TEN Effective Research-Based Instructional Strategies

Robert J. Marzano

Robert J. Marzano (2000) identified ten research-based, effective instructional strategies that cut across all content areas and all grade levels. Each requires specific implementation techniques to produce the effect sizes reported, so their use requires learning to use them correctly.

1. Vocabulary: Research indicates that student achievement will increase by 12 percentile points when students are taught 10-12 words a week; 33 percentile points when vocabulary is focused on specific words important to what students are learning. Requires specific approaches. (Effect size=0.95 or 32 percentile points)

2. Comparing, contrasting, classifying, analogies, and metaphors: These processes are connected as each requires students to analyze two or more elements in terms of their similarities and differences in one or more characteristics. This strategy has the greatest effect size on student learning. Techniques vary by age level. (Effect size=1.61 or 45 percentile points)

3. Summarizing and note-taking: To summarize is to fill in missing information and translate information into a synthesized, brief form. Note-taking is the process of students' using notes as a work in progress and/or teachers' preparing notes to guide instruction. (Effect size=1.0 or 34 percentile points)

4. Reinforcing effort and giving praise: Simply teaching many students that added effort will pay off in terms of achievement actually increases student achievement more than techniques for time management and comprehension of new material. Praise, when recognizing students for legitimate achievements, is also effective. (Effect size=0.8 or 29 percentile points)

5. Homework and practice: These provide students with opportunities to deepen their understanding and skills relative to presented content. Effectiveness depends on quality and frequency of teacher feedback, among other factors. (Effect size=0.77 or 28 percentile points)

6. Nonlinguistic representation: Knowledge is generally stored in two forms—linguistic form and imagery. Simple yet powerful non-linguistic instructional techniques such as graphic organizers, pictures and pictographs, concrete representations, and creating mental images improve learning. (Effect size=0.75 or 27 percentile points)

7. Cooperative learning: Effective when used right; ineffective when overused. Students still need time to practice skills and processes independently. (Effect size=0.74 or 27 percentile points)

8. Setting objectives and providing feedback: Goal setting is the process of establishing direction and purpose. Providing frequent and specific feedback related to learning objectives is one of the most effective strategies to increase student achievement. (Effect size=0.61 or 23 percentile points)

9. Generating and testing hypotheses: Involves students directly in applying knowledge to a specific situation. Deductive thinking (making a prediction about a future action or event) is more effective than inductive thinking (drawing conclusions based on information known or presented.) Both are valuable. (Effect size=0.61 or 23 percentile points)

10. Cues, questions, and advanced organizers: These strategies help students retrieve what they already know on a topic. Cues are straight-forward ways of activating prior knowledge; questions help students to identify missing information; advanced organizers are organizational frameworks presented in advance of learning. (Effect size=0.59 or 22 percentile points)

This book analyzes research from more than 100 studies on classroom management to assess how classroom management affects student achievement, techniques that teachers find most effective, and how important schoolwide policies and practices are in setting the tone for individual classroom management. Findings are applied to a series of action steps for educators to use: get the classroom management effort off to a good start; establish effective rules and procedures; implement appropriate disciplinary interventions; foster productive student-teacher relationships; develop a positive "mental set"; help students contribute to a positive learning environment; and activate schoolwide measures for effective classroom management. The book provides real stories (Contains 116 references.) (SM)

An excerpt from training materials for the SQS course "Measurement, Data Analysis, and Knowledge Management: Choosing Research-Based Instructional Strategies" by Dr. Susan Leddick; PKR, Inc.; January, 2005.

Marzano, R. (2000). What Works in Classroom Instruction. Alexandria, VA. ASCD.

Identifying Similarities and Differences

Seeing similarities and differences is a fundamental cognitive process (Gentner & Markman, 1994; Medin, Goldstone, & Markman, 1995). As an instructional strategy, it includes various activities that help learners see patterns and make connections. For example, students compare things that are similar and contrast things that express differences. They classify when they identify features or characteristics of a group of objects or ideas, and then develop a scheme to organize those objects. Metaphors are created when two ideas or experiences are compared based on a common underlying structure. Finally, analogies provide another way to identify similarities and make comparisons. Each approach helps the brain process new information, recall it, and learn by overlaying a known pattern onto an unknown one to find similarities and differences. Looking for similarities and differences prompts the learner to consider, "What do I already know that will help me learn this new idea? This fosters relationships and connections to new understanding.

Key Research Findings

- Cognitive research shows that educational programs should challenge students to link, connect, and integrate ideas (Bransford, Brown, & Cocking, 1999).

- Results of employing these strategies can help to boost student achievement from 31 to 46 percentile points (Stone, 1983; Stahl & Fairbanks, 1986; Ross, 1988).

- Students benefit by having similarities and differences pointed out by the teacher in an explicit manner. This can include rich discussion and inquiry, but allows students to focus on the relationship or bridge to the new ideas (Chen, Yanowitz & Daehler, 1996; Gholson, Smither, Buhrman, & Duncan, 1997; Newby, Ertmer, & Stepich, 1995; Solomon, 1995).

- Students also benefit by being asked to construct their own strategies for comparing similarities and differences (Chen, 1996; Flick, 1992; Mason, 1994, 1995; Mason & Sorzio, 1996).

- Combining this strategy with the method of using nonlinguistic representation enhances student achievement significantly (Chen, 1999; Cole & McLeod, 1999; Glynn & Takahashi, 1998; Lin, 1996).

Implementation

1. Students benefit by direct instruction and open-ended experiences in identifying similarities and differences. Teachers can increase learning potential with research-based strategies, such as:

2. Point out similarities and differences. Present students with similarities and differences explicitly when this helps them reach a learning goal. As a result of the teacher's instruction, students recognize similarities and differences in order to understand something specific.
3. Allow students to explore similarities and differences on their own. When the learning goal is to engage students in divergent thinking, ask them to identify similarities and differences on their own.
4. Have students create graphic organizers. Help students to create or use graphic or symbolic representations of similarities and differences, classification systems, comparisons, and analogies. Suggestions include Venn diagrams, comparison tables or charts, hierarchical taxonomies, and linked maps.
5. Teach students to recognize the different forms. Help students recognize when they are classifying, comparing, or creating analogies or metaphors.
6. Recognize that All the World's a Stage. Language is rich with metaphor. As students encounter metaphors in reading or speaking, generate a class list. Metaphors provide a source of history, generate literary references, and suggest new ways for students to express ideas.

