**Cooperative Learning Models**

**Student Teams-Achievement Divisions (STAD)**

STAD was originated by Robert Slavin and his colleagues at Johns Hopkins University. The STAD model underscores many of the attributes of direct instruction, and it is a very easy model to implement in the science classroom. As in the entire cooperative learning models to follow, STAD operates on the principle that students work together to learn and are responsible for their teammate's learning as well as their own.

There are four phases to the STAD model: teach (class presentation), team study, test and team recognition. We will illustrate how STAD works by using an example for life science---food making (photosynthesis).

**Phase I: Teach (Class Presentation)**

The class presentation is a teacher-directed presentation of the material---concepts, skills, and processes---that the students are to learn. Carefully written and planned objectives should be stated and used to determine the nature of the class presentation, and the team study to follow. Examples from a unit on Food making would be:

* Students will identify the steps in the food-making process
* Student will compare the light and dark phases of photosynthesis

Key concepts should be identified as well. In this case the following concepts would be presented: ATP, chlorophyll, dark phase, energy, glucose, light phase, photosynthesis.

The presentation can be a lecture, lecture/demonstration, or audiovisual presentation. You also could follow the lesson plans in your science textbook, including the laboratory activities in this phase of STAD. Several lessons would be devoted to class presentations.

**Phase II: Team Study**

In STAD teams are composed of four students who represent a balance in terms of academic ability, gender, and ethnicity. The team is the most important feature of STAD, and it is important for the teacher to take the lead in identifying the members of each team. Slavin recommends rank ordering your students in terms of performance. Each team would be composed of high and low ranking student and two near the average. The goal is to attempt to achieve parity among the teams in the class. Teams should also be formed with sex and ethnicity in mind. Each team should be more or less an average composite of the class.

Team study consists of one or two periods in which each team masters material that you provide. Team members work together with prepared worksheets and make sure that each member of the team can answer all questions on the worksheet. Students should move their desks so that they face each other in each small team. Give each team two worksheets and two answer sheets (not one for each student). For example in the case of the Food Making unit, the teacher would provide the diagram) summarizing photosynthesis, and construct a worksheet consisting of about thirty questions related to Food Making on a worksheet (Table 6.8).

In the STAD model the following team rules are explained and posted on the bulletin board:

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

It is important to encourage team members to work together. They work in pairs within the teams (sharing one worksheet), and then the pairs can share their work. A principle that is integral, not only to STAD, but to all cooperative learning models is that students must talk with each other in team learning sessions. It is during these small group sessions that students will teach each other, and learn from each other. One of the ways to encourage deeper understanding is for students to explain to each other their answers to the questions. One way to facilitate this process is for the teacher to circulate from group to group asking questions, and encouraging students to explain their answers.

**Sample Worksheet Questions (STAD)**

|  |  |  |  |
| --- | --- | --- | --- |
| 1. The organ of the plant in which photosynthesis most often takes place is thea. stemb. root c. leaf | 2. Plants need which of the following to carry on photosynthesis?a. O2, CO2, chlorophyllb. H2O, CO2, light energy, chlorophyllc. H2O, O2, light energy, sugar | 3. The energy stored in plants comes forma. soilb. airc. sunlight | 4. The first phase of photosynthesis is sometimes called thea. light phaseb. dark phasec. chlorophyll phase |
| 5. The oxygen released during photosynthesis comes from thea. chlorophyllb. carbon dioxidec. water | 6. Photosynthesis takes place in the \_\_\_\_\_\_\_\_ of a plant cell.a. cell wallb. cytoplasmc. chloroplast | 6. The energy from the sun is stored in a chemical compound calleda. ATPb. CO2c. H2O | 8. The second stage of photosynthesis is called thea. light phaseb. dark phasec. chlorophyll phase  |

**Phase III: Test**

After the team study is completed, the teacher administers a test to measure the knowledge that students have gained. Students take the individual tests and are not permitted to help each other.

**Science Experiences**

John Dewey once said, "education must be conceived as a continuing reconstruction of experience; that the process and the goal of education are one and the same thing." Science Experiences is a cooperative learning method that brings together the elements of discovery and inquiry methods. Students are involved in scientific investigation, critical thinking, problem solving and group participation.

