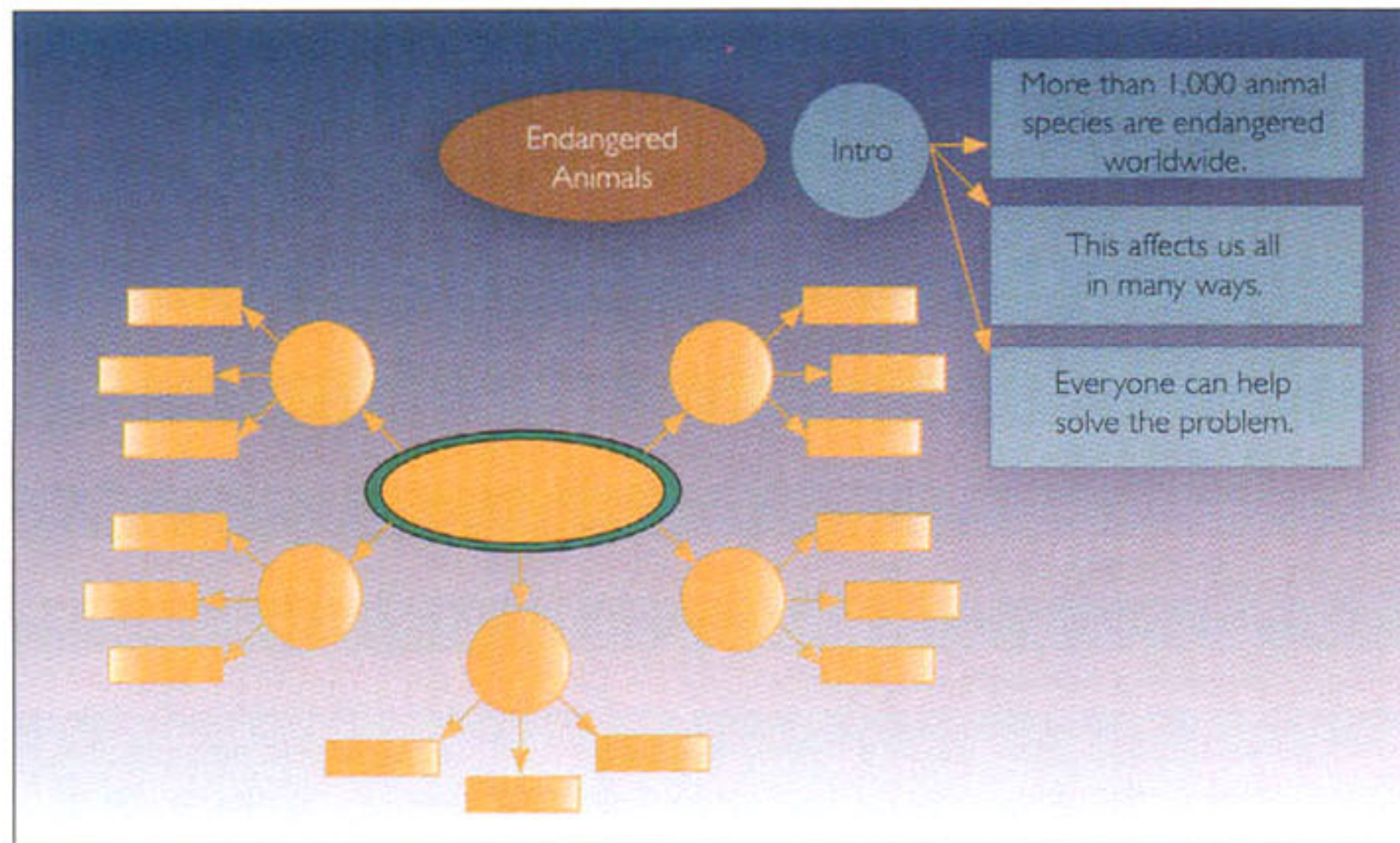
An effort and achievement rubric. Adapted from *Classroom Instruction That Works* (p. 52), by R. J. Marzano, D. J. Pickering, & J. E. Pollock.

templates that allow younger students to drag pictures and older students to type words into the appropriate boxes as they sort, classify, and compare items. Students can also create Venn diagrams and comparison tables.

Inspiration is another great resource for classroom activities that require students to summarize text. Rapidfire is a brainstorming tool within Inspiration that allows teachers

and students to quickly and automatically create concept webs. In particular, teachers can show students how to use the Rapidfire feature to create a summary web. With a single click of a button, students can switch between concept web and outline views. This approach also reinforces nonlinguistic representation.

You also might use Inspiration to construct a KWHL chart, which



An example of a teacher-provided advance organizer.

students can use to answer the questions: What do you know? What do you want to know? How will you find out? What did you learn? KWL charts can be used to set goals and provide feedback to students.

Students can use a program such as TimeLiner for several strategies, especially summarizing and note taking, advance organizers, and nonlinguistic representation.