Additional Resources

The Private Eye is a resource for teaching students how to use metaphor, and compare and contrast, through the use of jeweler's loupes and focused questioning. http://www.the-private-eye.com

The Sourcebook for Teaching Science provides an online guide for how to teach science through the use of analogies. http://www.csun.edu/~vceed002/ref/analogy/analogy.htm

Teaching Science Concepts to Children: The Role of Analogies is a Web site dedicated to improving science education provided by the College of Education, University of Georgia.http://www.coe.uga.edu/edpsych/faculty/glynn/twa.html

Thinking Allowed

Math students explain problem-solving out loud as they talk through their thinking

Summarizing and Note Taking

Effective summarizing leads to an increase in student learning. Helping students recognize how information is structured will help them summarize what they read or hear. For example, summarizing of a reading assignment can be more effective when done within summary frames, which typically include a series of questions the teacher provides to direct student attention to specific content (Marzano, Pickering, & Pollock, 2001). Students who can effectively summarize learn to synthesize information, a higher-order thinking skill which includes analyzing information, identifying key concepts, and defining extraneous information.

Note taking is a related strategy that teachers use to support student learning. Without explicit instruction in note taking, however, many students simply write down words or phrases word for word,

without analysis (or good effect). Successful note-takers summarize to arrive at a nugget of meaning, which they are much more likely to retain. Students also benefit from using their notes as a document of their learning. Teachers can prompt students to review and refine their notes, particularly when it is time to prepare for an exam, write a research paper, or other summative assessment of learning.

Key Research Findings

- Students have to analyze information at a deep level in order to decide what information to delete, what to substitute, and what to keep when they are asked to give a summary (Anderson, V., & Hidi, 1988/1989; Hidi & Anderson, 1987).

- Reading comprehension increases when students learn how to incorporate "summary frames" as a tool for summarizing (Meyer & Freedle, 1984). Summary frames are a series of questions created by the teacher and designed to highlight critical passages of text. When students use this strategy, they are better able to understand what they are reading, identify key information, and provide a summary that helps them retain the information (Armbruster, Anderson, & Ostertag, 1987).

- Teacher-prepared notes show students what is important and how ideas relate, and offer a model for how students should take notes themselves (Marzano et al., 2001).

- Notes should be in both linguistic and nonlinguistic forms, including idea webs, sketches, informal outlines, and combinations of words and schematics; and, the more notes, the better (Nye, Crooks, Powlie, & Tripp, 1984).

- When students review and revise their own notes, the notes become more meaningful and useful (Anderson & Armbruster, 1986; Denner, 1986; Einstein, Morris, & Smith, 1985).

Implementation

By deliberately teaching the skills of summarizing and note taking, teachers provide students with a stronger foundation for learning by employing research-based strategies such as:

1. Teach a formal process. Teach students the delete-substitute-keep process for summarizing. A "rule-based strategy" for summarizing includes a specific set of steps (Brown, Campione, & Day, 1981). The steps are:
2. Delete unnecessary words or sentences
3. Delete redundant words or sentences
4. Substitute super-ordinate terms (for example, "trees" for pines, oaks, and maples)
5. Select or create a topic sentence

What information can they delete because it is not essential or redundant? When they encounter unfamiliar vocabulary or specific examples of more general concepts, can they substitute another term that will help them remember the big ideas? What information is essential to keep?

1. Identify explicit structure. Help students identify how information is structured in different formats. For example, when they begin reading a play, make sure they understand the difference between scene descriptions, stage directions, and dialog. Use a newspaper to show them how news and opinion writing is structured differently. Examine a Web site together to make sure they understand which content is paid advertising.
2. Model good note taking. Model for your students how to take effective notes. Give them an outline of information you are going to cover in class, and have them use that as the starting point for their own notes. Show them that notes are living documents that change and evolve as the note-taker gains new understanding.
3. Frame summaries. Use framing questions to focus their attention on key concepts you want them to remember. To encourage students to synthesize ideas, give them a word limitation for summarizing information concisely.
4. Personalize. Encourage students to personalize their notes, using sketches, diagrams, color codes, idea webs, or other approaches that make sense to them. What matters most is that students make notes that are meaningful and useful to them.
5. Use notes as study aids. Have students compare and discuss their notes in small groups as a method for review and test preparation.

Additional Resources

The Virginia Tech Division of Student Affairs provides a list of note-taking skills.http://www.ucc.vt.edu/stdysk/notetake.html

The Academic Resource Center at Sweet Briar College also provides note-taking suggestions. http://www.arc.sbc.edu/notes.html

Reinforcing Effort

Although research on learning tends to focus on instructional strategies related to subject matter, students' beliefs and attitudes have a significant effect on their success or failure in school. Students growing up amid challenges can develop an attitude that "failure is just around the corner," no matter what. Research makes clear the connection between effort and achievement—believing you can often makes it so. This research shares recommendations and techniques that encompass student recognition, beliefs, and attitudes about learning.

Key Research Findings

- Not all students know the connection between effort and achievement (Seligman, 1990, 1994; Urdan, Migley, & Anderman, 1998).

- Student achievement can increase when teachers show the relationship between an increase in effort to an increase in success (Craske, 1985; Van Overwalle & De Metsenaere, 1990).

- Rewards for accomplishment can improve achievement when the rewards are directly linked to successful attainment of an understood performance standard (Cameron & Pierce, 1994; Wiersma, 1992).

- A critical decision for teachers is how to provide recognition. Abstract or symbolic recognition has more impact than tangible things, such as gum, movie tickets, or prizes (Cameron & Pierce, 1994).

