CHAPTER 6 MODELS & STRATEGIES

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Models of Teaching

Selecting specific models of teaching helps you clarify how you’re going to get across what it is you want your students to learn. Each model represents a distinct perspective on how to do this. Admittedly, some teachers are so passionate about a particular model that they use it exclusively as their teaching style, but this deprives their students of the variety and flexibility needed to acquire a well-rounded perspective. Let’s face it, you wouldn’t want to sit in a class learning things the “same old way day in and day out” and neither would your students. But it isn’t just for variety – each model is going to help you accomplish some things very well, other things not so well. Figuring out what you are most trying to accomplish, then selecting the model(s) that will best help you get there, means your students are going to have rich opportunities to obtain deep understanding.

Another way you might look at the models of teaching is that they provide the practical means to carry out inquiry-based instruction already covered in previous chapters. Some are less teacher directed; others more teacher directed. In some respects this means that the more open ended your inquiry is, the more likely you are to use problem-based learning, classroom discourse and/or cooperative learning; and the more structured your inquiry the more likely you are to use demonstration, direct instruction, and concept teaching. But don’t get too formulaic. Remember, it’s all about what you are most trying accomplish. Even the most open-ended inquiry requires some teacher-directed activities, just as highly structured inquiry needs some student-centered activities.

Spend some time with each of the five models. Get a sense of the kinds of learning goals they are designed to address – and not address. View the classroom examples of each of the five models. Practice planning and teaching lessons adhering to the structures of each model, then
reflect on how well the model helped you reach your intended objectives. What is it about another model that might have helped you reach some of the objectives more effectively? Master each model, then toss them up in the air and draw upon different aspects of each to do what only you can do – make them work for your particular group of students for your particular situation and goals.

**Problem-based Learning**

In many ways problem based learning (PBL) is the same as inquiry: A problem situation is posed to students who then set up the means to investigate, gather evidence, problem solve and present solutions. Indeed, some PBL scenarios can be so complex that an entire unit is driven by a single problem that invites multiple aspects of inquiry and problem-solving. But more likely it will be a subset of a unit – perhaps a series of lessons over several days, or maybe just a single activity.

The essential thing is that students are placed in the active role of solving a complex, real-world problem that has no simple, pre-determined “right” solution. It requires information-gathering and either drawing upon knowledge and skills already acquired or getting the knowledge and skills they need. You pose the problem and you facilitate the process by asking questions, challenging your students’ thinking, keeping them involved, scaffolding and managing group dynamics. Your students solve the problem by active participation in breaking down the problem and making decisions that ultimately help them make meaning out of the whole thing.

**Why use Problem-Based Learning?**

Well thought-out problems provide students with real-life dilemmas set in authentic contexts. At the very least this will stimulate interest and motivate students to find solutions to
the problem, which in turn sets the inquiry process in motion. They become actively engaged, start asking questions, and gathering information to get answers. As they draw upon what they already know they strengthen existing content knowledge but also invite new knowledge by figuring out what they need to know to come up with a solution. It also promotes higher order and creative thinking and sharpens problem-solving and inquiry strategies because of the multiple factors they must address, manipulate and reflect upon throughout the process. PBL also gives students a sense of relevance – or put another way, helps answer the question “what does this have to do with the real world?”

**Problem-based Learning in Practice**

No amount of words can replace the value of actually seeing PBL in action, so take some time to view the video clips before actually planning and implementing the model yourself. As you view the videos here are some questions to consider:

1. How are students oriented to the problem?
2. What organization and ground rules does the teacher establish?
3. How does the teacher facilitate and assist the problem-solving/ inquiry process?
4. What end products do students ultimately come up with and what do they do with them?
5. How do students make sense of what they learned when it is all over?

**Planning PBL Using GRASPS**

Grant Wiggins and Jay McTighe (2001) introduced the acronym of GRASPS for constructing assessment performance tasks, but it works equally well for planning PBL scenarios.
### Examples

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| **G** | **Goal:** A goal, challenge or obstacle for the problem scenario is posed.  
- The problem/challenge is to …  
- Your task is to …  
- The goal is to …  
- The obstacles to overcome are … |
| **R** | **Role:** The role the students play in the problem scenario should be defined and clarified.  
- You are a(n) (actor, candidate, detective, engineer, eye witness, inventor, jury, nutritionist, park ranger, pilot, reporter, scientist, tour guide, tutor) …  
- You have been asked to …  
- Your job is to … |
| **A** | **Audience:** Identify the audience that the problem solution is intended for.  
- Your client(s) is (are) …  
- The target audience is …  
- You need to convince …  
- (board members, community members, government officials, television viewers, a jury) |
| **S** | **Situation:** This involves setting and explaining the context for the problem Scenario.  
- The context of the situation you are in is …  
- The challenge involves dealing with …  
- The need/requirement is …  
- The environmental conditions are … |
| **P** | **Product:** Clarify what products or presentations students will create to demonstrate solutions to the problem.  
- You will create a(n) …  
- You need to develop … so that …  
- (advertisement, article, brochure, data display, demonstration, diagram, drawing, exhibit, graphic, newscast, poster, PowerPoint, story, web sit …) |
| **S** | **Standards:** State standards to evaluate and guide students’ problem-solving, decision-making, and solutions.  
- Your product needs to …  
- Your work will be judged by …  
- A successful result will …  
- (accurate, appropriate, convincing, defensible, justified, organized, persuasive, reflective, supported, understandable, unique, verified …) |

**PBL Scenarios**

If you use GRASPS and the same five questions you used above to observe PBL lessons, you will experience success. Let’s try a couple.
Scenario 1: The forces of flight.

You are an air controller for the local airport. Your job is to make a presentation to the city council on why more sophisticated instruments are needed to measure wind speed and air pressure. Sudden wind changes in the area have caused frequent shifts in air pressure and the pilots are complaining that they need better warning so they can adjust their wing flaps and engine speed accordingly. To get the council members to support better measurement instruments, your presentation should include physical demonstrations and explanations that accurately convey how thrust, lift, drag, and gravity affect flight, and how the new instruments will help you advise pilots in flight. Your presentation needs to be accurate, informative, and thorough enough to convey the function of these four flight concepts.

