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ABSTRACT

This paper discusses active and meaningful learning and the application of this instructional approach to the college classroom, focusing on techniques used in the author's biology classes. Active and meaningful learning places emphasis on students actually doing things and thinking about what they are doing, relating new information to information already known by the learner. Cooperative learning and critical thinking strategies can be used to promote active and meaningful learning. Examples of active and meaningful learning techniques are discussed, including the use of buzz groups and points to ponder, help sessions, team-based learning, undergraduates teaching in courses as practicum students, interactive computer programs, small working groups in a class, addressing different learners' needs, and creating a positive learning environment for non-majors. The incorporation of active and meaningful learning into textbooks and course materials is also discussed. (Contains 21 references.) (MDM)

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Life in a University is centered around learning. We faculty learn continually as we teach and carry out our scholarly activities. We strive to improve the learning environment for our students so they can learn. As a learning community, we continue to grow in our understanding of what constitutes good learning environments and how our teaching can facilitate learning for our students.

In teaching, my goals are to:

1. acquaint students with new knowledge;
2. facilitate their learning of new knowledge and help them integrate the new knowledge with their previous knowledge;
3. present information within a meaningful framework;
4. acquaint students with new ways to think and learn; and
5. by doing this, help prepare them for a lifetime of learning.

In my attempting to do this, I view myself as a coach and my students as a team. On the first day of class I tell my students that we are in this course together. If they fail, I fail. I will be their coach and help to guide them, but they are the ones that have to "play the game." They are the ones who will be the doctors, physical therapists, dietitians, and athletic trainers making the decisions on their patients and players.

The focus of this paper is active and meaningful learning. Within that framework, I will discuss unstructured cooperative learning and critical thinking. First the concepts will be defined, and then I will share my experiences in using these concepts in the courses I teach and in the textbooks I write.

What Is Active and Meaningful Learning?

In **active learning**, as defined by Bonwell and Eison (1991), students are *doing things and thinking about what they are doing*. Active learning can involve reading, writing, discussing or being engaged in solving problems. In other words, active learning is not a spectator sport. In this view of learning, it is the learners who are responsible for their understanding and their own active construction of meaning. The teacher's role is to facilitate that.

People have known for hundreds of years that they remember what they see and do. A 2000 year old proverb states: "I hear and I forget. I see and I remember. I do and I understand." Experience has taught me the wisdom of this proverb. Data given by Stice (1987) also supports this proverb. He indicates that learners remember ten percent of what they read, 26 percent of what they hear, 30 percent of what they see, 50 percent of what they see and hear, 70 percent of what they say, and 90 percent of what they say as they do something.

We live in a changing world, and a focus on facilitating lifelong learning seems especially valuable. Persons are likely, over their lifetime, to experience changes in their careers, and it will be beneficial if they are lifelong learners. With this goal, it becomes even more valuable to teach the process of learning as well as the facts. There's an old saying, "If you give a person a fish, you feed him for a day. If you teach him how to fish, he'll eat for a lifetime." We want to teach our students "how to fish."

To facilitate learning, teachers need to understand how students, and all of us, learn. One approach is meaningful learning. **Meaningful learning** emphasizes relating new information to information already known by the learner.

One analogy that is used to explain meaningful learning is to think of a sticky strip of Velcro (Cross and Steadmen, 1996). In the analogy, the existing knowledge of a learner is the "Velcro" of the mind. The new information sticks to it, and it is retained. But like lint that prevents sticking on Velcro, misconceptions can interfere with new information sticking to the existing knowledge. However, even this analogy works only if the learner knows what Velcro is. It is similar to a person getting a joke. A click occurs. Even smart people don't get jokes, or understand analogies, if they don't have the information needed to understand them. For example, if you use the analogy that electrons go around the nucleus of an atom like planets go around the sun, it is meaningful for only those students who know about the solar system.

Another analogy which attempts to add new knowledge to existing knowledge is the "lock-and-key hypothesis." All students have had experiences with a key and a locked door so they can easily build an understanding from it. When using this analogy, I explain that my house key opens the door to my house (one lock mechanism), but it won't start my Nissan Sentra (a different lock mechanism). Similarly, a particular enzyme will act on one specific substrate molecule but not another. In this analogy, a particular enzyme is similar to the key. It comes in contact with its substrate molecule. But while the substrate molecule is altered, just like the lock mechanism is, the enzyme leaves the contact with its substrate unaltered, just as the key does. When a learner connects new information to her or his base of existing knowledge, the information gets consolidated into the long-term memory and can be retrieved later.