Implementation

Recognizing learning includes specific tactics for improving students' beliefs about their abilities and how and when to recognize them when they achieve. Teachers who understand the value of tapping into students' affective domains for improving achievement employ research-based strategies, such as:

1. Teach the relationship between effort and achievement. Many stories exist to make the connection with famous people. Draw examples from the well-known as well as the unknown so students recognize success in all situations and under many situations. Encourage students to think about: What does effort look like?

2. Reinforce effort. Students who are recognized for effort will make the connection between effort and improvement. Students should be helped to internalize the value of effort to make a strong connection between effort and the desired outcome.

3. Visual representation of effort may increase effort. Students who are helped to design an "effort log" using graphic representation will be more likely to see it in their mind's eye, and refer to it when working.

4. Create a class effort rubric. A class that shares a common definition for effort will also share the understanding of effort and achievement. If students are in learning groups, on the same teams, or in study groups together, they will have a common language and a shared ideal regarding effort and achievement.

5. Be careful about how and when recognition is provided. Verbal praise for small or easy tasks can be construed by students as undeserved, and may actually decrease effort. Ensure that praise and rewards are provided because an authentic standard of performance has been achieved. Doing an activity to a predetermined standard may well be worthy of reward and result in increased effort and motivation.

6. Recognize individual students for personal progress. Winning usually indicates that others have lost, or are "below the winner." When students have personal goals, or reach pre-determined standards of excellence, recognition is for personal achievement, which is unique to each student.

7. Make clear the real goal of effort. "The harder you try, the more successful you are" is what the act of recognition should communicate to students, not "the harder you try, the more prizes you get." Make this clear to students and apply it in practice.

Additional Resources

Dr. Mel Levine publishes All Kinds of Minds - A Web site resource for educators. He shares ideas for recognizing effort of students, and how to support learning differences.
http://www.allkindsofminds.org/activity.aspx?id=12

Homework and Practice

Homework and practice are related, connected by the context when students are learning on their own and applying new knowledge. Effective teachers approach this kind of learning experience as any other—matching the planned activity to the learning goal. Research on homework indicates that it should be approached not as an afterthought to the school day, but as a focused strategy for increasing understanding. Knowing which of the type of homework is needed helps teachers design appropriate homework assignments.

Practice means students are engaged in applying new learning, often repeatedly. The goal of practice is for students to get as close to mastery as possible. Research on homework and practice answers important questions: When should students time their practice? How many skills should students practice at once? How can teachers ensure a strong connection between memorization and understanding? How much practice is necessary for mastery? Effective student practice is key to student achievement.

Key Research Findings

- Grade level is important when teachers assign homework. Impact of homework on achievement increases as students move through the grades (Cooper, 1989, a, b). At the high school level, for every 30 additional minutes of homework completed daily, a student's GPA can increase up to half a point (Keith, 1992). Elementary students should be assigned homework to establish good learning and study habits (Cooper, 1989; Cooper, Lindsay, Nye, & Greathouse, 1998; Gorges & Elliot, 1999).

- Teachers should assign appropriate homework at instructional levels that match students' skills and provide positive consequences for homework completion (Rademacher, Deshler, Schumacher, & Lenz, 1998; Rosenberg, 1989).

- A survey of teachers of students with learning disabilities found that 80 percent of teachers regularly assigned homework, but few matched the tasks to students' skills and provided feedback or positive consequences for homework performance (Salend & Schliff, 1989).

- Students should receive feedback on their homework. Student achievement can vary based on the kind of feedback provided by the teacher (Walberg, 1999). Grading homework is helpful, but homework in which a teacher has embedded instructive comments has the greatest effect on learning.

- Homework assignments provide the time and experience students need to develop study habits that support learning. They experience the results of their effort as well as the ability to cope with mistakes and difficulty (Bempechat, 2004).

- Mastery requires focused practice over days or weeks. After only four practice sessions students reach a halfway point to mastery. It takes more than 24 more practice sessions before students reach 80 percent mastery. And this practice must occur over a span of days or weeks, and cannot be rushed (Anderson, 1995; Newell & Rosenbloom, 1981).

- Teachers in the United States tend to compress many skills into practice sessions and instructional units. Students learn more when allowed to practice fewer skills or concepts, but at a deeper level (Healy, 1990).

- Complex processes should be broken down into smaller bits, or skills, which should be taught with time allotted for student practice and adaptation (Marzano, Pickering, & Pollock, 2001).

- Parent involvement in homework can hinder student learning (Balli, 1998; Balli, Demo, & Wedman, 1997, 1998; Perkins & Milgram, 1996). Appropriate parental involvement facilitates homework completion.

Implementation

Appropriate homework and well-designed student practice will increase student learning. A few key changes in practice may make a significant difference in student achievement by increasing the positive effects. Research suggests ideas for planning homework and activities to support practice:

1. Understand the four types of homework. Know when and why to have students practice:
    a. Memorization of basic rules, algorithms, or laws so the skill becomes rote.
    b. Increase in skill speed, used for improving students' abilities to apply these skills in more complex problem solving.
    c. Deepening understanding of a concept—providing students time to read further, elaborating on a new idea and expanding their understanding.

    d. Preparation for the following day's learning, such as an advance organizer or cue to increase readiness for new information.

2. Match the right type to the goal. Assign the appropriate homework type to meet the learning goal to make homework a more focused learning experience.

3. Assign the right level of homework. Homework assignments should be at the instructional level that matches students' skills.

4. Assign the right amount of homework time. A good rule of thumb is to multiply the grade x 10 to approximate the right amount of minutes per night for students.

5. Apply consistent consequences. Provide positive recognition for homework completion, and appropriate consequences for lack of completion.

6. Recognize student uniqueness. Students need time to adapt and shape what they are learning as they practice. As they practice, given time, they will incorporate the new skill into a knowledge base of their own, deepening understanding.

7. Provide clear homework policies. Create and communicate a homework policy at the school level. Policies developed in individual classrooms may communicate a mixed message to parents, and create confusion and frustration. Include expectations, consequences, guidelines, and helpful tips in school homework policies.

