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THE SCIENCE OF TEACHING

Is Teaching Scientific?

By Jamie Cano

Few, if any, activities are as crucial in schooling as teaching; and, as elusive and complex as teaching may be, research towards its understanding must continue. Most of the research on teaching, however, is not read by the most important group, that is, by teachers, who can and should benefit by knowing, understanding, and integrating the ideas, concepts, and conclusions of the research. Research about teaching and learning is what answers for us the "why" question we may have from time to time. There is a logical, scientific-based reason for the methods, activities, and materials that teachers use in the classroom! It doesn't just happen!!

Maybe we as teachers have yet to have conversations about teaching and learning with our colleagues because there is still another inherit problem in education. The problem is that we are unable to define precisely what effective teaching is, so thus, the preparation of teachers and the definition of teacher competency are open to widely varying interpretations. Though the question reads: What is known about effective teaching?, it could as readily have been framed as, What is known about successful teachers?, or What is known about what makes teachers good at what they do?

The answer to these questions embraces all of the research that deals with relationships between or among variables, including nearly all of the process-product research, as well as a portion of the research pertaining to teacher thinking, cognitive processing, teacher expectancy, as well as a number of studies dealing with the topic of learning to teach.

Research that studies relationships between variables entail a conception of knowledge about teachers and teaching that some believe to be critical for the advancement of teaching. Researchers in this category see themselves producing knowledge about teaching (science of teaching). Using methods and designs found in the social sciences, they seek the determinants of good (successful, effective) teaching. Their work rests on the belief that if their methods and designs are in accord with accepted scientific theory and practice, their results may safely be accepted as knowledge (science) about teachers and teaching.

Gage (1978), sets forth in his book, *The Scientific Basis of the Art of Teaching*, that the science which is the basis for teaching, is psychology. Gage further stated that "a scientific basis consists of scientifically developed knowledge about the relationship between variables." Working within what might be called a standard or conventional conception of science, Gage argues that scientific knowledge is nomothetic (law-like).

Another noted educational researcher, David Berliner (1987) contended that we are on the threshold of creating a scientific basis for teaching. Berliner (1987) argued that educational science has made practical contributions to education. In another effort to codify the knowledge accumulated through scientific studies for use by persons preparing to teach, the American Association of Colleges for Teacher Education commissioned William Gardner to create a manuscript on the science of teaching. Gardner (1989, p. ix) wrote that "teaching does have a distinctive knowledge base….This knowledge base has been generated in research…"

In the preparation of teachers, there is still another problem, and in examining teaching principles and practices, we cannot agree on whether teaching is a science or an art. Some readings say that this is a hopeless dichotomy, because the real world rarely consists of neat packages and either/or situations. A science of teaching is attainable because it implies that good teaching is possible by closely following rigorous laws that yield high predictability and control. This, my fellow colleagues, is THE science of teaching.

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Theme: The Science of Teaching

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The Science of Teaching

By R. Kirby Barrick

Like most undergraduates in agricultural education, I complained a lot. The curriculum was so jam-packed. We had to complete all of the campus-wide requirements, just like everyone else. Because of state teacher certification standards, we had to take more "agriculture" courses than nearly all of the other agriculture students. After all, we were earning a Bachelor of Science *in Agriculture*, so it made sense that we should study agriculture. And then we had to complete a carefully sequenced set of courses and experiences in professional education. Perhaps without fully realizing it, we were learning *what* to teach as well as *how* to teach it.

Don't get me wrong. The undergraduate education curriculum was excellent. After an introduction to the field (we were nearly all headed to high school teaching), we participated in an early experience to get a feel for what it might be like from the other side of the teacher's desk. Since I had experienced an excellent high school program and teacher and had been an "FFA jock," I caught on rather quickly. Then courses in history and philosophy of education and teaching methods (lesson planning, etc., etc.) were followed by the penultimate student teaching.

I survived. I survived because I had been given tools so that I knew, for the most part, what to do and how to do it. But there was something missing—something I could not identify until I started a master of science program. Then it all started to make sense.

Now, my teacher preparation program was not a cookbook approach at all. But with the confines of a rigorous curriculum designed to meet two objectives (a degree and a certificate), there had not been room for the third component—*why* do the tools work, and *why* do they, sometimes, not work. And I learned that there was and is a whole body of knowledge out there that I call the *science* of teaching. Dewey, Lancelot, Stewart, Bloom, and then Rosenshine and Furst, Dunkin and Biddle, Good and Brophy. Wow! All of that stuff I had learned to do suddenly made sense from a scientific approach!

> There is a whole body of knowledge out there that I call the ***science*** of teaching.

That is what this issue of *The Agricultural Education Magazine* is all about. Can we survive without understanding the science behind what we do in our classrooms, laboratories, experience programs, leadership development, and adult programs? Of course. Many teachers do. But when we fail to take into account what we know from science about the teaching and learning process, our teaching methods, our curricula, our assessment techniques all fall short. And, we are less able to justify why we have a laboratory, a greenhouse, a farm, or why we spend time with students in their home and work environment, or why we cannot teach for an entire year from one textbook, and why the FFA works.

The authors for this issue have done exceptional work in bringing together what we know about the teaching and learning process and what we do in agricultural education. But this is just the beginning. Subsequent issues will continue to address planning, the teaching act, assessment and other facets of teaching, reflecting on and utilizing the *science* of teaching. Enjoy reading, enjoy teaching, and enjoy knowing that what we do is well-grounded in the science of teaching.

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Organization and Structure for Effective Teaching

By Brian Warnick and Gary Straquadine

Effective agricultural education begins with organization and structure. Success is not a random act or merely an artful performance of the *sage on the stage*. Effective teaching which will result in effective learning must have a known organizational pattern and apparent structure. The "discovery" of the structure of DNA brought a new level of knowledge to biology. As Watson and Crick wrote in 1953, "the double helix structure has novel features which are of considerable interest. . . . It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." By understanding the organization and structure of the DNA strand, replication becomes possible. The purpose of our writing is to borrow from such a premise and to provide an organization and structure for the implementation of effective agricultural education.