Data Collection Tools. Handheld devices and appropriate software give teachers and students the mobility to collect, share, and analyze data. The Palm Web site spotlights several success stories. These examples show how PDAs help teachers and students generate hypotheses, take notes, identify similarities and differences, and provide immediate feedback.

Students can use several tools to formulate and test their hypotheses. Scientific instruments from companies such as Vernier allow students to collect real-time data. Students can use probes with provided templates and experiments to test hypotheses in real-world settings. Vernier probes also connect to Texas Instruments scientific calculators.

Scalar and others make USB microscopes that capture still images and movies and save them to the

computer. These images can be used to create nonlinguistic representations of science concepts.

Health and physical education teachers can use instruments such as pedometers and heart rate monitors to collect data on student activity levels to generate and test hypotheses about exercise and health. One good example is the Digi-Walker.

Multimedia. Nonlinguistic representation is a natural match for digital media creation. Software tools such as iMovie and Windows Movie Maker allow students to create and share video presentations that illuminate concepts or tell stories in unique or compelling ways. Digital still cameras allow students to capture visual phenomena easily, such as photographing plants at various growth stages. Find examples of excellent digital still and video projects online at the Apple Learning Interchange (ALI).

Presentation tools such as PowerPoint and HyperStudio can support the use of all nine strategies. These programs contain templates that make it easy to get started in multimedia creation. You can use presentation software to model appropriate use of the strategies for students and colleagues. Students can use presentation software to summarize the

Earth's land surfaces are also in motion. For example, the North American continent continues to move west over the Pacific Ocean basin, roughly at a rate equal to the growth of our fingernails. Earthquakes result when plates grind past one another, ride up over one another, collide to make mountains, or split and separate. These movements are known as plate tectonics. Developed within the last 30 years, this explanation has unified the results of centuries of study of our planet, long believed to be unmoving.

Source: Original text from *Solar System Bodies: Earth*, by NASA. See <http://sse.jpl.nasa.gov/features/planets/earth/earth.html>.

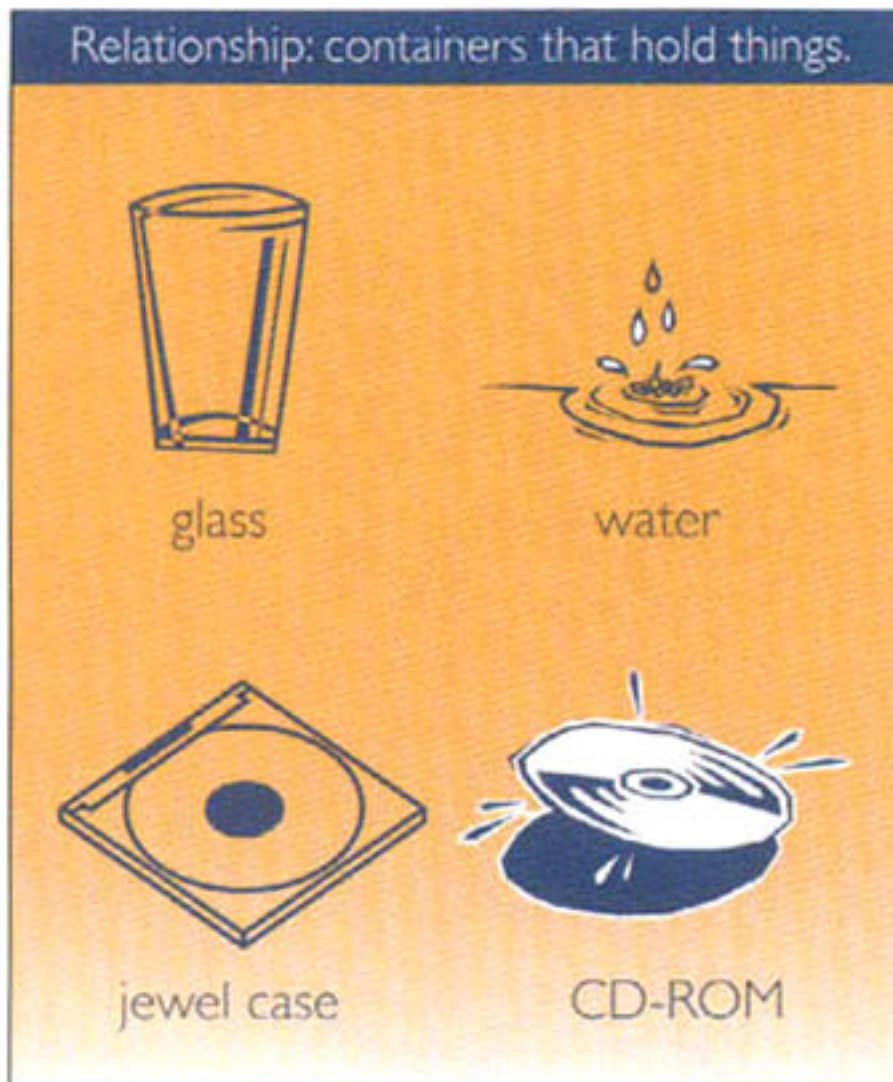
Summarizing text using Word's Track Changes tool.

main idea of a unit or research paper and present it to an authentic audience. Many teachers find cooperative learning to be an ideal strategy for the creation of multimedia projects. Find a Grade 2 student project about geometric shapes using PowerPoint online at ALI's student project site.