8. Ask parents to facilitate homework completion, not teach content. Communicate ways that families can support homework. Parents should provide a consistent time and place in the home for children to complete homework. Help parents understand that they are not expected to be content experts. If a student needs help with content, that's a sign that the homework assignment may be too difficult.

9. Homework should serve a clear purpose. Make the goal of a homework assignment explicit and clear to everyone, including students.

10. Provide appropriate feedback. Effective feedback corrects misunderstanding, validates process, and highlights errors in thinking.

11. Provide timely feedback. Student learning improves with timely feedback. It's best to provide constructive feedback within hours or a day after students complete an assignment.

12. Create support structures for homework. Journals, trackers, and other tools help students organize assignments and support communication between student, teacher, and parents.

Additional Resources

The National PTA provides information for parents about homework as part of its campaign, "100 Ways to Know More. Do more."http://www.pta.org/parentinvolvement/adcouncil/homework.asp

Increasing Student Engagement and Motivation: From Time-on-Task to Homework is a publication of the Northwest Regional Educational Laboratory that includes a synthesis of research and vignettes from schools in the Northwest region.http://www.nwrel.org/request/oct00/index.html

Teachers Involve Parents in Schoolwork is a research-based program to effectively involve parents in their children's education.http://spearfish.k12.sd.us/west/Specials/Penny/Teacher%20Involve/overview.htm

Nonlinguistic Representation

All the senses come into play in learning. In most classrooms, however, reading and lectures dominate instruction, engaging students through the linguistic mode. Learners also acquire and retain knowledge nonlinguistically, through visual imagery, kinesthetic or whole-body modes, auditory experiences, and so forth. Teachers who wish to take advantage of all modes of learning will encourage students to make nonlinguistic representations of their thinking. These can take many forms. When students make concept maps, idea webs, dramatizations, and other types of nonlinguistic representation, they are actively creating a model of their thinking. Computer simulations also encourage exploration and experimentation by allowing learners to manipulate their learning experience and visualize results. When students then explain their models, they are putting their thinking into words. This may lead to new questions and discussions, which will in turn promote deeper thinking and better understanding.

Key Research Findings

- Learners acquire and store knowledge in two primary ways: linguistic (by reading or hearing lectures), and nonlinguistic (through visual imagery, kinesthetic or whole-body modes, and so forth). The more students use both systems of representing knowledge, the better they are able to think about and recall what they have learned (Marzano, Pickering, & Pollock, 2001).

- Visual representations help students recognize how related topics connect (NCTM, 2000).

- Finding patterns helps students organize their ideas so that they can later recall and apply what they have learned. Research has shown an increase in understanding of geometry when students learn to represent and visualize three-dimensional forms (Bransford et al., 1999; Lehrer & Chazen, 1998).

- After brainstorming to generate ideas, students can improve their reading, writing, and thinking skills by using thinking maps to help them organize key concepts in a visual way (Hyerle, 1996).

- Using visual representation software in a science classroom helps students express their developing understanding of core chemistry concepts in the form of visual representations that are readily created and shared. These representations help students generate explanations of the phenomena they are investigating. (Michalchik, V., Rosenquist, A., Kozma, R., Kreikemeier, P., Schank, P., & Coppola, B., in press).

Implementation

Helping students understand and represent knowledge nonlinguistically is the most under-used instructional strategy (Marzano et al., 2001). Taking advantage of this teaching tool requires focusing on current classroom practice and looking for opportunities to engage students in multiple modes. Research suggests best practices for instruction:

1. Model use of new tools. Activities that involve nonlinguistic representation may be new to students who are accustomed to learning through lectures and readings. Scaffold student learning as you introduce activities such as concept maps, idea webs, and computer simulations by modeling how to use tools that help them represent their thinking nonverbally. Gradually remove the scaffolds so students eventually work independently with the new tool or technology.

2. Use nonlinguistic modes in the content areas. Math and science classrooms offer ideal settings for incorporating nonlinguistic learning experiences. Language arts classrooms provide natural connections from classifying words to modeling plotlines. Models, graphs, imagery, and other tools enable students to engage in actively constructing representations of their understanding.

3. Foster cooperative learning. Encourage students to work in small teams when they are constructing nonlinguistic representations. Students' questions and discussions will help them communicate and refine their thinking.

4. Teach interpretation of nonlinguistic forms also. Finding patterns helps students organize their ideas so that they can later recall and apply what they have learned. Teach students to represent and interpret information in graphs, charts, maps, and other formats that will help them see patterns and make connections.

5. Simulations offer new modes for learning. Use simulation software or online simulations to let students practice making predictions and testing outcomes. Combine nonlinguistic experimentation with verbal discussion, which prompt students to think through their understanding and raise new questions.

6. Stimulate body-mind connections. Kinesthetic learning is not just for primary grades. Older students continue to learn through physical activities. Incorporate dramatizations, dance, music, simulations, and other active learning experiences.

7. Integrate nonlinguistic forms into note-taking. Encourage students to take notes that are meaningful to them. Model use of sketches, graphs, and symbols.

Additional Resources

The Council for Exceptional Children provides a bibliography and resources about graphic organizers. http://www.ericec.org/minibibs/eb21.html

Carleton College publishes a Web site about teaching with visualization.http://serc.carleton.edu/NAGTWorkshops/visualization/index.html

ESRI maintains a variety of Web resources to support the use of global information systems (GIS) in the K-12 classroom, including case studies about schools that have used mapping software to support student learning. http://www.esri.com/industries/k-12/

Cooperative Grouping

Cooperative learning is actually a generic term that refers to numerous methods for grouping students. At least 10 different methods have been formally described in the research literature. Therefore, "cooperative learning" as a strategy requires a closer look to take advantage of potential benefits for learners. Effective cooperative learning occurs when students work together to accomplish shared goals and when positive structures are in place to support that process (Johnson & Johnson, 1999).Even though appropriate use of student groups for learning has been shown to yield significant learning improvement across disciplines, the successful application of cooperative grouping in classrooms still eludes many educators (Johnson & Johnson). Criteria for effective cooperative learning groups include:

- Students understand that their membership in a learning group means that they either succeed or fail—together. (Deutsch, 1962).
- "Positive interdependence" includes mutual goals, joint rewards, resource interdependence (each group member has different resources that must be combined to complete the assignment), and role interdependence (each group member is assigned a specific role).