Good teaching does not just happen. It is not a spontaneous set of actions in the universe that converge in some sort of harmonic alignment resulting in excellence. Good teaching begins with a thorough appreciation for and an understanding of the scientific foundations of teaching-learning organization and structure. For the purposes of this article, we want to address the science of organization as the curriculum. We will explore the application of structure to the teaching and learning process.

The curriculum for agricultural education in the public high school includes the principles, objectives, methodology and organization of reading skills, activities, and influences, both formal and informal, over which the institution has control in developing the growth of the enrolled youth and adults. A course of study is an arrangement of all materials and learning activities which serve as a guide for the teacher and school in harmony with the constitution, legislative mandates, and overall objectives of the governing board (Humpherys, 1965). Education is that re-constructing or reorganizing of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experiences (Dewey, 1916).

Organization of the curriculum

Philosophical concepts provide direction for curriculum organization and outcomes. These concepts are derived from professional agricultural education and grounded in the theory of community, sequence, and currency of issues. If the principle is accepted that education should prepare one to think and act purposefully in the solution of the problems of life, the curriculum of the school should be selected with this end in view (Berry, 1924).

A career in the diverse agricultural production, processing, and distribution industry requires a broader education than does any of the other vocations or professions. For example, agricultural production is not a single problem, but a multitude of problems centering about the factors which control and limit production. A national curriculum model for agricultural education would be reduced to a generic sprinkling of common topics – none specific to the environmental, social, or economic characteristics of a selected community. Unlike technology education, business and marketing, or even family consumer sciences, the unique differences in products, production models, and markets make a national agricultural education unrealistic.

On the other end of the spectrum is the local community. Each individual

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Theme: The Art of Teaching

This issue will look at the broad topics of delivering instruction to learners. Included will be articles on effective lecturing, active learning strategies, problem-based learning, case methodology, and the use of technology for the delivery of instruction.

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community will indicate special characteristics in culture and production strategy and can insist upon the authority to develop a locally specific program of study. Yet, too much diversity will eliminate the possibility for standardization within a state – and it is the state that is responsible. The 10th Amendment to the Constitution states: "the powers not delegated to the United States by the Constitution, nor prohibited by it to the State, are reserved to the States respectively, or to the people." Therefore, educational organization, specifically the program of study used for agricultural education, is a state responsibility, not a local opportunity for uniqueness.

> Effective teaching which will result in effective learning must have a known organizational pattern and apparent structure.

As early as 1924 Berry cited the limitation of the course of study used in many agricultural education programs. He wrote, ". . . the course of study has a tendency to limit the teacher in his study of community needs, and especially so when the time allotment is specified. It resembles the course of study pursued by the teacher at the agricultural college, and the usual procedure is to carry it out in a similar manner." We prepare teachers at universities with a higher education model of instruction (e.g. lectures, independent research and presentations, and problem-less, antiseptic lab experiments). The newly-minted teacher then proceeds to the high school where students look for realistic problems, cooperative learning activities, and the integration of information. The disconnect in how we prepare teachers and what their students need can be disappointingly apparent.

The rapidly expanding use of technology in presenting the curriculum is a blessing that is about to become a problem. Teachers are using technology as a tool to enhance the gathering of information and the analysis of data to reach logical and reasonable conclusions. Yet, for some agricultural education programs the use of technology has become a primary purpose independent of a problem to be solved. Canned software with colorful graphics and often sounds and links to internet sites are available from zero (share-ware) to thousands of dollars. Information is neatly compartmentalized and segments of information are provided like snacks on a cross-country flight. That degree of parsimony doesn't let the students see the complexity of the issue; they just don't get to see the big picture (Cooper, 1999).

Examine how you are using technology in your classroom and laboratory. Here are four of the most frequent reasons given for using technology (there are probably many more):

- to improve access to education and training
- to improve the quality of learning
- to reduce the costs of education
- to improve the cost-effectiveness of education.

Structure of the teaching-learning environment

The scientific basis for teaching is more than the closely followed procedures and rigorous principles that claim to yield predictability and control. The scientific basis for teaching includes the artful, informal, and qualitative strategies (Gage, 1978). Teaching is more than a science and more than an art.

Students look for structure, the routine or rhythm of the class. Consistent patterns of teacher behavior will result in students who exhibit on-task behaviors more quickly and stay focused on the learning activity. Rosenshine and Furst (1971) use the overarching term task oriented and/or business type behavior. It is more than anecdotal evidence. It works.

Students are more successful when they are told of the learning goals and objectives. At the university level we are continually surprised by how many professors prefer the guesstimation approach to teaching when they do not develop learning objectives. Floyd McCormick, a leader in Arizona agricultural education, states in his book *The Power of Positive Teaching*, "The quality of teaching will be a direct result of the quality of planning for delivering an interesting and exciting learning experience." And to achieve such a goal the teaching plan is developed to achieve specific educational objectives.

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Summary

You can make it happen – with an understanding of organization and structure. Your natural abilities as a stand-up performer in the classroom will only carry you so far in achieving excellence in teaching and learning. An understanding of the curriculum process and responsibilities of a state-based program of study is essential. In the classroom and laboratory, skills in the use of objectives and keeping students on-task must be developed. It is an important appointment. The impact you are making in your agricultural education program can best summarized by W.H. Lancelot (1944):

All teachers should see that, as they prepare young people to perform larger and more worthy parts in life, they are really giving shape and character to the society of the future – that education of today <u>*is to determine the history of tomorrow*</u>*. Others may be working for the present, but teachers are working for the future.*

Effective teaching in agricultural education *will* result in effective learning. Just as Watson and Crick's model for DNA holds a specified organizational pattern and apparent structure, effective teaching requires organization and structure. Following an organizational pattern and apparent structure allows effective teaching to be replicated just as the organization and structure of DNA provides for its replication.