Good communication with students, or anyone, requires knowing when, if, or how a message is received. If the message is clearly understood, one can build on it. If the message is not understood, then one can try to present the new information again, building from the existing knowledge the students have.

One quick and easy way to obtain this information from each student in a class is to ask each individual to write a One-Minute Paper (Angelo and Cross, 1993). In a **One-Minute Paper**, students are asked to write out their responses to one or two questions in a minute (or two). Typical questions are: 1) What is the most important thing you have learned in class today? 2) What is the question that is uppermost in your mind? The students in my class have been very frank in answering these questions, and I've been surprised by their responses.

While teaching the digestive system and the actions of individual enzymes, I assigned a One-Minute Paper. Even though the students had taken Principles of Biology and I had given a definition of enzymes in lecture, the question that was uppermost in many students' minds was what exactly is an enzyme and how does it function. In finding this out, I decided I needed to do a demonstration explaining enzymes or these students would remain lost as I continued to talk about particular digestive enzymes, their substrates, and their products.

The demonstration I decided to do on an enzyme and its substrate used balloons and student's arms. Each string of two balloons represented a substrate molecule (such as the sugar lactose). A rubber band tied between the ends of two balloons represented a chemical bond (the force holding atoms together). Individual students in the class, holding their arms in a particular configuration, represented the enzymes. The string of two balloons (substrate molecule) was tossed out into the classroom and was bounced around as it hit objects (random movement), or objects hit it (such as a student's fist). The pair of balloons ended up in the arms of a student (the enzyme), and I cut the rubber band (broke a chemical bond). In doing this, a complex molecule (two balloons tied together) was broken down into two simpler molecules (two separate balloons) when they came in contact, and the process of digestion had occurred.

By finding out what knowledge the students had and what knowledge they lacked, I attempted to add new knowledge to the "Velcro" of their minds. Later in my mid-semester evaluation, I asked "What helps your learning in class?" A number of students replied, "the balloon demonstration." So, it had communicated an understanding to some of the students.

How Are Cooperative Learning and Critical Thinking Strategies Used to Promote Active and Meaningful Learning?

One effective way to promote an active-learning environment is to put students into small groups to discuss the new information with their peers. This enables them to "stick" the new information onto their own "Velcro strip." In **unstructured cooperative learning,** the groups are temporary, and within a small group, an active-learning environment is created through cooperative interaction with peers. The purpose is to focus student attention on the new material to be learned and to give students a chance to cognitively process the material by discussing and questioning it.

In addition to facilitating learning, cooperative learning also helps develop other skills, such as communication, decision making, and conflict management (Slavin, 1991). These are all valuable skills to possess in both a person's professional and personal life.

Another way to actively involve students in their learning is to have them critically think both about the knowledge they have and the new knowledge they are learning. King (1995) states that "the hallmark of a critical thinker is an inquiring mind." **Critical thinking** stresses the individual's ability to evaluate and interpret information, make predictions, identify assumption, and draw conclusion from data. *Knowledge* is absolutely necessary for critical thinking. While critical thinking involves higher-order thinking skills, these cannot be utilized without knowledge. In Bloom's levels of learning, he lists a progression of learning from simple to complex: knowledge, comprehension, application, analysis, synthesis, and evaluation. All levels above knowledge require the use of knowledge. Clegg and Cashin (1986) briefly define each level:

> "Knowledge: simple recognition or recall of material; Comprehension: restating or reorganizing material to show understanding; Application: problem-solving or applying ideas in new situations; Analysis: separating ideas into component parts, examining relationships; Synthesis: combining ideas into a statement or product new to the learner; Evaluation: judging by using self-produced criteria or established standards."

Hirsch, in his 1996 book, "*The Schools We Need, Why We Don't Have Them,*" emphasizes that a lack of knowledge reduces a person's ability to think critically. He uses the example that a person with a 4th grader's vocabulary and knowledge cannot be successful in a challenging and responsible career such as banking, teaching, engineering, and the like. Critical thinking involves **analysis, synthesis, and evaluation:** knowledge, comprehension, and application are required prerequisites for these higher order levels of learning.