- Students help each other learn and encourage individual team members' success.

- Individuals in the group understand that they are accountable to each other and to the group as a distinct unit.

- Interpersonal and small-group skills are in place, including communication, decision making, conflict resolution, and time management.

- Members are aware of the group's processes. Individual members talk about "the group" as a unique entity.

Key Research Findings

- Organizing students in heterogeneous cooperative learning groups at least once a week has a significant effect on learning (Marzano, Pickering, & Pollock, 2001).

- Low-ability students perform worse when grouped in homogeneous ability groups (Kulik & Kulik, 1991, 1997; Lou et al, 1996).

- There may be no other instructional strategy that simultaneously achieves such diverse outcomes as cooperative grouping. The amount, generalizability, breadth, and applicability of the research on cooperative, competitive, and individualistic efforts provides considerable validation of the use of cooperative learning to achieve diverse outcomes, including achievement, time on task, motivation, transfer of learning, and other benefits (Cohen, 1994a; Johnson, 1970; Johnson & Johnson, 1974, 1978, 1989, 1999a, 2000; Kohn, 1992; Sharan, 1980; Slavin, 1977, 1991).

- Cooperative learning can be ineffective when support structures are not in place (Reder & Simon, 1997).

Implementation

Grouping students to work collaboratively and cooperatively offers benefits for learners. Teachers who are successful at facilitating cooperative learning employ research-based strategies, such as:

1. Create the right type of group for the need. Sometimes an occasional informal ad hoc group is needed, such as pair and share. Base groups are formed for long-term social and interpersonal support. Formal learning groups are used when a commitment of time and effort is required.

2. Keep group size small. Ideally, learning groups include no more than four students. Base groups may be larger, up to six students.

3. Use ability grouping sparingly. Students across the spectrum of abilities benefit by heterogeneous grouping, especially low-ability students.

4. Don't use cooperative learning for all instructional goals. While cooperative learning is a powerful strategy, it can be overused, or misapplied. Students need time to investigate ideas and pursue interests on their own.

5. Use a variety of strategies when choosing students for groups. Many selection strategies (common clothing, favorite colors, letters in names, birthdays) will work when attempting to randomly group students.

6. Facilitate success. Develop organizational tools, forms, learning journals, and other structuring documents that foster the smooth processes needed for effective cooperation and group work. Use online tools for ubiquitous access to forms.

7. Support new groups. Cooperative learning is a practiced skill that requires monitoring and adjustment. Teach specific skills before grouping students, define criteria for success, and develop rubrics for key expectations. Meet with new group members to support their success.

Additional Resources

The Cooperative Learning Center is a Research and Training Center housed at the University of Minnesota focusing on how students should interact with each other effectively. There you'll find articles, research, a newsletter, and other resources. The research team of Roger T. Johnson and David W. Johnson will even answer questions sent by teachers on cooperative learning, and past answers can be found in their Q & A section. http://www.co-operation.org/

Setting Objectives

Setting objectives involves specific teacher and student behaviors, including both decision-making and communicating. First, teachers select and refine learning goals, These goals may be narrow or broad, specific or general. Studies of effective goal setting suggest that goals with a narrow focus will actually minimize learning, because students focus on what has been communicated as important. If goals are too focused, students will ignore related information. Second, goal setting is an act of communicating. Since students focus on what has been set forth as an objective, communicating those objectives becomes central to success. Setting objectives, then, becomes a thoughtful exercise in considering how to generalize selected learning objectives while ensuring student focus, then letting students in on the process through clear communication.

Key Research Findings

- Instructional goals should not be too specific. When goals are too narrowly focused they can limit learning (Fraser, 1987; Walberg, 1999).

- If students are encouraged to personalize the teacher's goals, then learning increases. Student ownership enhances learning focus. Studies show the benefits of students setting sub-goals derived from the larger teacher-defined goals (Bandura & Schunk, 1981; Morgan, 1985).

- Some studies indicate that student learning "contracts" are effective in developing student ownership and completion of goals. A contract would be an agreement between student and teacher for a grade the students will receive if they meet established criteria (Kahle & Kelly, 1994; Miller & Kelley, 1994; Vollmer, 1995).

Implementation

Setting learning goals is another instructional practice which benefits from fine-tuning. Teachers who set, define, and communicate appropriate learning objectives employ research-based strategies such as:

1. Goals should be flexible and general. If a goal is too focused on a narrowly defined outcome, it limits learning potential. If students are shown one example of successful learning it will inhibit the possible range of artifacts students would create in their authentic construction of knowledge. If students understand that the goal is for them to learn how a piston works, they may fail to learn its relationship to other parts in an engine.

2. Student ownership makes a difference. Ask students to create their own goals. Help them personalize and refine their own set of goals by sharing examples, modeling the process, or creating strategies for documenting and completion, such as contracts, video-recordings, or learning journals.

3. Allow students enough time to adapt goals. Give students time to adapt the concepts and ideas in goals to their interests, learning styles, and existing knowledge base.

4. Use advance organizers to introduce goals. Use related strategies to enhance goal introduction to students. Advance organizers can help students prepare for, focus on, and personalize goals.

5. Help students understand different kinds of goals. There are short-term and long-term goals. In classrooms with different instructional practices, setting and meeting objectives may need to take many forms. Provide students practice setting personal goals and meeting them in different contexts.

6. Focus goals on understanding. Ensure that goals are less about accomplishing tasks and more focused on understanding and applying concepts.