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Student Motivation: The Bottom Line

By Jack Elliot and
James A. Knight

When reviewing the basic principles of teaching and learning (Newcomb, McCracken, Warmbrod & Whittington, 2004) and then overlaying those principles with the research that has been done in this arena, it is our view that we are inevitably drawn to the basic idea that the bottom line related to student achievement is the motivation of the students themselves (see motivation principles 3-6 from Newcomb et al.). Of course the other principles are important, but without student motivation little learning takes place. Motivated students can work through and overcome instructional shortcomings in other areas, but if their motivation is lacking, then even exceptional work of teachers with the other principles rarely compensates for that shortfall. The purpose of this article is to call attention to the impact that reward and reinforcement have on the motivation of students (see reward and reinforcement principles 7-9 from Newcomb et al.).

> The fundamental approach to the program components of classroom/laboratory, FFA, and SAE are the real sources of student motivation.

Theoretically and pragmatically speaking, the power of ideas like appropriate praise and positive reinforcement has been well established in the social science literature base. Duncan and Biddle (1974) found that praise in traditional teaching was in short supply and that appropriate praise was associated with more positive student self-concepts and higher student achievement. Criticism, on the other hand, was associated with lower student achievement (Rosenshine & Furst, 1971). Further, it was found that criticism has a negative correlation to student achievement. That is, generally the more the criticism the less well students perform. More recent research has reaffirmed those findings (Hancock, 2000, Hancock, et al. 2002). This does not mean that teachers should avoid giving academic directions. What it does say is that students generally perform better in situations where the climate is more positive in nature.

Motivating students to achieve academically raises the specter of intrinsic versus extrinsic motivation. Teachers want to know how to influence student motivation given that students often arrive at school with a predetermined attitude about their ability to succeed or fail. The fundamental competitive view of our economic system often dictates the ways in which many reward systems are organized to motivate students. Rather than finding ways to recognize each student as an individual as suggested by many school experts, teachers often set out to develop systems that will manage both behavior and academics by rewarding those who comply and punishing those who do not (Kohn, 1986; 1993; 1996).

The Skinnerian model of changing behavior by immediate feedback, such as praise or negative response, remains in classrooms even though the theory itself has been found ineffective for changing behaviors long term (Brophy, 1998; Carter, 1996; Jensen, 1998, Johnson, 1999; Kohn, 1993). Therefore, based on current research, it seems inappropriate to use behaviorist models to motivate students to achieve academically.

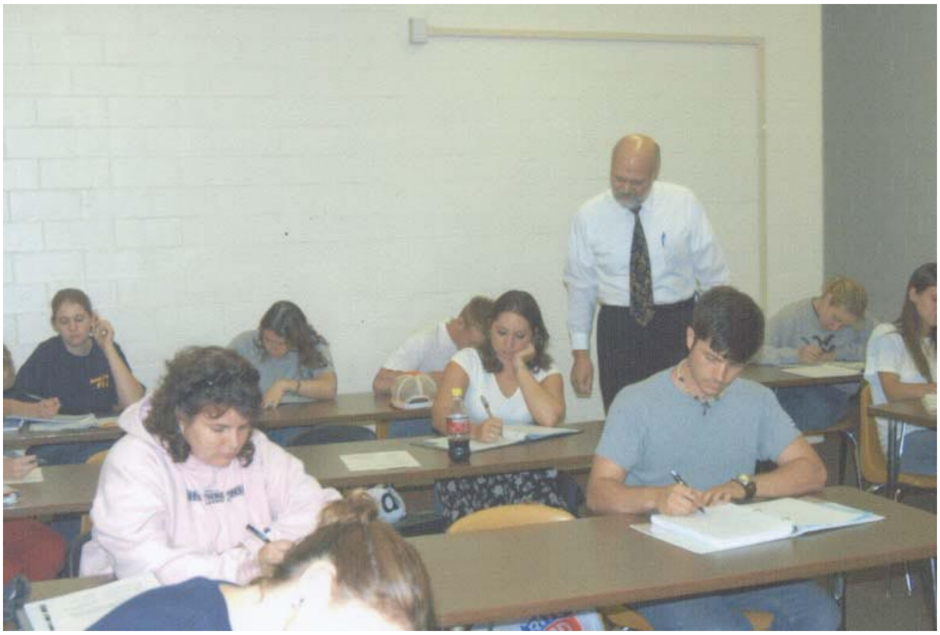
External rewards, while still popular, generally have only a short-term positive effect and possible long-term negative effects on learning. When students have a sense of control and choice, on the other hand, and are challenged just above their level of competence, they have increased intrinsic motivation, persistence, and belief that they can be successful. Brophy (1998) helps teachers make a distinction between positive recognition and providing rewards. He notes that intrinsic motivation is not undermined by the use of rewards as such, but offering rewards in advance of action as incentives leads students to believe that they engaged in the rewarded behaviors only to earn the rewards. The students' focus is on the reward, not on the learning that has value in its own right.

It is no surprise that to improve students' academic achievement, successful programs incorporate the social contexts for both intrinsic motivation and internalized extrinsic motivation. These include cooperative learning lessons (Bassett, McWhirter, Jeffries & Kitsmiller, 1999; DeKeyrel, Dernovish, Epperly & McKay, 2000) and programs that promote problem solving, feedback, and students' sense of control over learning activities (Hootstein, 1996).

New studies strongly indicate that teacher attitudes and actions influence students' sense of their abilities in math and science (Middleton & Spanias, 1999). Teachers need to give more sense of intrinsic motivation to students by improving instructional practices that promote interest and success. In a study of Hispanic science students, being able to see real life models of people practicing science changed students' attitudes and beliefs about their own abilities as well as their interest in science (Sorge, Newsom, & Hagerty, 2000).

The challenge for teachers is to provide appropriate balance as students develop both intrinsic motivation and internalized extrinsic motivation or goal orientation. Teachers can provide the optimal challenge and the problem solving support for academic success by including: choice, feedback, interpersonal involvement, acknowledgment offeelings, celebrations rather than rewards, real life models, and cooperative learning.

Strategies that provide students with renewed intrinsic motivation are (Anderman & Midgley, 1997): having meaningful tasks, communicating the idea that ability is not fixed, using a variety of instructional strategies and assessments, and providing a sense of competence and achievement along with some sense of autonomy in the learning process.