The activity process for Science Experiences includes an orientation phase, an action phase, and a reporting phase. In the Science Experiences method, the teacher orients the students to the activity, most of which require multiple abilities to accomplish. The activities are designed not to rely on reading, but to emphasize reasoning, hypothesizing, predicting, inductive thinking, imaging, manipulating concrete materials, and using a variety of media sources. To show how Science Experiences can be implemented, the activity "Intergalactic/Oceanographic Mission" is described.

**Phase I: Orientation**

The teacher sets the stage for the small group activity by asking the students why humans have dreamed of traveling to the stars or sailing across vast oceans. Students can generate a lot of reasons either as a whole class, or as members of a small team. In the latter case, the lists are pooled. A general discussion follows based on these questions: What might it be like to go on a journey into space, or across the oceans? What would be some of the preparations necessary to take such a trip?

In this activity, students generate a list of survival needs necessary for long-term travel and create a blueprint for a spacecraft or an ark. They will also make value judgments and consider some ecological implications for long-term travel.

To heighten interest in the activity, the teacher should read each of the following scenarios with dramatic flair!

**For the Space Trekkers**

Scientists as NASA have discovered a new planet that seems almost identical to Earth, but the new planet needs to be studied carefully before scientists know if it is safe to land. Your mission is to orbit the planet for one year in a sealed spacecraft and then return to Earth. Draw the various rooms in the spacecraft and label the things in each room. Be sure to include everything the crew will need to stay alive and well for a whole year.

**For the Ocean Anglers**

The Cousteau Society and a local television station owner have hired you to explore a series of islands that have never been studied by scientists. Your mission is to study these islands for one year in an oceanographic vessel that you cannot leave. The ship will take you to the island area and return you to your homeport in a year. Draw the various rooms in the ship and label the things in each room. Be sure to include everything the crew will need to stay alive and well for the whole year.

Divide the class into teams of four and assign each either as a Space Trekker or an Ocean Angler.

**Action**

Give each team one instruction sheet that contains the following information and problems.

1. Draw and label the things that are most important to stay alive and complete the mission. Work together as a team to design either a spacecraft or an ocean arc. Decide within your group who will be the design engineer, spokesperson for the group, equipment and materials manager, and group facilitator.
2. Obtain a large roll (about 10 feet) of paper for your blueprint, crayons, rules and pens.
3. Construct the spacecraft or ocean arc.
4. When your blue print is completed, make a list of the things that your team has brought on the voyage. Then rank the supplies into three categories:
a. Things that are essential for life and with which you would die.
b. Things that would be hard or uncomfortable to live without.
c. Things that would be nice to have but are not necessary.
5. Discuss the following questions and problems:
a. Will any of your supplies run out? Which ones?
b. How could you make supplies last for 10, 50, 100, or 1,000 years?
c. How would you get rid of waste materials?
Have the students post their blueprints on the walls of the classroom, and be prepared for reporting.

**Phase III: Reporting**

Reporting is a whole class activity, although it focuses on the work of the cooperative teams. In this case you should ask each spokesperson to explain their blueprint, and the rationale for the items and rooms in their ship. Reporting to the whole class should encourage dialog between the teams. This can be done by conducting a small group discussion among the spokespersons (with the rest of the class observing). Encourage critical thinking by asking students to explain and defend their team's work or results.

To encourage students to work harder, STAD uses an "individual improvement score." Each student is assessed a base score---based on his or her previous performance on similar quizzes and tests. Improvement points, which are reported for each team on a team recognition chart on the bulletin board, are determined based on the percentage of improvement from the previous base score. Generally speaking, if the student get more than 10 points below the base score, the improvement score is 0, 10 points below to 1 point below results in 10 improvement points, base score to 10 points above gives a score of 20, and more than 10 points above is worth 30 improvement points. (A perfect score, regardless of base score earns 30 improvement points.

**Phase IV: Team Recognition**

Team averages are reported in the weekly recognition chart. Teachers can use special words to describe the teams' performance such as *science stars, science geniuses, or Einstein's*.

Recognition of the work of each team can occur by means of a newsletter, handout, or bulletin board that reports the ranking of each team within the class. Report outstanding individual performances, too. Sensitivity is required here. It is important to realize that praising students academically from low status groups is an integral part of the effectiveness of cooperative learning. Elizabeth Cohen has found that it is important to be aware of students who you suspect have consistently low expectations for competence. When such a student performs well (not just on the quiz), give immediate, specific and public recognition for this competence.