Additional Resources

The North Central Regional Educational Laboratory publishes an online resource entitled Pathways to School Improvement. Pathways synthesizes research, policy, and best practice on issues critical to educators engaged in school improvement. See Critical Issues: Working Toward Student Self-Direction and Personal Efficacy as Educational Goals.http://www.ncrel.org/sdrs/areas/issues/students/learning/lr200.htm

Providing Feedback

Providing the right kind of feedback to students can make a significant difference in their achievement. There are two key considerations. First, feedback that improves learning is responsive to specific aspects of student work, such as test or homework answers, and provides specific and related suggestions. There needs to be a strong link between the teacher comment and the student's answer, and it must be instructive. This kind of feedback extends the opportunity to teach by alleviating misunderstanding and reinforcing learning. Second, the feedback must be timely. If students receive feedback no more than a day after a test or homework assignment has been turned in, it will increase the window of opportunity for learning. Feedback is a research-based strategy that teachers, and students, can practice to improve their success.

Key Research Findings

- When feedback is corrective in nature—that is, it explains where and why students have made errors--significant increases in student learning occur (Lysakowski & Walberg, 1981, 1982; Walberg, 1999; Tennenbaum & Goldring, 1989).

- Feedback has been shown to be one of the most significant activities a teacher can engage in to improve student achievement (Hattie, 1992).

- Asking students to continue working on a task until it is completed and accurate (until the standard is met) enhances student achievement (Marzano, Pickering, & Pollock, 2001).

- Effective feedback is timely. Delay in providing students feedback diminishes its value for learning (Banger-Drowns, Kulik, Kulik, & Morgan, 1991).

- Administer tests to optimize learning. Giving tests a day after a learning experience is better than testing immediately after a learning experience (Bangert-Downs, Kulik, Kulik, & Morgan, 1991).

- Rubrics provide students with helpful criteria for success, making desired learning outcomes clearer to them. Criterion-referenced feedback provides the right kind of guidance for improving student understanding (Crooks, 1988; Wilburn & Felps, 1983).

- Effective learning results from students providing their own feedback, monitoring their work against established criteria (Trammel, Schloss, & Alper, 1994; Wiggins, 1993).

Implementation

Fine-tune how you provide feedback by focusing on the details of what you say, as well as when you say it. Research suggests best practices for providing feedback:

1. Increase the value of tests and homework. Providing only a grade or number on a test or homework assignment leaves out critical information for students. Take time to write comments, point out omissions, and explain your thinking when reviewing student work.

2. Make feedback count. Feedback is best when it is corrective in nature. Help students see their errors and learn how to correct them by providing explicit and informative feedback when returning student work. Make feedback another part of the learning process.

3. Don't delay feedback. The longer students have to wait for feedback, the weaker the connection to their effort becomes, and the less likely they are to benefit.

4. Help students get it right. If students know you want to see them succeed, and you're willing to help explain how, their learning improves. Give students opportunities to improve, try again, and get it right.

5. Ask students to provide feedback. Students can monitor and provide feedback to other students, as well as compare their work to criteria. Engage students in review of their own work and others.

6. Give students time to absorb new ideas. Tests are more effective as opportunities for learning if a day has gone by between learning experiences and the test.

7. Use rubrics. Rubrics provide criteria against which students can compare their learning. Involve students in developing rubrics. Rubrics help students focus their effort.

Additional Resources

RubiStar is a free online tool that teachers can use to make and save rubrics. Developed by the High Plains Regional Technology in Education Consortium, RubiStar includes a tutorial for new users and a

feature that enables teachers to analyze student data and identify areas for focusing additional instruction. http://rubistar.4teachers.org/index.php

The National Center for Research on Cultural Diversity and Second Language Learning has published an article called The Instructional Conversation: Teaching and Learning in Social Activity. The authors discuss the use of modeling, providing feedback, contingency management, directing, questioning, explaining, and task structuring in classroom activity settings. http://www.ncela.gwu.edu/pubs/ncrcdsll/rr2.htm

Generating and Testing Hypotheses

Across content areas and grade levels, inquiry in the classroom turns native curiosity to the learner's advantage. Effective teachers create these opportunities to guide students through the process of asking good questions, generating hypotheses and predictions, investigating through testing or research, making observations, and finally analyzing and communicating results. Through active learning experiences, students deepen their understanding of key concepts.

Inquiry extends far beyond the science classroom. In math, students make predictions based on their understanding of statistics. In history, students look for evidence to support their theory about why certain events unfolded. In language arts, students predict what comes next in a story based on events that have already transpired. In every context, teachers can make inquiry more effective by scaffolding the learning experience.

Key Research Findings

- Understanding increases when students are asked to explain the scientific principles they are working from and the hypotheses they generate from these principles (Lavoie, 1999; Lavoie & Good, 1988; Lawson, 1988).

- By generating and testing a hypothesis, students are applying their conceptual understanding (Marzano, Pickering, & Pollock, 2001).

- In comparisons of inquiry-based instruction and more traditional teaching methods (such as lectures and textbook-based instruction), researchers have found that inquiry methods help students gain a better understanding of fundamental concepts in science (White & Frederickson, 1997, 1998).

- An interactive approach to teaching physics concepts provides a better environment for student learning than traditional textbook-based instruction (Hake, 1998).

Implementation

Fine-tune your use of inquiry by focusing on how students generate and test hypotheses and predictions. Research suggests best practices for instruction:

1. Good questions make better hypotheses. Teach students how to frame a good question. Help them narrow their inquiry to a topic they can reasonably explore.

2. Ask for explanations. Encourage students to explain their hypotheses or predictions aloud. This will prompt them to explain their understanding of underlying concepts, giving you a window into their understanding.

3. Watch for (and mediate) misconceptions. If students are basing a prediction on a false premise or conceptual misunderstanding, set up activities to challenge their thinking.

4. Scaffold investigations. Structure their learning experience to maximize results. Provide them with a framework for investigating.

5. Use role play. Acting out characters (Hamlet) or agents (red blood cell) prompts students to make predictions. Based on what they know about their role, how will their character react? How will the agent interact with other agents?