Notice that all the elements of GRASPS are present in this scenario, so with some careful planning on your part you should be able to find the right place in your unit to orient your students to the problem scenario. The key to effective planning is knowing what you are trying to accomplish and placing your PBL activity in the right place at the right time. For example, your students are going to have to know something about thrust, lift, drag and gravity to solve the problem. But is this going to be a PBL activity at the end of the unit so what you are really doing is assessing what they should have learned, or is it going to be earlier so through a more open inquiry they find out what these forces are all about? Your approach to how you will facilitate and assist the problem-solving and inquiry process will differ greatly depending upon this timing aspect. Your end products will likely be different as well, depending upon when you introduce the PBL activity. You also need to help students make sense of what they have learned through reflection, discussion, and other strategies. But once again, exactly how you do this will be dictated in part by the timing of the PBL in your unit. So it’s up to you. One approach is not necessarily better than another – you just need to know what you are trying to accomplish.
Scenario 2: Hurricane Katrina Aftermath

In August of 2005, a Category 4 hurricane made landfall in Louisiana, Mississippi and Alabama. In situated was exacerbated in New Orleans, Louisiana, when canals were breached and up to 80% of the city was covered in water. The governor ordered all of New Orleans to be evacuated, but with no place to go thousands were stuck in their houses, on the streets, and in the city superdome.

The hurricane dictated a series of unfortunate events. The flooding not only wrecked the water mains of the water treatment facility, causing pipe explosions and leakage of fresh water, but the sewage contaminated the local drinking water. People in the community desperately tried to isolate the remaining pool of fresh water with sand bags, but the safety of drinking the water was in question. Severe cases of diarrhea were reported, local fishermen complained that the hurricane seemed to have changed the living and non-living environment within the gulf’s system, and that they cannot consistently rely on the gulf for food anymore.

Support from the federal government has been set aside to help fund the clean up and rebuilding of New Orleans. Funding proposals need to provide information and predictions on the current state of the disaster affecting New Orleans and propose a clean up solution for the community’s drinking water.

As community members of a town not affected by the hurricane, you and your neighbors decide to apply for the funding and plan to analyze the gulf’s current system as well as find a solution to clean up the drinking water for the thirsty residents. The grant is very competitive and only a small number of proposals will be awarded funding. Specifically, your team is asked to do the following:

1) Predict what kinds of physical, chemical, and biological changes could have occurred in the gulf’s living and non-living system as a result of the hurricane, as well as how this might affect the types and the availability of food caught by the local fishermen.

2) Analyze the water at the water treatment facility. What kinds of contaminants are in the water? How did you test for these contaminants? Predict where each of these contaminants may have come from. What other contaminants may be in the water that you may not be able to test? Provide explanations for your answer.

3) Propose an effective solution to make the water collected from the damaged water treatment facility drinkable for the residents of New Orleans. Be sure to provide evidence of your proposed solution to the funding source (in other words, bring a water sample from the treatment facility that you purified).

Be prepared to present your funding proposal through a poster presentation on the last day of class.

The second scenario illustrates that problems can be socially relevant, real world situations that need genuine solutions. Furthermore, such a problem underscores the realization that science doesn’t work in isolation from the rest of the world. Problem-based learning is an
ideal candidate for interdisciplinary studies—it’s not a stretch to see that this scenario could open the door to a study of politics, economics, geography, culture, history and language arts.

Structurally, the scenario still conforms to GRASPS, but shows you that the approach should be adjusted to fit the specifics of your problem scenario. It is also important to understand that if you want a complex problem such as the Katrina aftermath to be a successful learning experience, you need to think through what supplementary materials are needed. Besides identifying necessary conceptual understandings of the ecology and chemistry of water you could gather articles, photographs, video clips, interviews, and/or a number of other resources to help inform and intrigue your stories and drive home the relevancy of such an event.

**Classroom discourse**

Think of classroom discourse as an enhanced form of everyday class discussions that is characterized by explicit attention to improving conceptual understanding, thinking processes, creativity, communication and social skills. The benefit of treating this as an actual model of instruction is it draws our attention to what makes good discussions. Let’s face it, too many discussions end up as one-way delivery systems because the teacher figured it is just a normal part of everyday instruction and neglected to plan what it takes to draw students in and keep them there.

Classroom discourse as a model encourages you to plan and teach full classroom discourse lessons. As you do so, and as you reflect on what worked and didn’t work, you will by natural extension begin applying your enhanced skills to everyday class discussions as well.

**Why Use Classroom discourse?**

Learning comes from experiencing the information, not the information itself. Discussion accomplishes this by encouraging students to manipulate, extend and express their
own ideas, and to listen to what others have to say. Good classroom discourse teaches the inquiry process – in fact, it replicates every phase of the 5Es.

Classroom discourse engages students with intriguing questions or ideas, and keeps them engaged as they think about and contribute to the ideas expressed. This naturally propels students into the explore phase as they dig deeper and take responsibility for their thinking about the content. This raises more questions and invites explanations that lead to new understandings, and it extends thinking by giving students opportunities to take their ideas down paths hitherto uncharted. And because students are expressing their ideas it provides an ongoing evaluation of conceptual understanding, misconceptions, communication, and thinking skills.

Finally, let’s not overlook the personal and social skills classroom discourse builds. Students learn to analyze their own thinking processes and develop communication skills to get their ideas across. They also learn to listen to and respond to others’ ideas and to ask the right questions.

Classroom discourse in Practice

View the video clips of the classroom discourse lessons. As you do so, consider these questions:

1. How does the teacher introduce the discussion and draw the students into the conversation?
2. In what ways does the teacher keep the flow of discussion going?
3. What do you notice about the nature of questioning, responses, wait time, paraphrasing, summarizing, and so on used by the teacher?
4. How does the teacher summarize the discussion?
5. How has the discourse supported understanding, communication, and thinking processes?

*Planning Classroom discourse Lessons*

The first step to successful classroom discourse lessons is to recognize that you need to plan and prepare just like you would with any other lesson model. Rich discussions seldom occur without a plan. If you try to wing it so will your students. Fortunately, your plan doesn’t have to be elaborate. Just remember these six conditions:

1. **Purpose.** Know the purpose of your lesson and match the right kind of discussion to fit that purpose. The three main kinds of discourse discussions are:

   - **Recitation** – used to both find out what your students know about the topic and to build upon what they know to carry the understanding further. Recitations are teacher-directed: you ask a question—students respond— you react.