These strategies, along with positive teacher attitudes, help students develop a sense of competence and achievement through positive recognition for their work.

While we in Agricultural Education have utilized lots of external reward systems and generally consider them to be effective, the more recent research findings tend to lead us to conclude that the fundamental approach to the program components, classroom/laboratory, FFA, and SAE, are the real sources of student motivation. That is to say, by connecting the instruction in a more holistic way where students are able to make personal connections among the three components, motivation to learn appears to be stronger and more persistent.

As students see how the instruction in a classroom relates to their personal goals and choices and are able to then apply that instruction to a supervised experience program, they will tend to be more motivated. Now, add opportunity connected to both, where students can be rewarded and/or recognized in some form or other from external sources like the FFA, and we are more likely to positively affect student motivation.

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> The challenge for the teacher is to provide appropriate balance as students develop both intrinsic and extrinsic motivation.

The Problem-Solving Approach: Taking Students Beyond Knowledge

By Rick Rudd

It was a very cold and snowy January morning in London Ohio. I was buried in my bed, somewhere between dreams of springtime and the chilly reality of the day ahead when the telephone ring pushed me into the later. It was Bob, a freshman in my agricultural education program. He was calling from the barn where he reported that his gilt was in the process of delivering her first piglets. The conversation went something like this;

Bob – "Mr. Rudd, she's having the piglets!!"
Me – "It's OK, Bob; she knows what to do. She and the piglets will be fine"
Bob – "But it is so cold… I SEE ONE! CATCH IT!!"
Bob's Dad – "Mr. Rudd? I am sorry to bother you at home but we would feel better if you were here to help."
Me – "I'll be there as soon as I can."

While driving through the darkness to the barn, I realized that Bob and his dad were faced with a new problem. They lived in town and had no experience with farm animals. Even though we had discussed parturition and covered the bases on what needs to happen during the process, they were experiencing this situation for the first time. When I arrived at the barn I was surprised to see four vehicles parked outside. The audience, including grandparents, siblings, and cousins, was gathered around Bob as he waited with a towel in hand, kneeling at the back of the gilt, waiting for the next delivery.

Did the gilt and the piglets need all of this attention? Probably not. But the learning taking place around the event was rich! We discussed the process. I talked with the family about processing the pigs from this point (needle teeth, tail docking, iron supplements, etc.). Everyone, including Bob, was ready to learn what to do to make sure the newborns thrived. Although the lessons had been taught in the classroom, this was real! Bob was presented with a situation that was important to him and he was never more ready to learn.

Dr. Lowell Hedges, a mentor of mine from my undergraduate days at Ohio State, often said that people do what they do for one of two reasons; they want something that they do not have, or they have something that they do not want. In other words, people are driven by perceived needs, desires, questions, or problems to be solved. When problems interfere with our basic needs of life, or obstacles stand between what we desire and reality, we are receptive to solutions that enable us to reach our goals.

This basic philosophy has been a driving force behind utilization of the problem solving approach to teaching in agricultural education. But is our desire to help students learn through problem solving a viable teaching philosophy?

Problem solving represents an approach to teaching that provides students with the opportunity to move from declarative (facts and beliefs), contextual (knowledge about agriculture) and procedural (knowledge about agricultural processes) knowledge to more complex cognitive processes like problem solving, critical thinking, and decision making as an agriculturalist. Students also learn to solve familiar problems with strategies that can be used to solve unfamiliar problems in the future (Shunk, 1996; Hedges 1991).

The problem solving approach to teaching should not be confused with an individual teaching method or technique. It is an approach to teaching that utilizes many methods while focusing on problems to be solved, decisions to be made, situations to be improved, and reasoned thinking (Shunk 1996; Hedges 1991; Ceci 1989; Perkins & Salomon 1989; Chi & Glasser 1985). Problem solving involves the acquisition and use of thinking strategies triggered in situations where we apply declarative, contextual and procedural knowledge to solve problems or make decisions (Anderson, 1993).

Problem solving begins with insight or a sense that a problem exists with a need to find a solution. Wallas (1921) studied a group of expert problem solvers and developed the following model for expert problem solving:

1. Preparation – Learn about the problem and gather information.

2. Incubation – Think about the problem over time.

3. Illumination – Insight into potential problem solutions.

4. Verification – Test problem solutions.

This simple model is very similar to many that have been written since. This model is supported by Gestalt theorists who would argue that learning is insightful and requires the learners to change their perception (Kohler, 1947; Tolman, 1949; Wertmeimer 1945).

Problem solving strategies are used to promote heuristics (rules of thumb), model problem solving practice, and serve as frameworks for solving future problems. Some strategies include: generate and test, means-ends analysis, analogical reasoning, forked road situation, possibilities-factors, steps and key points, situation to be improved, given the effect find the cause, and four-question approach (Shunk, 1996; Hedges, 1991; Resnick, 1985; Stewart, 1950).

Problem-Solving Strategies

Generate and test – This technique is used when multiple solutions may solve a problem. Different problems may require more or less declarative, contextual, or procedural knowledge to solve. For example, you flip the light switch and the light fails to work. Several solutions may fix the problem. You may need to replace a bulb, fix a short in the wiring, reset a breaker, or perhaps electricity is out due to a downed power line. Knowledge and experience will help students prioritize the possible solutions for testing.

Means-ends analysis – When using means-ends analysis, students are charged with examining the current situation and comparing it with the ideal situation (the goal). Sub-goals are then identified to close the gap between present and ideal. Declarative, contextual and procedural knowledge are keys to determining meaningful sub-goals. Complex problems can be a challenge in that many sub-goals can be generated to reach ideal conditions. For example, a student has a goal to raise top quality Holstein replacement heifers. She would consider her current situation as a beginning point and prepare sub-goals to reach her goal.

Analogical reasoning – Using a familiar situation to solve problems in unfamiliar situations is an example of analogical reasoning. Cognitive psychology tells us that connecting new learning to what we already know increases the chances of remembering the new lesson. Glick and Holyoak (1983) found that by providing analogous stories related to new problem situations students could solve the new problems faster and more effectively than they were able to without the stories. This technique was even more effective if students were asked to summarize the analogies with emphasis on the underlying problem themes.