Critical thinking skills are valuable to all students, and to all of us. At a University Faculty Conference, our faculty was informed that employers of Kansas State University students reported that K-State students lacked critical thinking skills and that they could not use these skills in a group setting - which is what they wanted their employees to do. I have heard this same criticism expressed by national leaders in education across the country. The SCANS (Secretary's Commission on Achieving Necessary Skills, U.S. Department of Labor, 1991) report for America 2000 states that after spending 12 months talking to employers the message was: "good jobs depend on people who can put knowledge to work...Employers and employees share the belief that all work places must 'work smarter'" (p. 31). SCANS research verified that *workplace know-how* has two elements: *competencies* (5 parts) and a *foundation* (3 parts). One of the three foundation skills they list is *higher-order thinking skills*.

As a member of a faculty team, I participated in exit interviews of Kansas State University seniors. We found that the few students we interviewed were unfamiliar with critical thinking and floundered on the question that required it. The students were very bright, knowledgeable and capable, but appeared unfamiliar with the process of critical thinking.

Robert D. Allen (Vice President for Instruction, Victor Valley Community College, CA) in his workshop, *Teaching Critical Thinking Skills in Biology* (1994), stressed at the outset that critical thinking is a learned skill for most people. He has taught critical thinking skills to his students for over 30 years. In his workbook given at his workshop, he states: "Critical thinking is difficult for students. The research literature is clear on this matter" and that, "Critical thinking is a skill much like writing and reading. As such, it takes time to develop."

In Allen's critical thinking questions, he guides what the students focus on by giving five options to respond to. Each student accepts or rejects each option and is required to write out a full *justification* for accepting or rejecting each option. An example of one of Allen's critical thinking questions follows (Allen, 1995).

> "A student proposed that humans could consume enzymes to increase the digestion of food or to digest material that could not normally be broken down. Which of the following most strongly contradicts this proposal?
> 1. Most enzymes in the body are found in the small intestine.
> 2. Enzymes are composed of protein, a polymer of amino acids.
> 3. Acid and enzymes in the stomach would digest the ingested enzymes.
> 4. Enzymes catalyze only very specific reactions.
> 5. If enzymes are ingested, they should catalyze reactions inside the digestive system."
>
> (Without going into the justifications—the most important part—option 3 is accepted and all other options are rejected.)

In one section of 112 students in the General Biology course at West Virginia University, Allen gave students 10-12 critical thinking practice problems per week. Of these, one was graded and returned promptly. The results of the study showed a strong statistically significant correlation between scores on practice problems and on course examinations which included critical thinking questions. Once again the old adage, "If you don't succeed the first time, try, try again" proves true.

Examples of Active and Meaningful Learning

I have attempted to facilitate active and meaningful learning in a number of ways, and some examples follow.

Examples Using Small, Unstructured Cooperative Learning Groups

1. <u>Buzz groups and points to ponder</u>. In Structure and Function of the Human Body (an introductory human anatomy and physiology course), I give my 180 students an opportunity to be actively involved in their learning. During a lecture I give a "point to ponder." After introducing new subject matter, I pose a related situation, and give them 3-5 choices to think about. For example, after explaining the structure and function of the brain and spinal cord, I give this "point to ponder."

> A patient has a lesion in the right half of the most superior region of the spinal cord—just inferior to the medulla oblongata of the brain. When a painful stimulus is applied to the left foot, the patient reports no feeling of pain. When the left foot is lightly touched, however, the patient reports that the stimulus is felt normally. Accept or reject each option, and justify each decision.
> 1. There is damage in the left part of the brain.
> 2. The pain signal crosses to the right side in the spinal cord on its way to the cerebrum.
> 3. The signal for touch crosses to the right side of the body in the medulla oblongata.
> 4. Motor neurons carrying nerve impulses are damaged.

I present a "point to ponder" to the students on the overhead or the chalkboard. Each student is asked to accept or reject each choice, and give <u>full justification</u> for either accepting or rejecting each choice. First, I have the room quiet for one minute while each student mentally makes his/her own decision about each choice. Sometimes I ask individual students to participate by raising their hands and voting to accept or reject each of the choices. Then I ask them to discuss their choices with their buzz group. I assign four students seated near one another as a buzz group. Each student is asked to defend their choices to the other students in the group and then the whole group comes to a consensus on each choice. In the discussion within a buzz group, a student has the opportunity to express herself or himself, to listen, and to justify her or his choice. (An opportunity to stick something new on the "Velcro strip.") Each buzz group selects a spokesperson. Then I ask the spokespersons to contribute the group's decision and their justification as we discuss each choice with the entire class. Each buzz group has to be ready to justify their choices because I call on the groups at random.