   - **Guided Discussion** – a process that builds student understanding by guiding students through relevant inquiry considerations. For example, a discussion to explore a misconception might ask students to compare, interpret, and infer the information before them, then to explain what they think that means. Though less structured than recitation, guided discussions are still largely teacher-directed. Provocative questions and effective “wait-time” help promote an environment for student thinking and independence.

   - **Open-ended Discourse** – this approach encourages students to take responsibility for their thoughts and understandings with as little teacher intervention as possible. You are not trying to lead your students to predetermined conclusions; rather, you are helping them to extend their understanding through logical inquiry applications. You do this through divergent questioning and follow-up statements that seek clarification and/or elaboration. Thinking is creative and higher order process skills such as predicting and hypothesizing are encouraged. The discussion may lead to student-devised investigations, problem-solving, and evidence-driven decision-making.

2. **Space.** “… if we put before the mind's eye the ordinary schoolroom, with its rows of ugly desks placed in geometrical order, crowded together so that there shall be as little moving room as possible …and add a table, some chairs, the bare walls, and possibly a few pictures, we can reconstruct the only educational activity that can
possibly go on in such a place. It is all made ‘for listening.’” John Dewey made that statement in 1899, but it still depicts today’s typical classroom. You can rearrange desks or chairs into a circle or semi-circle in a couple minutes. The difference can be students engaged in genuine discourse with one another versus a student to teacher answer session.

3. **Invite.** Like any good lesson, you need something to draw students in – a hook – be it an interesting statement, a discrepant event, or the right kind of leading question. Your job is to invite students into the discourse by coming up with this hook, then have at your disposal a cache of questions and statements to hold them and move them forward. The typical question-answer pattern prevalent in most classrooms doesn’t cut it. This scene from *Ferris Bueller’s Day Off* is a great comedy scene but only because it parodies real classroom life so well.

Social Studies Teacher: In 1930, the Republican-controlled House of Representatives, in an effort to alleviate the effects of the... Anyone? Anyone?... the Great Depression, passed the... Anyone? Anyone? The tariff bill? The Hawley-Smoot Tariff Act? Which, anyone? Raised or lowered?... raised tariffs, in an effort to collect more revenue for the federal government. Did it work? Anyone? Anyone know the effects? It did not work, and the United States sank deeper into the Great Depression. Today we have a similar debate over this. Anyone know what this is? Class? Anyone? Anyone? Anyone seen this before? The Laffer Curve. Anyone know what this says? It says that at this point on the revenue curve, you will get exactly the same amount of revenue as at this point. This is very controversial. Does anyone know what Vice President Bush called this in 1980? Anyone? Something-d-o-o economics. "Voodoo" economics.

The remedy is summarized by Vygotsky (1926, 1991): “Before you want to involve the child in some kind of activity, interest the child in it, being concerned to make sure that the child is ready for this activity, that all the child's strengths needed for it are exerted, that the child will act for him/herself, and that for the teacher remains only the task of guiding and directing the child's activity.”
4. **Flow.** Once you’ve successfully invited your students into the discourse process you need to exercise a number of strategies to keep them there and to manage the flow of the discussions. Central to these strategies will be questions – questions that provoke, invite, and make students think. The primary strategies are:

- Prepare questions and possible follow-up questions ahead of time. Don’t expect good questions to pop up spontaneously, no matter how well you understand the content.

- Use “wait time” after asking a question. It takes practice to wait five seconds, but this is what students need to process the question and formulate a response. Don’t be Ferris Bueller’s teacher by answering your own questions.

- Reduce the “startle” effect by asking the entire class the question first, then say the student’s name and repeat the question. Some students forget the question when they suddenly hear their name and all eyes turn to them.

- Be prepared for the dominant talkers (e.g., ask for raised hands, use a talking stick) and the reticent talkers (e.g., use small groups and have them take turns to “report out”).

- Slow down and probe. Rather than moving on after an initial short answer, let another student comment, then come back and ask the first student if that has altered the original answer. Encourage elaboration. And remember that you are there to facilitate the students’ discussion, not to be the main voice.

- Refocus the discussion when it starts getting too far off track.

- Summarize points before moving on, but not until students have had opportunities to comment first. This does not mean re-answering the question. Let your students take responsibility for the accuracy and clarity of their statements and don’t send the signal that only you have the real right answer.

- Don’t interrupt and don’t let other students interrupt.

- Pay attention to body language and nonverbal signals, including your own signals of approval, disapproval, interest, or impatience.

5. **Variety.** Varying your question types helps keep the discussion alive. Though you are unlikely to use all seven types of questions in a single session, use more than one type. Recall from the *Explain* section of this chapter that those question types are:
• Attention-focusing Questions -- To help students focus on observations and other details and make connections;

• Measuring and counting questions – To help students develop confidence because the questions can be answered directly from the experiences of the activity;

• Comparison questions – To help students focus their observations and to classify, categorize and/or order objects or results.

• Action questions – Help students explore new materials, properties, forces, and/or events. Can be answered through simple investigations

• Problem-posing questions – Engage students in realistic problem-solving situations, encourage experimentation and promote critical thinking

• Reasoning Questions – Stimulate students reasoning and help them to draw conclusions and generalizations, leading to expanding or changing their ideas. These questions should not be asked until students have sufficient experience to reason from evidence.

• Metacognitive Questions – These questions help students think about the own thinking processes.

6. **Close.** Draw your discussions to a meaningful close. This means summarizing the main ideas, relating the discussion points to your unit’s big ideas, and/or prompting your students to summarize what they got from the discussion. We’ve all been part of discussion which seemed to be going somewhere but then left us hanging. That’s because the facilitator failed to close the discussion and bring it to the next level. Think back to why you initiated this discussion in the first place. Was it to get your students to think about additional evidence? To face their naïve conceptions? To recognize alternate viewpoints? To evaluate each other’s conclusions? Whatever your initial purpose, bring it back into the close and let your students see it through the lens of their own thinking and ideas. This is how your transform a typical classroom discourse into an inquiry-based learning experience.
Cooperative Learning

Simply defined, cooperative learning is students working together in small groups, learning through interaction with each other while the teacher coaches the process. The broad goal is to teach collaboration skills so that the inquiry process can unfold. Successful cooperative learning comes about by thoughtful foresight on your part as to the tasks of each group and each individual within that group. The notion that you can simply tell your students to get into small groups to “work on the problem” isn’t cooperative learning, as any teacher who has tried this hit-or-miss approach will tell you.