Forked road and Possibilities-factors – These strategies involve making decisions. In the forked road situation, you have only two choices; in the possibilities-factors situation you could have many choices. A possible forked-road decision could be a situation where you are faced with studying for a test or not studying for a test. In a possibilities factor example you must decide to spend time studying for your chemistry, algebra, biology, or history exam. In both cases, you would consider the implications of your choice. Perhaps you have already spent an adequate amount of time preparing and you should take time to relax before the exam. Maybe you are comfortable with all of your examinations except for a particular biology concept. Students weigh choices and make the best decision in light of what they know and believe.

Steps and key points – This approach utilizes logic and proper procedure for solving problems. Students may have a list of steps with key points to consider, or be challenged to develop their own based on similar situations. Examples include jump-starting a vehicle with a dead battery, or preparing a plan of practice for a woodworking project.

Four-question approach – The four-question approach utilizes the following prompts to elicit responses from students in an effort to guide learning based on real questions or problems being experienced by the learners. The question or problem must be identified up front to engage the students in the discussion with the four questions. Let's use the example of a freshman class building a sawhorse. The question in this case is, "How can we build a good sawhorse?" With this question in mind, let's walk through the four question approach.

Question: How can we build a good sawhorse?

1. How important is it to you to build a good sawhorse?

2. What problems have you had (or known others to have) with building wood projects?

3. What do we need to know or be able to do to avoid these problems?

4. What specific information do we need and what skills should we have?

As the teacher leads this discussion, students will help build subsequent lessons to be taught before entering the laboratory to begin work on the sawhorse. Students may be able to provide most of the lesson topics you consider to be important but they may need prompting to arrive at some of the things they need to know or be able to do. This technique leads nicely into the lessons to be taught with student buy-in.

The four question approach is often mistaken for THE "problem solving teaching method," a mistake that has unfortunately turned many teachers away from the overarching approach of using a problem-oriented classroom. This is a powerful strategy, but as evidenced from the other strategies shared above, it is not the only way to integrate problem solving into the classroom.

While early agricultural educators leaned heavily on behavioral psychology to shape students through training and repetition, agricultural education through problem solving is more closely tied to social cognitive theory (modeling, goals, learning related to performance), cognition (using familiar situations to learn new concepts), self-regulation (building powerful schemes to address questions and problems) and constructivism (constructing declarative, contextual and procedural knowledge in a problem oriented setting). Teaching with the problem solving approach helps students learn, retain, and apply the agricultural knowledge and concepts we want them to know as well as teaches students strategies they can employ to solve future problems and make reasoned decisions.

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Problem solving on-sight: "The "laboratory" clarssroom.

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Can You Hear Me Now?

By Jacquelyn P. Deeds and Kirk A. Swortzel

Do you sometimes want to walk around your classroom like the man on the cellular phone commercial asking, "Can you hear me now? Can you hear me now?" The students just don't seem to understand what you are saying. Perhaps the problem isn't the reception; it could be that the signal is not clear.

"Instructional clarity refers to the teacher's ability to provide instruction that helps students come to a clear understanding of the material" (Cruickshank, Jenkins & Metcalf, 2003, p. 65). Rosenshine and Furst (1971) identified the cognitive clarity of the teacher's presentation as being the most promising teacher variable related to student achievement. The researchers identified several major areas where clarity was most important: a) clarity of presentation, b) instructions are clear and easy to understand, c) concepts are explained clearly, d) questions answered intelligently and e) material is sequenced in an understandable manner.

Clarity of Presentation

Do you remember having a teacher somewhere along the way that was very knowledgeable in the subject matter but didn't present it in a way that you could understand? The teacher jumped from one topic to another without a clear transition or started a new topic without finding out if you understood the previous concept. Even if you wrote down everything that was written on the board, you still didn't understand what had happened. This teacher did not provide clear presentations.

Clarity in presentation is guided by the unit goals and objectives: what the students should know or be able to do at the end of the unit. Teachers must identify the main points of the lesson that students should know and decide how to best present them.

At the beginning of class, teachers should provide the students with the objectives or in some way provide structuring comments that prepare students for the lesson topic. Using instructional aids such as the chalkboard, overheads, or PowerPoint slides to provide students with a visual supplement to the oral discussion is very important. When presenting the lesson teachers should not clutter the board or visuals with unimportant detail that might be confusing. Teachers using electronic aids should not move too quickly because students can not write as fast as teachers can talk. Pacing is important to make sure students have mastered the material. Teachers need to review and check with students to determine if they have achieved competence to the desired level. A review at the end of the five day unit is not sufficient. Review periodically throughout the lesson and determine if students truly understand.

Instructions Are Clear and Easy to Understand

Agriscience teachers who attended the "Life Knowledge" training were taught the importance of clear and easy instructions. "Life Knowledge" trainers modeled making sure all the students knew what to do before small group activities.

Teachers who say "Let's go to the lab" without preparing students for the activity planned are setting themselves up for problems. Once 20 freshmen get in the agriculture mechanics lab without something specific to do, they will make up something and it is rarely what the teacher had in mind. Effective teachers have a clear plan

> Teachers spent the largest portion of planning time dealing with content. After subject matter, teachers concentrated on process. The smallest proportion of planning time was spent on objectives.
>
> Clark & Peterson (1986)

and have established procedures for laboratory activities. These teachers discuss the planned activity while all students are in their seats and distribute lab instructions and responsibilities as needed. On a signal from the teacher, the students move to the designated area, don safety equipment as necessary, and begin to work without a lot of milling around and horseplay. This clear transition reduces teacher stress and gives the students more time on the designated task.

Concepts Are Clearly Explained

Soil nutrition may be a hard concept for many students to understand because of the background they have

> Effective teachers have a clear plan and have established procedures for laborabory experiences.

been given related to human nutrition with carbohydrates and protein. Just telling them that soil nutrients are important for plant growth and giving them the acronym "C HOPKNS CaFe Mg BI Mn CoZn Mo" is not going far enough. Teaching students which nutrients come from air and water and the difference between macro- and micro-nutrients is a start, but still falls short. Students must be taught what symptoms reflect a specific nutrient deficiency in plants and the relationship of nutrients to soil pH if they are going to truly understand the concept of soil nutrition.