2. **Help sessions.** Each week at a scheduled time, students in my course can attend an optional help session. It allows students to ask and discuss any questions they have over the new subject matter. It allows them more time to wrestle with subject matter that is complex and difficult. To begin with, we discuss any questions the students have. Then, the students are put into "buzz groups" of 2–4 students. Focus questions, with no options listed for answers, are put up on the chalkboard or overhead. Students are given a few minutes to discuss them, check their books and notes, and within each buzz group, decide on their answers. They are then asked to discuss their answers with the entire class. One example of a question given on the urinary system was the following: "A man on a road crew is working in the hot sun and sweating profusely as he digs a ditch. Predict if this activity alters his secretion of the antidiuretic hormone and his excretion of urine, and if so, explain the mechanism."

Again, by questioning and discussing the new subject matter, the student has an additional chance to stick new ideas onto the "Velcro" of the mind.

3. **Cadaver dissection teams of 10.** In Structure and Function of the Human Body, we obtain three cadavers from the University of Kansas Medical School for the study of anatomy. It would be extremely difficult to have 180 students dissect three cadavers. Consequently, students in the course apply to be a member of a cadaver dissection team. Thirty students are selected from among those who apply and these students are put into three teams of 10 students each. The three teams dissect the three cadavers and teach anatomy from the cadavers to their peers in lab. All 180 students in the class are responsible for learning anatomy from the cadavers, but only the teams do the actual dissection. Students on the cadaver dissection team receive a number of opportunities for active and meaningful learning: performing the dissection and puzzling out the structures that are being exposed; discussing the anatomy with their team members and instructor as the dissection progresses; and demonstrating anatomy from the cadavers to their peers in their 40-person lab.

4. **Undergraduate students teaching in the course as Practicum students.** A faculty member in the Division of Biology thought that students should have a chance to learn by *teaching* the subject matter. He maintained that people learn subject matter thoroughly by teaching it. He stressed that biology should give undergraduates the opportunity to learn in the same way. Consequently, a Practicum in Biology course was developed. Students who have taken a course and received a B or better, can be undergraduate teaching assistants (Practicum students) for university credit. Undergraduates who have completed Structure and Function of the Human Body teach in the lab, in cadaver dissection, and in peer tutor groups (the latter focuses on helping students learn the lecture material, and is described below).

Under the guidance of a professor, Practicum students in Structure and Function of the Human Body teach in labs of 40 students. The Practicum students get experience explaining the subject matter, demonstrating it, and answering students' questions. They receive similar experiences helping to teach the students on the cadaver dissection team.

Practicum students (peer tutors) also teach the subject matter presented in lecture to small groups (3–16 students) in Structure and Function of the Human Body. Someone has suggested that it is the tutor who should pay tuition, because it is the tutor who learns the most. So in addition to a Practicum student being actively involved in her or his learning while teaching the group, each student in the small group gets a chance to learn by active participation. I do observations of these peer tutor groups, and the students attending are energetically involved in explaining topics, asking questions, and correcting misconceptions.

5. **Interactive computer programs.** In a small lab which is open 12 hours a day Monday through Friday, we have computers set up with programs so students can be exposed to subject matter and questioned over it. For some students, who tend to be independent learners, this is a preferred method. We have quizzes set up over particular topics, modules that we have developed on difficult topics, and A.D.A.M. programs (produced by Benjamin/Cummings) on Interactive Anatomy and Interactive Physiology. The programs ask students to make choices, and the program produces a response so students know whether they have chosen the correct response or not. This interchange does require the student to "think about what they are doing," part of our definition of active learning.

6. **Small working groups in a class.** Labs and studios give students a chance to learn and understand by performing exercises and experiments. The 2000 year old proverb referred to at the beginning of the paper states that people have understood this for a long time. Students in my course, Structure and Function of the Human Body, attend 40-person labs for six hours each week. The students are divided into small groups to do the exercises. Pairs of students work together on dissection of a rat and answering the critical thinking questions. For the exercises in physiology, they work in groups of four. Within the group of four, particular tasks are assigned so each student is actively involved and partially responsible for the results. The students engage in lively discussion and clearly teach one another. In addition to them working together in class, they study together outside of class. We have a small, 24-person lab, called a Study Room, four doors down from the 40-person lab, and students can study, either together or alone, the subject matter they are exposed to in lab and lecture. It is a place where students have a chance to meet other students in the course—those not in their 40-person lab. Often these meetings result in students finding new study partners.