Collaboration is a skill, and like any skill it needs to be taught and you need certain tools (such as tasks, roles, communication and reflection) to carry it out. You are the task-master, or at least the task-setter, and each student has a well defined role that clearly identifies what is expected of that role. As small groups work on their tasks you rove and coach the process, encouraging students to participate and communicate with one another. You provide ongoing feedback and evaluation, and ask the students to do the same, leading to meaningful reflection and understanding.

Why Use Cooperative Learning?

Cooperative learning is perhaps the most efficient and effective mechanism to attain the goals of inquiry. Cooperative learning provides focused and supportive structures for inquiries to occur while interacting with students; gets students talking with one another about scientific ideas; challenges students to accept and share responsibility for their own learning; responds to student diversity and encourages all students to participate fully in science learning; and encourages and models the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science (NSES, 1996).
Ample research on cooperative learning points to a strong potential for students to: (a) successfully integrate information, (b) improve ability to respond critically, (c) develop more authentic views of the nature of concepts, (d) improve skills in creative thinking, (e) improve attitudes and motivation, (f) develop greater interest in learning, (g) enhance social and interpersonal skills such as building lasting friendships with individuals from diverse backgrounds, and (h) attain high levels of self-efficacy (Blumenfeld et al., 1991; Conrad & Hedin, 1981; Gore & Nelson, 1984; Jelinek, 1997; Miller, 1982; Wiley, 1991; Zoller & et al., 1990). Or, to quote John Dewey, [Cooperative learning creates opportunities for students] “…to handle, to move about, to hunt, to uncover, to mix things separated and divide things combined, to talk and to listen. Method is their effectual organization into continuous dispositions of inquiry, development, and testing.... Reason, the rational attitude, is the resulting disposition” (Dewey, 1930; p. 55).

**Cooperative Learning in Practice**

Ponder the following questions as you view the cooperative learning video clips.

1. Describe the nature of the cooperative structure the teacher sets up. In what ways does this seem to support the lesson’s goals?
2. How does the teacher organize group tasks and individual roles? Does it work? Why or why not?
3. Describe the teacher’s facilitation of the overall process as well as specific scaffolding strategies to support the learning experiences.
4. How well did the groups work together? Did they display a quality of “we’re all in this together” or “I’ll do it by myself”? How did the teacher address this?
5. Did they learn anything? How do you know?
Planning Effective Cooperative Learning

In general, cooperative learning demands specific attention to managing logistics, guarding the learning environment, coaching, establishing accessible relationships with students, recognizing differences, and stimulating authentic learning experiences. By the same token, once you’ve attended to these details and oriented your students to them, the learning environment becomes more productive and manageable. There are five overarching principles to successful cooperative learning.

1. Clearly connected goals with the correct cooperative structure.

Cooperative learning structures range on a continuum from simple partner-sharing to complex jig-saw arrangements. Knowing your objectives, then choosing the structure best suited to help you get there is the key to a successful cooperative learning lesson. As a general rule, keep groups as small as possible and increase the numbers in proportion to the complexity of the task. What follows are common structures (http://scied.gsu.edu/Hassard/Teems/cooperative_structures.htm).

- Think-pair-share. Give students a question or a problem and have them think quietly of an answer or solution. Have them discuss their response with a student sitting close by, and then have them share with the entire class. A time limit of one or two minutes should be used for the pair exchange. This is a good technique for breaking up a presentation, as well as an assessment of student understanding.

- Pairs check. Partners coach each other on a worksheet or text problem and/or check notes for completeness and accuracy. Time: two minutes.

- Three Step Interview. Students form pairs and one-partner interviews the other on a predetermined topic (What are some of the most significant health issues facing humankind today?) for two or three minutes; partners switch roles. Then pairs combine to form groups of four. Each group member introduces his or her partner, sharing the information from the original interview. This is a great icebreaker activity and also fosters active listening.

- STAD (Student Teams-Achievement Divisions). After a lecture, video, demonstration or discussion of a chapter in the text, teams of three or four receive a worksheet to discuss and complete. When team members feel they have reached acceptable solutions, you can give a brief oral or written quiz to the group, representative, or each member of the team to assess mastery of the material.

- Jigsaw. Each member of a base group is assigned a mini-topic to research. Students then meet in expert groups with others assigned the same mini-topic to discuss and refine their
understanding. Base groups reform, and members teach their mini-topics to each other. You can give a brief oral or written quiz to the group, representative, or each member of the team to assess mastery of the material.

- Constructive controversy. Pairs in a group of four are assigned opposing sides of an issue. Each pair researches its assigned position, and the group discusses the issue with the goal of exposing as much information as possible about the subject. Pairs can then switch sides and continue the discussion.

- Numbered heads together. Each member of a team of four is assigned a number. Pose a thought question, a problem, or present an EEEP, and allow a few minutes for discussion with the groups. Call out a number after randomly selecting a numbered card from a deck. The person whose number is called stands and represents the group. Call on selected students who are standing. See page 25 of the Cooperative Learning Handbook.

- Roundtable/Circle of Knowledge. Groups of three or more members brainstorm on an assigned topic, with each member taking turns to write down one new idea on a single piece of paper. The process continues until members run out of ideas. When time is up, the group with the most number of independent ideas presents to the class. See page 70 of the Cooperative Learning Handbook.

- Talking Chips. This is a method to ensure equal participation in discussion groups. Each member receives the same number of chips (or index cards, pencils, pens, etc.). Each time a member wishes to speak, he or she tosses chip into the center of the table. Once individuals have used up their chips, they can no longer speak. The discussion proceeds until all members have exhausted their chips.

- Co-op cards. Each partner in a pair prepares a set of flashcards with a question or a problem on the front and correct answer(s) on the back. One partner quizzes the other until the latter answers all the questions or problems in the set correctly. Then they switch roles and use the other set of flashcards. A great technique to help students memorize information and review.