Clarity is improved by the use of examples, explanations, and elaborations. Agriscience teachers do not just discuss monocot and dicot plants; they give examples of corn and beans. They do not just tell students in livestock judging that having a long loin is important; they explain that the loin is the most expensive cut of meat, so producing animals with a long loin is more profitable. Teachers presenting new or unclear terms need to further elaborate beyond the basic definition for students to truly comprehend. Research also shows that the use of graphic illustrations and visuals increases clarity and improves student comprehension.

Answering Questions Intelligently

Teachers are often frustrated when students respond to questions with "I don't know" rather than thinking about an appropriate response. Students are equally frustrated by inadequate answers from the teacher to their questions, or if by word or action the teacher implies that it was a dumb question. Teachers who strive for cognitive clarity assure students that all questions related to the topic are good questions and should be asked to make sure that students understand the material.

Intelligent answers to questions often begin with probing the student's question to see where the confusion lies. Probing helps students to focus on what they do understand and makes the connection to what needs further explanation. Redirecting the student's question to another student who understands the concept may help in clarification. The student who understands can explain the concept using different terms that the inquiring student will understand or provide a clarifying example.

A father explained the solar system to his son, how the planets revolved around the sun and the distance they were from the sun. When he was finished the son said "I don't understand." The father repeated the instruction using the same words and examples the son did not understand the first time, and then realized that if the son did not understand it the first time an exact repeat was not going to help. Teachers often do this in classes when students don't understand the concept. It is important to rephrase the answer, use different examples, or break the concept down into smaller bits of information to be digested more easily.

Effective teachers are aware that students often have questions they may not ask out loud. Be aware of facial expressions and body language that relay confusion. Where confusion is evident, repeat the concept or instructions using different words or examples before the students ask.

Material Is Sequenced In an Understandable Manner

Instructional sequencing is often associated with the overall curriculum. An example of sequencing is teaching plant parts before teaching plant propagation. Teachers know that the topic sequence is important to assure that students have the requisite knowledge to grasp the new concept. Sequencing is an important part of unit planning.

Students need to be prepared for the lesson. They need to know the objectives they are expected to achieve. Students need to be provided with an interest approach that introduces the topic and helps them to understand the benefits of mastering the material. Students also need to be reminded of how the current instruction relates to previously learned concepts. This prepares students for the instruction and makes it clear where the teacher is going from the very beginning.

After the introduction, teachers mst present information in an organized manner for the students to achieve clarity. Using a step-by-step process on some topics may be appropriate. Making the teaching outline stand out by using parallel phrases like "the first point or topic one for today" is a good way to help students follow the thread of the lecture. Make sure any lists on the board, transparencies or slides have a visible title or heading to help students in organizing note taking and studying. Take time to elaborate on the introductory and important concepts students need for a foundation for further learning. If they fail to get the basic concepts, future clarity is of little importance.

Summarizing Behaviors that Characterize Clear Teachers

Teachers that strive for cognitive clarity in their instruction know their instructional objective and how to organize the instruction so students achieve the objectives. They plan the instruction, provide examples for clarification, and answer students' questions intelligently. In *The Act of Teaching* (2003), Cruckshank, Jenkins and Metcalf list 10 behaviors that characterize clear teachers which summarize the concept and provide a guide for teachers at all levels who want to be more effective by being more clear. Those behaviors are:

1. The lesson is planned and implemented in an organized manner.

2. Students are informed of the lesson objectives in advance.

3. The lesson is conducted step-by-step.

4. The teacher draws students' attention to new or important points by writing them on the board, by repeating them, by reviewing them at appropriate points in the lesson, and by incorporating deliberate pauses that allow time for processing and reflection.

5. The teacher presents and works examples that explain and support the concept or ideas being presented.

6. The teacher explains unfamiliar words before using them in the lesson and points out similarities and differences between ideas.

7. The teacher asks students lots of questions and gives application exercises to find out if students understand the content.

8. The teacher carefully monitors students' work for understanding.

9. The teacher encourages and allows time for students to ask questions.

10. When students do not understand, the teachers repeats main points, presents additional examples or explanation, or elaborates until the students achieve understanding.

If they fail to get the basic concepts, future clarity is of little importance.

Teachers who demonstrate these behaviors will not have to ask "Can you hear me now?" They can rest assured that the signal is being received loud and, more importantly, *clear*.

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Is Your Classroom the Happenin' Place to Be?

By Nevada A. Nevin and
Neil A. Knoblock

Close your eyes. Take a few seconds and try to remember your favorite grade school teacher. How about your favorite high school instructor? College professor? As you reflect upon these individuals, think about why you chose them as your favorites. Do you consider these teachers to be effective? Do they possess similar characteristics? There has been a great deal of research on the characteristics of effective teachers during the past century. Among the characteristics that are continually ranked high when surveying excellent teacher characteristics are variability and enthusiasm (Rosenshine & Furst 1971; Sherman, Armistead, Fowler, Barksdale, and Reif, 1987). The consistently high placement of these two variables, *variability* and *enthusiasm*, make acknowledgement of these two characteristics crucial to any effective educator.

Rosenshine and Furst's review of 42 correlational studies showed that 11 teacher behaviors were strongly and consistently related to student achievement. Rosenshine and Furst variables have guided effective teaching for over 25 years. However, the focus has shifted from teaching and teachers to learning and learners. The American Psychological Association (APA, 1997) created a document of 14 psychological principles that were consistent with more than a century of research on teaching and learning. The *Learner-Centered Psychological Principles: A Framework for School Redesign and Reform* brings together research and practice from developmental, educational, social, organizational, community, and school psychology. These science-based principles support active and reflective learning and learners.