7. **Addressing different learners' needs.** In Structure and Function of the Human Body, some students excel in both anatomy (study of structure) and physiology (study of

function) while other students do poorly in physiology but well in anatomy. Because anatomy is basically a concrete study while physiology requires more conceptual and abstract thought, one explanation for this difference in performance might be found in Piagetian learning theory (Sund, 1976). This theory states that intellectual development occurs in stages, with the Concrete Operational Stage (thinking of the world in terms of concrete objects) preceding the Formal Operational Stage (thinking of the world in terms of the abstract, pure possibility, and logic). A study completed at Kansas State University (Parnell, 1974) found that only about half of the students in a general physical science course were formal operational thinkers. From this study we inferred that our anatomy and physiology course probably had a mixture of concrete and formal operations thinkers.

To aid learning of concepts in this undergraduate introductory course, learning units (consisting of videotapes, models and exercises) were developed. The development of the learning units was made possible by an NSF LOCI grant. These were produced for five abstract physiological topics that students in past classes had found the most difficult to learn, for example "Energy Transformation in the Cell." The learning units were designed so that the student could proceed from concrete to formal (abstract) thinking.

Comparisons between the control group (classes who did *not* use the learning units) and the experimental group (classes who did use the learning units) showed that these learning units significantly improved the learning of material which was specifically related to them. They also facilitated learning of material that was closely or broadly related to them, but to a lesser degree.

On an overall basis, the average gain, adjusted for differences in ability and effort, for material specifically related to the subject of the videotape amounted to 7.1 percent (Stalheim-Smith and Hoyt, 1984). This is a noteworthy improvement since it represents additional gains to those produced by a proven teaching strategy, the traditional lecture, and laboratory. The adjusted gains for related materials, either closely or broadly related, averaged about 4.0 percent. The amount gained is understated by these figures since it ignores learning of materials to which control subjects were not exposed. Special materials prepared for the course appeared to help students achieve a greater mastery of its content. Instructors confronted with similar problems are encouraged to develop such materials.

8. Creating a positive learning environment for elementary education majors. Principles of Biology, the introductory biology course, has about 750 students enrolled each semester. Small groups of these students attend recitations of about 24 students and a large, audio-tutorial lab (based on *The Audio-Tutorial Approach to Learning* by Postlethwait, Novak, and Murray, 1969). As a participant in a National Science Foundation (NSF) grant, "The Development of an Innovative Model for the Preservice Preparation of Elementary Teachers for Enhanced Science, Mathematics, and Technology," I taught a recitation consisting of elementary education majors. During the same semester, I collaborated with Larry C. Scharmann, from the College of Education, who taught the same students a Biological Teaching Methods course.

We organized the experience for these students to be similar to a modified learning cycle (Lawson, Abraham, & Renner, 1989). This three stage learning-teaching model (i.e., Exploration→Concept Invention/Term Introduction→ Concept Application) attempts to emulate how scientists generate and test new knowledge claims. A particular subject was introduced first in the audio-tutorial biology lab (Exploration), then it was discussed in a 50-minute recitation on a subsequent day (Concept Invention/Term Introduction), and then was followed by an application of the weekly subject matter in the Biological Teaching Methods course (Concept Application). The latter sometimes included having the students go into the elementary classroom and teach elementary students.

In this large, standardized Principles of Biology course the text assignments, laboratory exercises, and exam questions were identical for all 768 students. The NSF-sponsored recitation section of 13 students in the elementary education program performed significantly better than did students in the other course sections taught in the same semester ($\chi^2 = 11.67$, $p < 0.05$). In addition, this group of 13 students performed better than other recitation sections taught by me over the previous five-year period. (First, to control for instructor, day, and time, comparisons were made only with other sections taught by me on Friday at 12:30 p.m. during three of the past four semesters. A Kruskal-Wallis k-sample test produced a significant result: $\chi^2 = 10.41$; $p < 0.01$. Second, comparisons were made with all other sections taught by me, regardless of time or day. This second test also produced a significant result: $\chi^2 = 25.03$; $p<0.01$.) Finally, the elementary education majors' section of Principles of Biology performed better (in achievement terms) than did the composite of all sections of Principles of Biology over a cumulative period of 10 years ($\chi^2 =10.39$, $p<0.05$; Stalheim-Smith and Scharmann, 1994).