- Send a Problem. Similar to Co-op Cards, each member of a group writes a question or problem on a flashcard. The group reaches consensus on the correct answer(s) or solution and writes it on the back. Each group then passes its cards to another group, which formulates its own answers or solutions and checks them against those written on the back by the sending group. Stacks of cards continue to rotate from group to group until they are returned to the original senders, who then examine and discuss any alternative answers or solutions by other groups.

- 10-2. In this structure, present information for ten minutes, then stop for two. During the “wait time” students in pairs or small groups share their notes, fill in the gaps, or answer a question.

- Think-aloud-pair-problem solving. Students are paired off, assigned a role of problem solver (student A), or listener (student B). Present a problem to be solved. Student A solves the problem by talking aloud, while student B encourages, supports, and asks questions (to help with the solution). Randomly select a group and ask them to present the solution to the class. Present a second problem, but this time ask the students in pair to reverse roles.

2. **Well defined tasks and roles.**

Students need to know what is expected of them once they get into their groups. This includes tasks for the groups themselves and specific roles for each individual. So write a “job
description” for each role and consider putting these on cards or posters. Typical job
descriptions are:

- **Facilitator.** Help keep the group on the assigned task. Make sure everyone get help as needed, and
that each member has an opportunity to participate and contribute. Also responsible for making sure
safety precautions are followed.

- **Recorder.** Keeps the group’s records of activities and maintains files and folders of required
materials, including contributions from each group member. The recorder writes out the group’s
solutions to use as notes for communicating results to the teacher or whole class.

- **Reporter.** Reports to the whole class during wrap-up/debriefing time.

- **Monitor.** Acts as a timekeeper and lets the group know when it is time to clean up. The monitor
makes sure that the work area is left the way it was found.

- **Wildcard.** If there are more than 4 members, the wildcard either takes on some of the tasks of other
members or assumes the role of any missing member.

3. **Continuous coaching.**

   As a coach you facilitate the overall flow of group processes, but don’t micro-manage.

   Assure that the groups and individuals are kept on task; scaffold academic, social and
   cooperative learning activities; and formatively assess students throughout the process. You also
   help bring activities to an overall close, which usually includes orchestrating team reporting-out
   or presentations and maybe some form of summative assessment. Finally, remember that group
   and individual efforts deserve recognition.

4. **Collaboration.**

   The sense that we all “sink or swim together” sums up the collaborative spirit. The group
   needs to “share” a common goal and understand that each individual is needed to make it work.
   You can help engender a sense of positive interdependence by attending to a few details. First,
   assure that peers help each other to clarify and communicate ideas, that they value and promote
   individual differences, and solutions, no matter how “creative”, are heard. Second, lay out the
   tasks in such a way that students understand how and why they need each other to successfully
   complete the team’s task. Third, hold each individual accountable for contributing to successful
completion of the task. Ultimately, this includes a demonstration that the lesson objectives have been mastered.

5. **Group Processing.**

Students need time to step back and look at what they have done. Remember that you are encouraging inquiry, and that means confronting naïve ideas, retrying investigations, asking “what-if” and checking it out, and genuinely getting excited about carrying out the task, not just completing it. Students also need to process how they worked together – did they all have a chance to do the activities? How could they have supported each other better to get things done? Was everyone included?

Usually, you will transition from small group processing to some form of whole group debriefing or presentations.

**Concept Teaching**

If you think about it, you are teaching concepts no matter what approach you use. So what is a concept? It depends upon who you ask. Here are just a few examples you’ll find on the web.

- A belief, theory, idea, notion, principle, or the like. [highered.mcgraw-hill.com/sites/007256296x/student_view0/glossary.html](http://highered.mcgraw-hill.com/sites/007256296x/student_view0/glossary.html)
- A general idea formed in the mind. Something conceived in the minds such as a plan, a design, a mental image or a thought. [www.cgcc.cc.or.us/Library/lib-instruction/define-terms.htm](http://www.cgcc.cc.or.us/Library/lib-instruction/define-terms.htm)
- A general notion around which ideas are developed [www.foodforum.org.uk/cgi-local/glossary.pl](http://www.foodforum.org.uk/cgi-local/glossary.pl)
- The basic unit of thought or (put another way) the idea in your head [www.cs.man.ac.uk/mig/links/RCSEd/termtools.htm](http://www.cs.man.ac.uk/mig/links/RCSEd/termtools.htm)
- An abstract or general idea inferred or derived from specific instances [wordnet.princeton.edu/perl/webwn](http://wordnet.princeton.edu/perl/webwn)
- An abstract, universal idea, notion or entity that serves to designate a category or class of entities, events or relations. [en.wikipedia.org/wiki/Concept](http://en.wikipedia.org/wiki/Concept)
Big ideas are concepts – they encompass the common elements in all of these definitions, which is why the big idea approach to planning and instruction is emphasized in this textbook. Without an organizing principle like big ideas you could easily get bogged down in a sea of concepts – for how would you decide which ones to teach? Content standards or curriculum frameworks often contribute to this sea of concepts sensation. While they may justifiably identify every concept students should learn, attempting to teach all of these standards results in broad coverage but not learning and understanding.

Why Use Concept Teaching?

Conceptual understanding is the antidote to wrong science. Look back at the Chapter 2 discussion of wrong science and it is apparent that simply covering a concept does not mean our students really get the concept. We need to use every means at our disposal to help our students acquire the conceptual knowledge to become scientifically literate. Even when using indirect means as might be found in open-inquiry, our ultimate goal is to teach concepts. But indirect means are not practical for teaching all concepts – oft-times the best approach is the most direct approach.

Whether deductive (naming and defining the concept first, then encountering examples and nonexamples) or inductive (encountering examples and nonexamples before arriving at the concept), concept teaching explicitly teaches concepts and nurtures logical reasoning and critical thinking. The other thing about concept teaching is that even though the exact approach differs according to the nature of the concept, there are still structural characteristics that help us define what should be included. Arends (2007) outlines these in Learning How to Teach:

1. Concepts are learned through examples and nonexamples. When teaching the concept of mammal, you might give dog as an example and a lizard as a nonexample.
2. **Concepts may be influenced by context.** The concept of *scientist* has different attributes when considering a geologist versus a zoologist. So, too, will the concept of understanding the night sky vary if you are viewing it from close to the equator versus close to the North Pole, or at 6 PM versus 11 PM.