The purpose of this article is to provide scientific evidence for teacher enthusiasm and variability. In doing so, we aligned two of Rosenshine and Furst's (1971) variables with the current science-based learner-centered principles. With a focus on learning and the learner, teacher enthusiasm can support the need for a positive learning environment for student motivation, and variability can support accommodating the diverse needs of learners.

Enthusiastically Create a Positive Learning Environment

Teachers play a major role interacting with students and affecting their learning. Teacher enthusiasm and motivation can influence students' orientation toward learning, motivation, and ways of thinking (APA, 1997). The classroom environment and the degree it nurtures learning can significantly influence learning. Teachers, particularly through their enthusiasm and motivation, play a major role in creating a positive learning environment.

Enthusiasm in the classroom helps to promote a healthy environment not only for learning but for social growth and development as well. Numerous studies have found that enthusiasm makes a difference in student learning in the classroom (Rosenshine & Furst, 1971; Sherman et al., 1987; McDermott et al., 1998). Enthusiastic teachers are willing to learn about their students' backgrounds, motivate them to learn, and hold high expectations for all students' learning (McDermott et al., 1998). Peterson (1998) compares humans to zippers—every team [classroom] needs a person who brings others together and interlocks them as a unit. In the classroom, the instructor plays this role. Peterson shared that a team cannot survive on an empty spirit. If you fill your team with positive energy and radiate that energy with a smile or boisterous laugh, your team will succeed. Ginott added, "I [the teacher] am the decisive element in the classroom. It's my personal approach that creates the climate. It's my daily mood that makes the weather. As a teacher, I possess tremendous power to make a child's life miserable or joyous." If your heart is not into your students and your teaching, few will benefit.

Use Variability to Meet the Diverse Needs of Learners

Teachers also play an important role in directly the teaching and learning process in the classroom. Learning can be enhanced when the instructional tasks engage students in the learning process. Students have learning preferences for how they like to learn and the pace at which they learn (APA, 1997). Some learners need to interact and collaborate with others. Some students need to listen and observe the interactions. Some learners learn by hearing, some by doing, and others by seeing. Sometimes these preferences are not always helpful to learners. Teachers need to get to know their learners and help accommodate their needs. Teachers can help learners develop learning strategies, be sensitive to learning differences, and vary their instructional methods to meet as many learner needs as possible.

Variability has often been reported to be a characteristic of excellent teachers. Teachers serve as a vital link between learners and the environment in which they learn (APA, 1997). It is essential to an effective classroom that variability is utilized to maximum potential. The dilemma of individual differences in the classroom has been the interest and importance in education since Francis Galton (Abell, 1936). After many investigations into individual differences within the classroom setting, it has been concluded that the "range of differences among humans is much greater than commonly supposed" (Abell, 1936, p.268).

Being able to recognize and understand these differences is part of what makes an effective teacher effective. Rosenshine and Furst (1971) studied a number of cases on the teacher's use of variety and variability in the lesson. All studies have indicated that student achievement is positively related to classrooms where a variety of instructional procedures and materials is provided, and where the teacher varies the cognitive level of discourse and of student tasks (Rosenshine and Furst, 1971).

Stimulating teaching has been described as entertaining, motivating, interesting, and thought provoking (Sherman et al., 1987). McDermott, Rothenberg, and Gormley (1998), sum up it up best when they write, "Highly effective teachers know when to be flexible or structured, and they can give and take depending upon children's behavioral needs." Stimulated teachers understand that varying methods of instruction are more beneficial to the learning processes of students and are more likely to produce *stimulated, effective* learners.

Turn Ordinary School Days into Extra*ordinary Moments*

We have summarized the key points in this article by providing five teaching tips for teachers to enthusiastically create a positive learning environment and six teaching tips for teachers to use variability to accommodate the diverse needs of learners. We hope that one of these tips sparks an idea that turns an ordinary school day

Recommendations for Teachers

Enthusiastically Create a Positive Learning Environment

- ♦ Smile. Laugh. Show emotion. Show a passion for teaching and learning when you teach
- ♦ Do exercises (e.g., jumping jacks) between classes to get your blood pumping; look at yourself in a mirror—are you happy with yourself?
- ♦ Engage students in activities that will ask them to share their personal background and experiences
- ♦ Ask students to help decorate your classroom and make it an inviting place to learn
- ♦ Promote out-of-school interactions with students through FFA activities and SAE projects

Use Variability to Accommodate the Diverse Needs of Learners

- ♦ Plan learning activities using Gardner's Multiple Intelligences
- ♦ Switch to different instructional tasks every 10 minutes for passive learning and 20 minutes for active learning
- ♦ Use audio, visual, and kinesthetic modes of instruction
- ♦ Use realia or real-life materials in instruction
- ♦ Engage students in application exercises and activities during every class
- ♦ Ask students for input and feedback on the instruction

into *extra*oridinary learning moments.

It Only Takes a Spark

There are several different characteristics that make teachers effective. This article briefly touched on two important teacher characteristics: enthusiasm and variability. In today's society, students gain more from their teachers than just about any other variable in education. Students view their instructors as not only educators but as role models as well. Try to reach every student in the classroom. Remember and recognize different learning styles and abilities.

Prepare lessons that will involve the entire class and break the melancholy of everyday class work. New ideas and ways to do even the simplest of tasks promote motivation and excitement in the classroom. Enthusiastic learners are ready to dive into class, they are motivated both intrinsically and extrinsically to learn, and they help promote a positive learning environment. Remember, it only takes a single spark to start a fire. School should be a place of great enjoyment for both teachers and students.

Being enthusiastic both in and out of class helps bring about class morale and pride. Variability in classroom delivery increases student achievement and allows for outreach to more students. Enthusiasm can be seen in the smallest smile, heard in the quietest of voices, and is easy to promote. Keep in mind the recommendations stated above such as bringing plants into the classroom, switching weekly tasks among students, and encouraging more experiential styles of learning in class. These few, basic techniques will make your classroom the one everyone wants to come into, instead of walk out of.

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Stimulating teaching has been described as entertaining, motivating, interesting, and thought provoking.

Students will be highly motivated to learn when they attribute success (or failure) to their effort (or lack of it).