We relate the better performance to four factors.
1) Priority by the faculty to help the students become knowledgeable, comfortable, and confident in science (a focus in the courses in their first semester in the program and by me). 2) The group of 13 students were cohorts going through a second semester of courses together. Active learning was observed because the students felt comfortable enough to continually ask questions of each other and the professors. 3) The students were put into groups of four (using *The Science Teaching Efficacy Belief Inventory*, Enochs & Riggs, 1990) and encouraged to perform lab exercises together and study together. As a result, the students taught and supported each other. 4) Students were exposed to new knowledge in a modified learning cycle format.

A factor, in addition to the four listed above, that may have contributed to the success of the elementary science education students is the reduction in size of the recitation section from 24 to 13 students.

An Example of Using Critical Thinking Strategies

To focus on teaching critical thinking skills in Structure and Function of the Human Body, we now assign four or five critical thinking questions during the semester to a pair of students. We explain the process of critical thinking to them and give them examples in both lab and lecture, as well as on a handout. The latter emphasizes what they'll be expected to do: **evaluate** the accuracy of the evidence; **determine** whether a prediction is reasonable based on the evidence; **distinguish** between relevant and irrelevant information; **identify** assumptions; and **draw** conclusions (stressing that observations differ from conclusions).

To give the critical thinking questions more focus, we give short-answer questions posed in the multiple-choice format with 4-5 options, as Allen does. Students are asked to accept or reject each option and—the most important part—*justify* why they accepted or rejected each option.

We give a critical thinking question to partners in lab and this gives them the experience of critically thinking with others. Students have several days to complete their answers and hand them in. Instructors stress that the critical thinking question is not a quiz and they are encouraged to discuss the question and each of the options with each other and with the instructor. After discussing it, the partners are asked to come to an agreement and write their acceptance or rejection of each option with a justification of each. Each pair hands in one set of answers and receives the same grade. In a mid-semester evaluation, the majority of students stated that the critical thinking questions aided their learning of the subject matter.

Examples Using Enhanced Textbooks

1. **Incorporate active and meaningful learning into the text**. In our textbook, *Understanding Human Anatomy and Physiology* (1993), my co-author, Greg Fitch, and I include many features that encourage active and meaningful learning. Some examples are, we: 1) start each chapter with an introductory incident that is easy to relate to and in the incident ask pointed questions (to increase curiosity) that will be answered in the chapter; 2) follow the presentation of new information with a clinical perspective or exercise box which requires the use of that information; 3) use questions in some of the headings within the chapter; 4) use concept maps to have students visualize the relationship between structure and function (and encourage them to design their own concept maps); 5) have chapter summaries in question form so students can find out what they know and don't know; and 6) have a section with critical thinking questions at the end of each chapter.

2. **Meeting the needs of all students**. Ron Gaines, Sally Robinson, and I are writing a new text, *Fundamentals of Human Anatomy and Physiology* (unpublished), for students that lack background and confidence in science. A special feature of the text is that it will have active-learning exercises interspersed within the written text of each chapter. The exercises, called "Before You Go On...," will often require written responses by the students. A student will read a section on a particular topic, and immediately following it will be a related "Before You Go On..." For example, in the section "What Types of Contractions Do Skeletal Muscles Make?" we have this "Before You Go On...":

> Close your jaws and then clench your teeth. (Put your finger on the jaw muscle as you clench your teeth and feel the change in the tension in your muscle.) Is the clenching an isotonic or isometric contraction?____________
> As you write your answer, are the muscles in your hand making isotonic or isometric contractions?____________"

In doing the "Before You Go On's...," we are emphasizing the second part of the definition for active learning; *thinking* about what they are reading.

Conclusions

In addition to seeing the benefits that students can receive by focusing on their learning, instructors are motivated and invigorated when they try innovations in class. We ask our students to take some risks in their learning. We can learn by doing the same: by trying some new strategies in our teaching. If we keep in mind the adage of "Adapt, not adopt," the chance that an innovation will work in our class increases.