6. Highlight patterns and connections. Help students recognize patterns in their findings. Show them how to transform raw data into graphs or other visual representations that will help them see patterns and make connections.

7. Use questioning strategies. Ask questions throughout the inquiry cycle—when students are posing questions, while they are investigating, when they analyzing results or presenting conclusions. At each stage, challenge them to explain their reasoning and defend results.

Additional Resources

North Central Regional Educational Laboratory's enGauge resources include a publication focused on inquiry in high school mathematics instruction entitled Teaching and Learning High School Mathematics Through Inquiry: Program Review and Recommendations.http://www.ncrel.org/engauge/resource/hs.htm

The Northwest Regional Educational Laboratory provides a Web resource on the Science Inquiry Model. http://www.nwrel.org/msec/science_inq/index.html

Cues, Questions, and Advance Organizers

Teachers set the stage for learning by finding out what students already know, then connect new ideas to students' existing knowledge base. Using a variety of instructional strategies, teachers guide students from the known to the unknown, from familiar territory to new concepts. Cues, questions, and advance organizers are among the tools and strategies that teachers use to set the stage for learning. These tools create a framework that helps students focus on what they are about to learn.

Asking questions and prompting students' replies with cues are strategies that come naturally to most teachers. In fact, some 80 percent of student-teacher interactions involve cues and questions (Marzano, Pickering, & Pollock, 2001). By fine-tuning questioning strategies with insights from research, teachers can become even more effective at guiding students' learning.

Like questions, advance organizers are also commonly used to help set the stage for instruction. Since David Ausubel (1960) first described advance organizers as a cognitive strategy to help students learn and retain information, teachers have developed a variety of forms for effectively organizing learning. The K-W-L chart, for example, lists what students know, what they want to find out, and what they have learned (Ogle, 1986). Graphic organizers show how new ideas or concepts relate, providing students with a visual framework for acquiring and organizing new information.

Key Research Findings

- Learning increases when teachers focus their questions on content that is most important, not what they think will be most interesting to students (Alexander, Kulikowich, & Schulze, 1994; Risner, Nicholson, & Webb, 1994).

- Higher-level questions that ask students to analyze information result in more learning than simply asking students to recall information. (Redfield & Rousseau, 1981). However, teachers are more apt to ask lower-order questions (Fillippone, 1998; Mueller, 1973).

- Advance organizers, including graphic ones, help students learn new concepts and vocabulary (Stone, 1983). Presenting information graphically as well as symbolically in an advance organizer reinforces vocabulary learning and supports reading skills. (Brookbank Grover, Kullberg, & Strawser, 1999; Moore & Readence 1984).

- Students learn more when they are presented information in several modes (Paivio, 1986).

- By increasing the amount of "wait time" after asking a question, teachers foster increased student discourse and more student-to-student interaction (Fowler, 1975).

Implementation

Teachers want the time spent planning and teaching to generate the most effective and sustained learning. By implementing the recommendations below focused on cues, questions, and advance organizers teachers can gain from research and maximize effort.

1. Pace yourself. Teachers commonly underestimate how often they ask questions in class. Use questions to help students focus on what is more important to learn. Remember to ask questions when you introduce new content, and not just at the end of a learning experience. Asking questions will not only tell you what students already know, but also whether they are starting with misunderstandings about a topic.

2. Ask higher-level questions. Think about how to phrase questions. By asking questions that require analysis, you prompt students to go beyond simple recall of information and help to develop their higher-order thinking skills.

3. Wait time matters. Give students time to think before jumping in with an answer to your own question. Pausing for just a few seconds is likely to generate better classroom discourse, including more conversation among students.

4. Preview the big picture. Help students see where you are going by giving them an overview of what a lesson or unit will cover.

5. Use multiple modes. Connect with diverse learning styles by presenting previews of information in multiple ways—visually with graphic organizers, verbally (aloud), and in writing.

Additional Resources

For more on David Ausubel's theories about meaningful learning and the use of advance organizers, see Dr. Jack Hassard Web site entitled The Art of Teaching Science. He is Emeritus Professor of Science Education at Georgia State University.http://scied.gsu.edu/Hassard/

The Northeast Texas Consortium provides a resource for developing advance organizers, especially for distance learning.http://www.netnet.org/instructors/design/goalsobjectives/advance.htm

The North Central Regional Educational Laboratory publishes Pathways to School Improvement which include Critical Issues. Building on Prior Knowledge and Meaningful Student Contexts/Cultures is a resource discussing the use of advance organizers.http://www.ncrel.org/sdrs/areas/issues/students/learning/lr100.htm

Simulations and Games

Much education research encourages teachers to foster the kinds of environments and tools provided by simulations and games. For example, the more students use multiple systems of representing knowledge, the better they are able to think about and recall what they have learned (Marzano, Pickering, & Pollock, 2001). Providing students the opportunity to visualize and model improves their chances for understanding. Simulations enhance this potential by making modeling dynamic. Games and modeling activities can elicit curiosity, create a demand for knowledge, and enable students to discover knowledge through exploration (Edelson, 1998). Experimentation, manipulation of media, and personal experience are critical allies in deepening learning. We know that student engagement and motivation are critical to sustained understanding. Simulations and games provide powerful new opportunities for learning.

Simulations allow learners the opportunity to model, explore, and try out a variety of strategies. Role-playing is a learning experience where students collaboratively invent, experiment, and practice interpersonal skills in a relatively low-risk environment. Games and simulations differ in important ways, although contexts may overlap. In simulations, no one "wins," and participants role-play experiences that result in their character suffering or benefiting from decisions and actions. Simulations are multi-modal and non-linear, branching into scenarios based on user choice. Finally, simulations are structured by authentic rules that mirror actual results. This definition can be broken down further to describe how students can learn from simulations.