3. **Concepts have definitions and labels.** *Heat* is a label and the definition is *a form of energy that is transferred by a difference in temperature*. We need both the definition and label to communicate the concept, but learning the definitions does not equate learning the concept. Think back to the hundreds of definitions you had to memorize over your school career and you will grasp the distinction.

4. **Concepts have critical attributes.** A critical attribute must be present or the item under consideration isn’t an example of the concepts. The critical attributes of *feed on mother’s milk, have hair, and warm blooded* help us understand the concept of *mammal*. Since a dog has these critical attributes it is a mammal; since a lizard does not have these critical attributes it is not a mammal.

5. **Concepts have noncritical attributes.** A noncritical attribute may be present in some members of the class, but not all. Examples of noncritical attributes for mammal are habitat, eating habits, and color. We can talk about these attributes to understand a particular kind of dog, but these are not the attributes we need to understand what a mammal is.

Let’s look at the *mammal* concept in table format.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Example</th>
<th>Nonexample</th>
<th>Critical Attributes</th>
<th>Noncritical Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammal</td>
<td>A warm-blooded animal that has hair and feeds its young on the mother’s milk.</td>
<td>Dog</td>
<td>Lizard</td>
<td>Has hair</td>
<td>Habitat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat</td>
<td>Chicken</td>
<td>Young feed on mother’s milk</td>
<td>Color</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horse</td>
<td>Fish</td>
<td>Warm-blooded</td>
<td>Eating Habits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cow</td>
<td>Bird</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Concept Teaching in Practice**

As you view the video clips of concept teaching, keep these questions in mind.

1. How does the teacher set the stage and conditions for learning this concept?

2. What strategies did the teacher use to present examples and nonexamples, and do you think the students grasped these? Were the examples and nonexamples sufficient?

3. Describe the various techniques used to draw attention to critical and noncritical attributes. Did this engage the students, stimulate their thinking and encourage them to assess the consequences of their choices?
4. When the concept was defined, did the students “buy” it? Why or why not?

5. What were the most effective approaches to help the students grasp the concept and big ideas? Least effective? What else could have been done?

Planning Effective Concept Teaching

Whatever your approach to concept teaching, the six steps that follow apply.

1. **Identify concepts.** Identify the concepts you expect your students to learn and complete this table:

<table>
<thead>
<tr>
<th>Concept</th>
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<th>Example</th>
<th>Nonexample</th>
<th>Critical Attributes</th>
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<tr>
<td></td>
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</tr>
</tbody>
</table>

2. **Select approach.** Select an approach that fits with the concept you will be teaching. The prevailing approach for inquiry-based teaching is *concept attainment*. This approach most closely follows the 5 Es approach in that students *attain* the concept *after* having *engaged* and *explored* the big ideas first. Still, there are times when you need to present concepts up front – for example, when they serve as stepping stones to more in-depth inquiry learning. This is called *concept presentation*.

3. **Choose examples and nonexamples.** Present examples and nonexamples. Example should include all of the critical attributes while nonexamples will include some, but not all, of the critical attributes.

4. **Identify critical and noncritical attributes.** Probe, give cues, and draw attention to critical and noncritical attributes, examples and nonexamples. It is important to involve students in coming up with examples, examining their thinking and the consequences of their choices.
Choose from one or more of the following strategies to increase the chances of success for this step:

- **Comparing** – a process of identifying similarities and differences of critical attributes between or among different concepts.

- **Classifying** – a basic process skill of organizing attributes into groups according to their similarities. Rules that determine membership within particular classification schemes need to explicitly articulated.

- **Metaphors** – an abstract or nonliteral relationship between two unobvious attributes. The metaphor of an army of ants squeezing through a narrow gap in their path, for example, might be a metaphor for the attribute of electrons flowing through a filament to light up a light bulb.

- **Analogies** – a relationship between two pairs of concepts or attributes. The first pair is provided and the task is to find the word that accurately completes the second pair. Dog is to mammals as lizard is to **reptiles**. Oxygen is to humans as carbon dioxide is to **plants**.

- **Graphic Organizers** – visual tools that assist in the understanding of: descriptive patterns, time-sequence patterns, episode patterns, generalization/principle patterns, and concept patterns (Marzano, et.al, 2003).

- **Concept Maps** – a visual arrangement depicting structural patterns and relationships between big ideas, major concepts and their attributes. Concept mapping is among the most powerful strategies to help students see and grasp the interconnectedness of concepts and their critical attributes.

5. **Define concept.** Define (or redefine) the concept. Draw upon student input and the strategies used in step 4 to word this definition.

6. **Extend.** Extend the process with more examples and nonexamples until it is clear that the students grasp the concept. Once again, use the strategies outlined in step 4. Ultimately, you should relate the concept to the big ideas of the unit.

**Direct Instruction**

Direct instruction is a highly structured model that systematically takes students through well-defined steps and procedures. The underlying premise of direct instruction is that certain
kinds of knowledge and skills need to be taught as efficiently as possible while moving students to mastery as quickly as possible. Proponents cite a wealth of research to support the thesis that direct instruction works (in fact, that it works better than any other approach). Opponents argue that it is one-sided and counterproductive to the goals of learner-centered teaching. Inquiry-based teaching provides a happy compromise. Indeed, direct instruction is teacher-centered, and if used exclusively as the means to teach science it would deprive students of the benefits inquiry-based learning bring. But seen from another standpoint, students need to master certain factual knowledge and skills that are best grasped through structured teacher-directed approaches.

**Why Use Direct Instruction?**

There are times when content needs to be organized and presented to students in a structured, step-by-step fashion. For example, demonstrations, a necessary staple of science instruction, are a form of direct instruction. Communication via well-structured presentations, another form of direct instruction, is a cornerstone science process skill.

Even if we could teach all the procedural skills and factual knowledge through indirect means, we’d run out of time to do the activities that really should be inquiry-driven. We need to teach what can be taught by direct means to equip our student with the necessary knowledge and skills for inquiry-based investigations. The trick is knowing when to use direct instruction and to what extent.

**Direct Instruction in Practice**

As you view the video clips of direct instruction teaching, keep these questions in mind.

1. What approaches does the teacher use to introduce the lesson and connect prior knowledge to new knowledge?
2. As you observe the demonstrations put yourself in the place of the students. Was your attention aroused? What helped or hindered you from retaining and/or repeating the demonstration?