**Other Models of Science Teaching**

So far we have presented three types of models based on behavioral, cognitive and social-humanistic learning theory. Several additional science teaching models are described that extend the previous models.

**Synectics**

Synectics is a process in which metaphors are used to make the strange familiar and the familiar strange. Synectics can be used to help students understand concepts and solve problems. Synectics was developed by William J.J. Gordon for use in business and industry, but it has also been used an innovative model in education.

According to Gordon, "the basic tools of learning are analogies that serve as connectors between the new and the familiar. They enable students to connect facts and feelings of their experience with the facts that they are just learning." Gordon goes on to say, "good teaching traditionally makes ingenious use of analogies and metaphors to help students visualize content. For example, the subject of electricity typically is introduced through the analogue of the flow of water in pipes."Synectics can be used in the concept introduction phase of the conceptual change teaching model.

The synectics procedure for developing students' connection-making skills goes beyond merely presenting helpful comparisons and actually evokes metaphors and analogies from the students themselves. Students learn how to learn by developing the skills to produce their own connective metaphors.

Gordon and his colleagues, know as SES Associates, have developed texts and reference materials, and provide training to help teachers implement synectics into the classroom.Here is an example of a synectics activity that you could do with students. In this example students learn to examine simple analogies and discuss how they relate to teach other.

* Give students analogies and then ask them to explain how the content (the heart) and the analogue (water pump) are alike. Here are some examples:
* The heart and water pump
* Orbits of electrons and orbits of planets
* The nucleus of an atom and a billiard ball
* Location of electrons in an atom and droplets of water in a cloud
* Small blood vessels and river tributaries
* The human brain and a computer
* The human eye and a camera

After students feel skillful linking the strange with the familiar, challenge them to create analogies for concepts they are studying.

**Person-Centered Learning Model**

The person-centered model of teaching focuses on the facilitation of learning, and is based on the work of Carl Rogers and other humanistic educators and psychologists. The model is based on giving students freedom to not only choose the methods of learning, but to engage in the discussion of the content as well. In practical terms, the person-centered model can be implemented within limits. Rogers believed, as do other psychologists, that making choices is an integral aspect of being a human being, and at the heart of learning. Secondly, Rogers advocated trusting the individual to make choices, and that it was the only way to help people understand the consequences of their choices.

There are several aspects of the person-centered model that appeal to the science teacher, namely, the role of the teacher in the learning process, and the creation of a learning environment conducive to inquiry learning.

**The Teacher as A Facilitator.**

In order to implement a person-centered approach, the teacher must take on the role of a facilitator of student learning rather than a dispenser of knowledge or information. Three elements seem to characterize the teacher who assumes the role of learning facilitator: namely realness, acceptance, and empathy. In the person-centered model, the teacher to show realness must be genuine and willing to express feelings of all sorts---from anger and sadness to joy and exhilaration. In the person-centered model, the teacher acts as counselor, guide and coach, and in order to be effective must be real with his or her students.
Rogers also advocated and stressed the importance of accepting the other person---indeed prizing the person and acknowledging that they are trustworthy and can be held responsible for their behavior.

Finally, to Rogers at least, the most important element in this triad was empathy. Empathy is a form of understanding without judgment or evaluation. Empathy in the science classroom is especially important in developing positive attitudes, and helping students who have been turned off to science to begin to move toward it.
Naturally there are more than these three elements to being a learning facilitator. Technical aspects such as setting up a classroom environment conducive to learning, providing learning materials, and structuring lessons that encourage person-centered learning are involved as well.

**The Person-Centered Environment and Inquiry.**

In the person-centered classroom, students are encouraged to ask questions, choose content, decide upon methods and resources, explore concepts and theories, and find out things on their own and in small teams. Clearly these are elements that foster inquiry. Teachers who truly implement inquiry will find themselves fostering the attitude advocated by person-centered educators. Here is a checklist of elements that signal the existence of a person-centered environment:
In the person-centered classroom, students are encouraged to ask questions, choose content, decide upon methods and resources, explore concepts and theories, and find out things on their own and in small teams. Clearly these are elements that foster inquiry. Teachers who truly implement inquiry will find themselves fostering the attitude advocated by person-centered educators. Here is a checklist of elements that signal the existence of a person-centered environment:

* A climate of trust is established in the classroom, in which curiosity and the natural desire to learn can be nourished and enhanced.
* A participatory mode of decision-making is applied to all aspects of learning, and students, teachers, and administrators each have a part in it.
* Students are encouraged to prize themselves, to build their confidence and self-esteem.
* Excitement in intellectual and emotional discovery, which leads students to become life-long learners, is fostered.