Strategies Applied

The nine instructional strategies reviewed in this article are most successful when students learn to apply them consistently themselves. You should first model the use of the strategies and then assist students in learning and practicing them. As you create lesson plans, consider using three approaches in incorporating the effective strategies.

1. *Focus on the strategies.* A teacher decides to concentrate on the strategy of setting goals and providing feedback. He then identifies lessons where the strategy applies and determines how technology can be integrated into the lessons.
2. *Focus on the available technology.* Although technology use shouldn't trump content or strategy, it can be used to lead the way in lesson planning. For instance, a primary teacher preparing to teach the concept of a community might



You can use drawing tools to create analogy tasks.

inventory available technology and discover that PowerPoint and a computer projector are readily accessible. She decides that the strategies of setting goals and identifying similarities and differences are compatible with using a computer projector in a whole-class situation. For the goal-setting activity, she constructs and shows a PowerPoint slide show that illustrates the big ideas in the community unit. After students have examined several examples of communities, she uses graphical organizer or concept-mapping software, such as Kidspiration, in a whole-class activity during which students determine how the communities studied are similar and different.

3. *Focus on the unit.* A teacher presenting a unit on the Lewis and Clark expedition decides that many of the strategies and available technologies can be integrated in the unit. For example, he decides to integrate summarizing and note taking using word processing and Web features, identifying similarities and differences using Venn diagrams, and nonlinguistic representations using graphic organizers. Starting with a unit focus is the most ambitious approach. Teachers who are comfortable us-

ing multiple technologies in a unit find this approach a good way to incorporate instructional strategies throughout that unit.

Conclusion

Millions of dollars are spent annually on classroom technology, but having technology available in classrooms is only half the battle. The classroom strategies we have outlined here provide guidance and tools for helping students increase their capacity for learning in a deliberate and focused way. We've suggested ways to integrate technology in the implementation of those research-based classroom strategies and ways to apply the strategies consistently.

Lesson planning should focus first on content and classroom strategies, then on ways in which technologies can enhance the lesson. Building lessons on a solid, research-based foundation of effective strategies, adding appropriate technologies, and consistently applying those strategies should help ensure high-quality instruction that has the potential of maximizing student achievement.

Resources

Books

- Marzano, R. J. (1998). *A theory-based meta-analysis of research on instruction*. Aurora, CO: Mid-continent Research for Education and Learning.
- Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Alexandria, VA: Association for Supervision and Curriculum Development.

Education Publishers

- Glencoe: <http://www.glencoe.com>
- Harcourt: <http://www.harcourschool.com>
- Macmillan/McGraw-Hill: <http://www.mmhschool.com>

Hardware

- Digi-Walker: <http://www.digiwalker.com>
- Scalar: <http://www.scalaramerica.com/USB.htm>
- Texas Instruments: <http://www.ti.com>
- Vernier: <http://www.vernier.com>

Software

- HyperStudio: <http://www.hyperstudio.com>
- Inspiration/Kidspiration: <http://www.inspiration.com>
- TimeLiner: <http://www.tomsnyder.com>

Online Tools

- Apple Learning Interchange (Grade 2 student project): http://ali.apple.com/ali_sites/deli/exhibits/1000171/Student_Work.html
- Bernie Dodge's WebQuest Page: <http://Webquest.sdsu.edu>
- Cooperative Learning Center: <http://www.co-operation.org>
- Discovery School: <http://school.discovery.com/schrockguide/assess.html>
- NoteStar: <http://notestar.4teachers.org>
- Palm Education Success Stories: <http://www.palmone.com/us/education/studies>
- RubiStar: <http://rubistar.4teachers.org>
- University of Northern Iowa's Professional Development Rubrics: <http://www.uni.edu/profdev/rubrics.html>

Web Page Hosts

- Blackboard: <http://www.blackboard.com>
- eBoard.com: <http://www1.eboard.com>
- Myclass: <http://www.myclass.net>



Kathy Brabec is a senior consultant with Mid-continent Research for Education and Learning (McREL) in Aurora, Colorado. She has worked in K-12 education since 1971. Kathy has taught English, social studies, and elementary, middle, and high school educational media. She has helped teachers and students use technology since the mid-1980s.



Kimberly Fisher is a senior consultant with McREL in Aurora, Colorado. Kimberly has been in educational technology for more than 20 years, teaching elementary school, then working for Jostens Learning as a trainer and instructional designer. She also enjoyed time as an educational technology consultant to the Colorado Department of Education.



Dr. Howard Pitler is director of educational technology for McREL in Aurora, Colorado. Prior to joining McREL, he was an elementary and middle school principal in Wichita, Kansas, for 15 years. He is an Apple Distinguished Educator and former National Distinguished Principal.

www.iste.org/LL