3. Likewise, as you observe the presentations put yourself in the place of the students. What aspects of the presentations helped you understand the material? What aspects hindered understanding?

4. What strategies does the teacher employ to guide practice and monitor student learning?

5. How is the lesson brought to a close and what kind of evidence demonstrates that learning has occurred?

6. How is independent practice approached, and how effective is it?

**Planning Effective Direct Instruction**

Strictly speaking, direct instruction proceeds through five tightly structured steps of advance organization, demonstration or presentation, guided practice and monitoring, debrief/closure, and independent practice. As you look at these five steps in more depth, keep in mind that even though highly structured, they can and should still be augmented with effective inquiry strategies such as questioning, predicting, and problem-solving.

**Step 1: Advance Organizers**

The advance organizer provides a preview of information to be learned. The premise is that meaningful learning results when the student is able to connect new knowledge with existing schema. You might think of it as a special case of Engage. You still need to grab your student’s attention, but you do it by presenting a structured overview of what is to be taught and connected it to what they already know. This might be done with an outline, a graphic organizer, or orally.
The point is that you have taken this new information and made it more familiar, then you are ready to move on.

**Step 2: Demonstration/Presentation**

**Demonstrations** are essential components in every phase of science inquiry and can be found in virtually any model of instruction. You use demonstrations to: grab attention (discrepant events), invite questions, model proper skills or procedures, focus attention on specific challenges, help solve problems, model safety, avoid putting students in danger, support slow learners and challenge advanced learners. Students are learning by observation rather than doing, which requires some specific strategies to be successful (Bandura, 1986).

- **Attention**: Students can only learn if they pay attention to what’s going on. Hopefully your advance organizer has drawn them in, but the demonstration itself needs to hold their attention. Build in ways for students to identify with the demo, build up their expectations, arouse their emotions.

- **Retention**: Your students need to retain what it is they just observed so it can be recalled later and used. You increase opportunities for retention by involving students in the demonstration when feasible, repeating certain steps to focus attention, keeping the demo visible, using simple and familiar materials, and minimizing the steps.

- **Reproduction**: If you expect your our students to repeat the demonstration or to grasp the principles, they need to be capable of reproducing the demonstration. Just think about observing the assembly of a car engine. Don’t try it on your own. On the other hand, you could probably reproduce the steps of using new features in the car you just purchased provided you carefully observed a demonstration of these features.

- **Motivation**: Give your students a reason to learn from the observed demonstration. In the case of learning how to use the gadgets on your fancy new car you may have all the motivation you need, but don’t expect your students to be equally motivated to learn how to measure light levels with your fancy light meter. Sometimes that reason is good old reinforcement or punishment. “After you do your light measurements, we can watch our movie.”

**Presentation** is the predominant instructional delivery system used by K-12 teachers and university professors alike. After all, there is so much material to cover and so little time to do it
in. But if you think about that presentation in your college class which laid out more information in fifty minutes than existed in the first millennium of human existence, you realize the potential danger of the presentation method. And now we have sophisticated presentation tools like PowerPoint – double edged swords that make it easier to put together effective presentations but also increase the risk of overcoverage. So once you have identified the information to be presented and organized it at least so it makes sense to you, how do you present information so it will sink in? Three tips will help you turn that presentation into something you and your students will enjoy.

• Use Visuals. Visual aids such as pictures, graphs, tables and props increase the chances of meeting your lesson objectives. So once you have assembled and organized the new information to be presented, toss out the bullet points and replace whatever you can with visuals.

• Rehearse. A presentation may not be a speech to be memorized but it is a delivery of information that needs to be engaging and comprehensible. Hemmingway said “the first draft of anything is shit” and this applies as much to your presentation as it does to a manuscript. Though you are well on your way once you have all your points together and have eliminated unnecessary details and come up with great visual aids, you are not done until you iron out the kinks. You do this through rehearsal.

• Less is More. Cognitive science teaches us that children’s working memory can hold four chunks of information for a short period of time, but even then we need to build in memory-retrieval strategies to help students access and use that information later (Cowan, 2005). Practically speaking these means the “rule of 3” for presentation makes sense. Beginning-middle-end -- that’s good, as long as your presentation structure doesn’t have a fourth part you’re set there. If you have over four main points for any of these parts, get rid of one. Then just make sure none of your main points have no more than three sub-points.

**Step 3: Guided Practice and Monitoring**

This step affords students opportunities to practice and demonstrate their understanding of the material, and for you to monitor the level of mastery. If you had demonstrated the concept of pitch by plucking a string as you shortened the length, then guided practice might involve students trying this out on their own while you assist them in accurately measuring the lengths
and entering the results in a data table. Or if you had introduced the concept of static electricity by presenting the interrelationship of attraction, repulsion and friction, guided practice might include rubbing materials (friction) and recording the effects of attraction and repulsion. Again, the guided practice is tightly structured since your objective is to assure that students understand the concepts correctly before moving on.

This is also your opportunity to apply strategies that will help students reinforce and retain those chunks of information presented during the previous stage. Thanks to research summarized in books such as Classroom Instruction that Works (Marzano, Pickering, and Pollack, 2001), we have a fairly reliable sense of the most successful strategies to help accomplish this. Some have already been touched on in this chapter, others are detailed in other chapters, or you can click on the “More Information” icon to explore them now. They are:

- Identifying similarities and differences (comparing, classifying, metaphors, analogies)
- Summarizing and note taking.
- Reinforcing effort and providing recognition.
- Nonlinguistic representations (graphic organizers).
- Generating and testing hypotheses (systems analysis, problem solving, decision making, investigation, inquiry, invention).
- Questions and cues.

Step 4: Debrief and Closure

As with debriefing in any of the instructional models, students are guided through a process that helps them make sense of what was taught, though the approach is more structured as you look for specific evidence to ascertain that the lesson objectives have been met. Whereas some debriefing sessions in student-directed models might lead down uncertain roads, you know
what you’re looking for in direct instruction and your job is to make sure students get there. In terms of the 5Es this is where you Extend and Evaluate student understanding.

Your strategies can be drawn from the same six strategies outlined for guided practice, though the way you use them concentrates on extending understanding, not just reinforcing presented material.