Try New Approaches

Some instructional strategies involve taking more risks than others. It is easier to start by integrating a lower risk strategy into our usual teaching format. Bonwell and Eison (1991) have a table (Table 2, p. 69) that ranks a number of instructional strategies in terms of 1) whether students are active or inactive and 2) whether the strategy has a lower or a higher risk. For example, the structured small-group (a group that works together for extended periods of time) discussion has active students and requires only a low risk for the instructor, while a responsive lecture (one class period each week which is devoted to answering student-generated, open-ended questions on course material) has active students but involves a higher risk. It is my experience that good teaching does not require gigantic leaps, but can be expressed by *adapting* this old proverb to the teaching profession. Instead of "Greatness is but many small littles," I suggest that "Good teaching is but many small littles."

To draw what I've said together and relate it to the goals I listed at the start, I'd like to share with you a definition of learning I like from "Tools for Teaching" (1993) by Barbara Gross Davis: "Learning is an active, constructive process that is contextual: new knowledge is acquired in relation to previous knowledge; information becomes meaningful when it is presented in some type of framework" (p. 177).

In conclusion, to determine how we view teaching and learning, we can ask ourselves the often-quoted question, "Do you regard 'learning' as a noun or a verb?"

References

Allen, R. D. (June 1994). *Teaching critical thinking skills in biology.* Workshop conducted in Portsmouth, New Hampshire.

Allen, R. D. (1995). *Critical thinking student workbook to accompany Biology: A critical thinking approach.* Dubuque, IA:. Wm. C. Brown.

Angelo, T. A. & Cross, K. P. (1993). *Classroom techniques: A handbook for college teachers* (2nd ed.). San Francisco: Jossey–Bass.

Bonwell, C. C. & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom.* ASHE-ERIC Higher Education Report No. 1. Washington, D.C.: The George Washington University, School of Education and Human Development.

Clegg, V. & Cashin, W. (Sept. 1986). *Improving multiple choice tests.* IDEA Paper No. 16. Manhattan, KS: Kansas State University, Center for Faculty Evaluation and Development.

Cross, P. K. & Steadman, M. H. (1996). *Classroom research: Implementing the scholarship of teaching.* San Francisco: Jossey–Bass, Inc. Publishers.

Davis, B. G. (1993). *Tools for teaching.* San Francisco: Jossey–Bass Inc., Publishers.

Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice scale. *School Science and Mathematics, 90*(8), 694–706.

Gardner, H. (1984). *Frames of mind, The theory of multiple intelligences.* New York: Basic Books.

Hirsch, E. D. (1996). *The schools we need and why we don't have them.* New York: Doubleday Publishing.

King, A. (1995). Inquiring minds really do want to know: Using questioning to teach critical thinking. *Teaching of Psychology, 22*(1), 13–17.

Lawson, A. E., Abraham, M. R., and Renner, J. W. (1989). *A theory of instruction: Using the learning cycle to teach science concepts and thinking skills* (NARST monograph No. 1). Columbus, OH: National Association for Research in Science Teaching.

Parnell, D. R. (1974). *A piagetian evaluation of some conservation concepts for university general education physical science students.* Unpublished doctoral dissertation, Kansas State University, Manhattan, KS.

Postlethwait, S. N., Novak, J., & Murray, H. T., Jr. (1969). *The audio-tutorial approach to learning* (2nd ed.). Minneapolis, MN: Burgess Publishing Company.

Secretary's Commission on Achieving Necessary Skills. (1991). *What work requires of schools: A SCANS report for America 2000.* Washington, DC: U.S. Department of Labor.

Slavin, R. E. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 48*(5), 71–82.

Stalheim-Smith, A. & Fitch, G. (1993). *Understanding human anatomy and physiology.* Minneapolis: West Publishing Company.

Stalheim-Smith, A. & Hoyt, D. P. (1984). *Facilitating the learning of abstract concepts in physiology.* Unpublished manuscript.

Stalheim-Smith, A. & Scharmann, L. (April 1994). General biology: Creating a positive learning environment for elementary education majors. *The American Biology Teacher*, 216–220.

Stice, J. E. (1987). Using Kolb's learning cycle to improve student learning. *Engineering Education, 77*(5), 291–296.

Sund, R. B. (1976). *Piaget for educators.* Columbus, OH: Charles E. Merrill Publishing Company.

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