**Integrative Learning Model**

Imagine for a moment a physics classroom. After the students have come in and seem ready to begin class, the teacher says that they are going to begin a new unit on mechanics. He begins the lesson by getting students (and himself) to stand in a circle and begin passing a tennis ball around. At first the teacher tells the students to pass the ball at a constant speed or velocity. Then he says, "Accelerate the ball!" After a few moments, "Now, decelerate it!" The teacher now turns the activity into a game, students may take turns calling out "constant velocity," "accelerate," and "decelerate." As simple and as unusual as this activity is, this teacher has a reputation in the school for doing such activities in his physics class.

In another school, an earth science teacher is playing classical music while she reads a story to the class about how the giant continent of Pangea broke up, and drifted apart, creating new ocean basins, pushing rocks together to form huge mountain chains, and causing earthquakes and volcanoes. After the story is read, students get into small groups to collaborate and create a metaphor of the story, e.g. a drawing, a clay model, or a diagram.

The head of the biology department is seen taking her students outside (once again). This time, the teacher explains that the students are going on a "still hunt." Once outside, the students are assigned to sit in an area of the school grounds (this school has a wooded area to which the teacher takes the class quite often). For five minutes the students sit in their assigned area watching for the presence of organisms----ants, spiders, earthworms, birds, mammals---anything that they can see. They are asked to observe and to record their observations in a *Naturalists Notebook*. The students are assembled at the edge of wood and report their findings from the still hunt. Then the teacher gives the students modeling clay, string, paper, yarn, buttons, cloth, and toothpicks, etc. and says, "Design an animal that will fit into this environment but will be difficult to be seen by other animals." When the creatures are completed students place them in "their habitat." The teacher then has the whole class walk through the area looking for the creatures to find out how well they were designed to survive unnoticed in their environment.
Each of these teachers is implementing a model of learning which some refer to as integrative learning. It is a model of learning which suggests that all students can learn with a limitless capacity, and that students can learn by interacting with their "environment freely, responding to any and all aspects of it without erecting barriers between them."

The learning cycle used in the integrative learning model consists of three phases: input, synthesis, and output. Equal emphasis is placed on all three of these phases. The origin of integrative learning can be traced to Georgi Lozanov, of the University of Sophia (Bulgaria). Lozanov had discovered a method of learning which involved the use of music to help relax the learner, the creation of an atmosphere in which the mind is not limited, presentation of new material to be learned with what is called an "active concert," followed by a period of relaxation, and ending with a series of games and activities to apply the new material that was learned.

The Lozonov method made its way to the United States and can be found in such work as superlearning, accelerated learning, whole brain learning and so forth. Peter Kline, developer of integrative learning has stressed the importance of student synthesis and output in learning. In the integrative classroom, the teacher encourages students to use their personal styles of learning (see McCarthy, Chapter 5), and thus provides auditory, kinesthetic, visual, print-oriented and interactive learning activities. Music, movement, color, mini-fieldtrip, painting, the use of clay, pair and small group discussion are an integral part of the integrated learning model.

---

Jack Hassard, Science Experiences: Cooperative Learning and the Teaching of Science. (Menlo Park, CA: Addison-Wesley, 1990).

Jack Hassard, Science Experiences: Cooperative Learning and the Teaching of Science, pp. 144-145, used with permission of Addison-Wesley.

W.J.J. Gordon and Tony Poze, "SES Synectics and Gifted Education Today,"Gifted Child Quarterly, Vol. 24, No. 4 (Fall, 1980), pp. 147-151.

For training and resource materials on synectics, write: SES Associates, 121 Brattle Street, Cambridge, Mass. 02138.

Carl R. Rogers, Freedom to Learn. (Columbus, OH: Charles E. Merrill Publishing Company, 1983).

Paul S. George, Theory Z School: Beyond Effectiveness (Columbus, OH: National Middle School Association, 1983).

Peter Kline, The Everyday Genius. (Arlington, VA: Great Ocean Publishers, 1988), p. 65