**Step 5: Independent Practice**

Students need considerable practice to master a skill or to deepen their understanding of content. In fact, Marzano, Pickering, and Pollack (2001) also highlight practice as one of the research-based categories of *Classroom Instruction that Works*. Their research indicates that students need 20 or more practice sessions before the content or skill can effectively be used on their own. Thus it behooves you to build independent practice into whatever you teach. The following five approaches are particularly effective.

- Assign homework. When students are given the purpose of a homework assignment and the expectations are clear, it works. Thus, homework tied to content or skills acquired in class stands a good chance of doing what you expect it to do – reinforcement through practice.
- Select just the most important content and skills to practice.
- Schedule massed practice (sessions close together) and distributed practice (sessions spaced apart).
- Have students chart speed and accuracy.
- Help students shape their new skill or process.

**Summary**

- **Models of Teaching** represent distinct perspectives on how to get across what it is you want your students to learn. Whereas inquiry-based instruction may leave the teacher uncertain about how to implement it, the models provide the practical solution. Like inquiry, some models of more student-directed, some more teacher-directed; but also like inquiry, once the
models are understood they can be adapted to suit your particular needs and group of students. The models are: Problem-based Learning (PBL), Classroom discourse, Cooperative Learning, Concept Teaching, and Direct Instruction.

- In Problem-based Learning (PBL) a problem situation is posed to students who then set up the means to investigate, gather evidence, problem solve and present solutions. Planning PBL activities is based on the acronym GRASPS. **Goal:** A goal, challenge or obstacle for the problem scenario is posed. **Role:** The role the students play in the problem scenario should be defined and clarified. **Audience:** Identify the audience that the problem solution is intended for. **Situation:** This involves setting and explaining the context for the problem Scenario. **Product:** Clarify what products or presentations students will create to demonstrate solutions to the problem. **Standards:** State standards to evaluate and guide students’ problem-solving, decision-making, and solutions.

- Classroom discourse is an enhanced form of everyday class discussions, characterized by explicit attention to improving conceptual understanding, thinking processes, creativity, communication and social skills. Six conditions will help the teacher plan effective classroom discourses. **Purpose.** Know the purpose of your lesson and match the right kind of discussion to fit that purpose. **Space.** Arrange or rearrange the room (e.g., desks in a circle or semi-circle) to create a more conducive environment for students to engage in genuine discourse with one another versus a student to teacher answer session. **Invite.** Like any good lesson, you need something to draw students in – a hook – be it an interesting statement, a discrepant event, or the right kind of leading question. **Flow.** Once you’ve successfully invited your students into the discourse process you need to exercise a number of strategies to keep them...
there and to manage the flow of the discussions. **Variety.** Varying your question types helps keep the discussion alive. Though you are unlikely to use all the different types of questions in a single session, use more than one type. **Close.** Draw your discussions to a meaningful close by summarizing the main ideas, relating the discussion points to your unit’s big ideas, and/or prompting your students to summarize what they got from the discussion.

- **Cooperative Learning** is students working together in small groups, learning through interaction with each other while the teacher coaches the process. The broad goal is to teach collaboration skills so that the inquiry process can unfold. There are five overarching conditions to successful cooperative learning. 
  1) **Clearly connected goals with the correct cooperative structure.** Cooperative learning structures range on a continuum from simple partner-sharing to complex jig-saw arrangements. 
  2) **Well defined tasks and roles.** Students need to know what is expected of them once they get into their groups. This includes tasks for the groups themselves and specific roles for each individual. 
  3) **Continuous coaching.** As a coach you facilitate the overall flow of group processes, assure that the groups and individuals are kept on task; scaffold academic, social and cooperative learning activities; and formatively assess students throughout the process. 
  4) **Collaboration.** The sense that we all “sink or swim together” sums up the collaborative spirit. The group needs to “share” a common goal and understand that each individual is needed to make it work. 
  5) **Group Processing.** Students need time to step back and look at what they have done, confront naïve ideas, retry investigations, and genuinely getting excited about carrying out the task, not just completing it.
•  **Concept Teaching** is a teacher-directed model that guides students through conceptual understanding by providing examples and nonexamples; critical and noncritical attributes. The five steps for planning effective concept teaching are: 1) **Identify concepts.** Identify the concepts you expect your students to learn and include the following information: *concept, definition, example, nonexamples, critical attributes, noncritical attributes.*

2) **Select approach.** The approach most closely follows the 5 Es approach is *concept attainment* in that students *attain* the concept *after* having *engaged* and *explored* the big ideas first. Still, there are times when you need to present concepts up front – for example, when they serve as stepping stones to more in-depth inquiry learning. This is called *concept presentation.*

3) **Examples and nonexamples.** Present examples and nonexamples. Example should include all of the critical attributes while nonexamples will include some, but not all, of the critical attributes.

4) **Critical and noncritical attributes.** Draw attention to critical and noncritical attributes of the concept.

5) **Define concept.** Define (or redefine) the concept.

6) **Extend.** Extend the process with more examples and nonexamples until it is clear that the students grasp the concept.

•  **Direct Instruction** is a highly structured teacher-directed model that presents content to students in an organized, step-by-step fashion. It is used when students need to master certain factual knowledge and skills that are best grasped through teacher-directed approaches.

Direct instruction proceeds through five sequential steps. **Step 1: Advance Organizers.** The advance organizer provides a preview of information to be learned. The premise is that meaningful learning results when the student is able to connect new knowledge with existing schema.

**Step 2: Demonstration/Presentation.** Demonstrations are essential components in every phase of science inquiry and are used to: grab attention
(discrepant events), invite questions, model proper skills or procedures, focus
attention on specific challenges, help solve problems, model safety, avoid putting
students in danger, support slow learners and challenge advanced learners.

**Presentation** is the predominant instructional delivery system but trying to present
too much information can backfire. Three tips can help: *Use visuals, rehearse,* and
*less is more.* **Step 3: Guided Practice and Monitoring.** This step affords students
opportunities to practice and demonstrate their understanding of the material, and for
you to monitor the level of mastery. **Step 4: Debrief and Closure.** Students are
guided through a process that helps them make sense of what was taught. **Step 5:
Independent Practice** Students need considerable practice to master a skill or to
deepen their understanding of content. A number of strategies are provided to assure
practice sessions are productive.