Experimental simulations provide learners the opportunity to engage in situations that would otherwise be too hazardous or cost prohibitive to conduct in the classroom. For example, a simulation of an atom smasher uses gum balls to help students envision what happens in a linear accelerator; a rollercoaster design simulator allows students to experiment with slope, angle, and speed. Symbolic simulations dynamically represent the behavior of a population, system, or set of processes. The student is on the outside looking in, conducting operations and manipulating variables to explore reactions. Symbolic simulations allow students to discover and explain scientific relationships, predict events, and learn procedural skills. For example, biology students can use simulation software to explore the implications of vanishing habitat on various species. The use of technology offers unprecedented experimental environments in which to learn.

Serious games is a new term for games that are applied to "serious" goals instead of entertainment, bringing gaming technology to fields such as education, policy development, and leadership. Major corporations, government institutions, foundations, educators, and nonprofits are turning to games and emerging technologies as a new approach to simulations, training, education, and other practical applications.

Key Research Findings

- Simulation environments and modeling have unique capabilities for enhancing learning (Gordin & Pea, 1995).

- Gaming teaches competition strategies, cooperation and teamwork, and conflict resolution (Neubecker, 2003).

- The effectiveness of gaming relies on the degree to which the games simulate real life (Hood, 1997).

- When students are able to represent and explore new information in science classrooms using modeling tools, they are able to explore and deepen their understanding, as well as share it with others. This helps them understand the phenomena they are investigating (Michalchik, V., Rosenquist, A., Kozma, R., Kreikemeier, P., Schank, P., & Coppola, B., in press).

- Games are dynamic, intrinsically motivating, and involve high levels of involvement. They provide immediate feedback to participants, and mistakes do not result in actually losing assets (Hood, 1997).

- Games have been found to serve a range of functions in education including tutoring, exploring and practicing skills, and attitude change (Dempsey et al., 1994).

- Simulations can provide students engaging experiences towards learning crisis -management, communication and problem solving, data management, and collaboration (Gredler, 1994).

- The effective use of games differs depending on the educational areas where the games are employed. The best results were found to be in the areas of mathematics, physics, and language arts (as opposed to social studies, biology and logic). The beneficial effects of gaming are most likely to be found when specific content is targeted and objectives precisely defined (Randel et al 1992).

Implementation

Simulations and games provide new learning opportunities for students. Teachers who have an interest in increasing learning potential employ strategies such as:

1. Incorporate simulations into curriculum. Explore online simulations that offer skill or concept learning.

2. Simulations support related research recommendations. View the incorporation of simulations into curriculum through the lens of other related research-based strategies. Providing feedback, setting objectives, nonlinguistic representation, and homework and practice are strategies that simulations support.

3. Use dynamic simulations to model complex systems. Help students understand systems and variables by using software that allows students to see the impact of change. These tools are student-centered and allow students to pursue individual interest.

4. Teach cooperative learning skills through role-playing simulations. Role-playing can provide important opportunities to learn and practice skills when forming cooperative learning groups. Individual and small-group skills can improve with teaching and practice, which in turn impacts the success of cooperative learning.

5. Foster meta-cognitive awareness. Games and simulations offer students a chance to "get outside themselves." Introduce to students the concept of "watching yourself act" as a way to raise awareness of important meta-cognitive processes. Students can learn to be more self-reflective when engaged in a simulation or game.

Additional Resources

The Society for the Advancement of Games and Simulations in Education and Training (SAGSET) Formed in 1970, SAGSET is a voluntary professional society dedicated to improving the effectiveness and quality of learning through the use of interactive learning, role-play, simulation and gaming. http://www.simulations.co.uk/sagset/

For a list of upcoming conferences, publications, organizations, and resources discussing games and simulations in education visit Simulation in Education and Training.http://www.site.uottawa.ca/~oren/sim4Ed.htm.

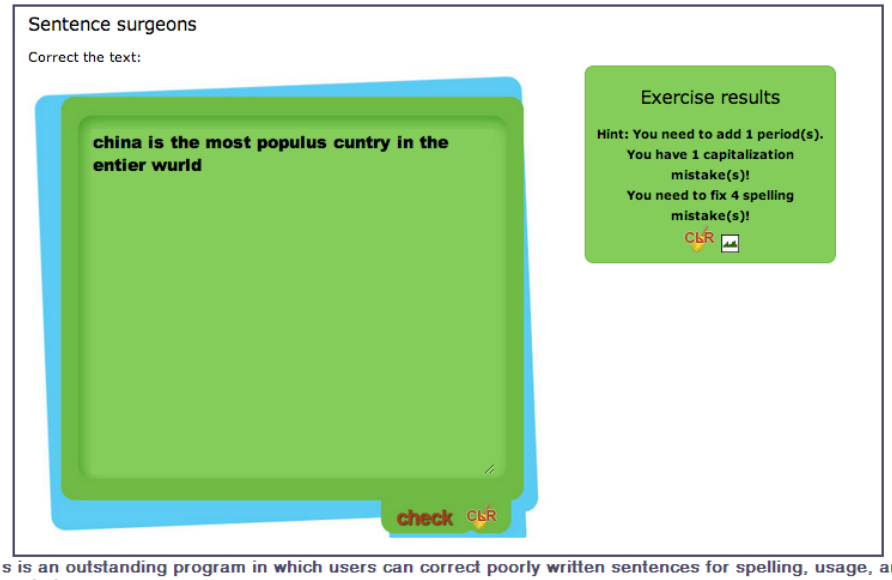
Future Play is an International Academic Conference on the Future of Game Design and Technology. The goal of Future Play is to bring together academics, industry, and students to advance game design and technology through peer-reviewed research, creative and experimental game design and development, and formal and informal discussion on academic and industry-related topics. http://www.futureplay.org/

The Use of Computer Games in Learning: A Review of the Literature. This publication also contains a comprehensive bibliography of related references.http://www.lsda.org.uk/files/PDF/1529.pdf

Marc Prensky, a often-cited author on the subject of games and simulations in education, maintains a Web site where he publishes articles of interest on the subject.http://www.marcprensky.com/writing/default.asp

http://mrnussbaum.com/surgeonsindex/

Sentence Surgeons – Sentence Correction Exercises



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