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The Science Underlying Task-Oriented Teaching Behavior

By Greg Miller

Task-oriented teaching behaviors are related to student achievement. Is this statement supported by scientific knowledge? Yes, but you should be interested in the operational definition of task-oriented teaching behaviors. You should also be interested in knowing more about how this knowledge was created and its limitations. In this article, I will define task-oriented teaching behavior, explain its scientific basis, and describe its relevance today. Finally, I will share my opinion on where agriculture teachers should seek scientific knowledge to support their teaching.

Task-oriented was fourth on Rosenshine and Furst's (1971) list of teacher behaviors that had been correlated with student achievement. Rosenshine and Furst did not provide a straight forward operational definition of task-oriented behavior. Fortunately, Garton, Miller, and Torres (1992) developed examples of how task-oriented behaviors could be incorporated into the agricultural education classroom. Some examples included: providing structure, organization, and guidance; encouraging hard work; and ensuring a safe, clean, and orderly learning environment.

So what was the research like that supported including task-oriented teaching behaviors on Rosenshine and Furst's (1971) list? They found six studies that reported statistically significant correlations between student achievement and teacher behaviors they categorized as task-oriented. For those of you who have a basic understanding of research, you have probably already said to yourself that statistical significance does not equal importance and that correlation alone does not allow one to say that task-oriented behaviors caused increased student achievement. To their credit, Rosenshine and Furst began by writing "this review is an admission that we know very little about the relationship between classroom behavior and student gains" (p. 37). For the record, it was easy to determine that at least three of the studies cited by Rosenshine and Furst were conducted with first and third grade classes. You might reasonably raise an external validity concern by asking whether you can generalize these findings to a secondary or postsecondary agricultural education program.

> Task-oriented teaching behaviors are related to student achievement.

Task-oriented teaching behaviors have been associated with student achievement in more recent studies. Brophy and Good (1986) reviewed research that had shown relationships between teacher behaviors and student achievement. They built upon prior reviews and focused on research that was reported between 1973 and 1983. Brophy and Good concluded that student achievement was related to "high-inference ratings of the degree to which teachers are businesslike or task oriented" (p. 360). Closer to home, Roberts and Dyer's (2004) panel of 36 experts in agricultural education agreed that, among other things, the effective agriculture teachers

- "Effectively manages student behavior; maintains discipline in class" (p. 91)
- "Encourages, counsels, and advises students" (p. 91)
- "Effectively manages, main tains, and improves laboratories" (p. 93)
- "Is well organized; has excel lent time management skills" (p. 93)

So, there is science to back up the statement that task-oriented teaching behaviors are related to student achievement. However, this science would not meet today's gold standard which requires the use of true experimental designs. It would instead meet the bronze standard (The National Clearinghouse for Comprehensive School Reform, n.d.). The research on teacher behaviors that was primarily conducted in the 1960s and 1970s continues to influence what we do as teachers and is reflected in current teacher evaluation systems (Danielson & McGreal, 2000). For example, Iowa uses eight standards as the basis for teacher evaluation. One standard and its model criteria are clearly about task-oriented teaching behavior. The standard and associated criteria are as follows:

Demonstrates competence in classroom management.

Model Criteria

The teacher:

- Creates a learning community that encourages positive social interaction, active engagement, and self-regulation for every student.
- Establishes, communicates, models, and maintains standards of responsible student behavior.
- Develops and implements classroom procedures and routines that support high expectations for student learning.
- Uses instructional time effectively to maximize student achievement.
- Creates a safe and purposeful learning environment. (Iowa Teaching Standards and Model Criteria, 2002, Standard 6)

I'll bet that you can find similar expectations reflected in the evaluation criteria used in your state.

If you are interested in gold standard research that shows how very specific teaching strategies impact learning, I invite you to read selected papers presented at the National Agricultural Education Research Conference and articles published in the *Journal of Agricultural Education*. Let me refer you to one recent example. If you teach students how to troubleshoot small engine problems, I would strongly encourage you to read an article by Pate, Wardlow, and Johnson (2004) published in the *Journal of Agricultural Education*. In their study, the group of students who spoke out loud their thought processes while troubleshooting engines experienced an improvement in success rate over the control group of about 100%. Wow! We have many opportunities to base our decisions about teaching on scientific knowledge. Even better, some of this research was conducted by fellow agricultural educators.

> Wow! We have many opportunities to base our decisions about teaching on scientific knowledge.

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Teacher Behaviors: Student Opportunity to Learn

By M. Susie Whittington and James Connors

How much more logical can it be than for a teacher to plan daily for students to be given the opportunity to learn the criterion material (Rosenshine and Furst, 1971)? After all, isn't learning, and therefore the opportunity to learn, the basis for our educational endeavors? Why then, would opportunities to learn be absent from many teachers' daily plans, and thus, absent from classroom and laboratory learning environments? The answers might lie in the need to further expand the definition of this characteristic of engaged teaching, and in the possibilities to apply this characteristic in learning environments.

Definitions of Opportunity to Learn

"In three investigations an attempt was made to assess the relationship between the material covered in the class and the class criterion score (Rosenshine, 1968). Thus the absolute definition in the original Rosenshine and Furst (1971) meta-analysis refers specifically to the relationship between content presented and content tested. Today, in the agricultural education methods class at The Ohio State University, the definition for opportunity to learn criterion material has been expanded beyond the relationship between content delivered and content on the test to address opportunity to learn as a two-sided teacher responsibility including content planned, delivered and assessed by multiple means.

For the first side of the two-sided responsibility, we teach our preservice teachers that teachers must *provide every* student, regardless of learning modality (Grinder and Bandler, 1981), strength in multiple intelligence (Gardner, 1983), learning style (Witkin, et al., 1977), or special needs (Teaching Students with Disabilities, 2001), the opportunity to learn that which the teacher has planned to be learned. Choosing to expand the definition of Rosenshine's opportunity to learn had its roots in motivating students. Specifically, a principle of teaching and learning (Newcomb, et al., 2004) that states, "Students must be motivated to learn. Learning activities should be provided that reflect the wants, needs, interests, and aspirations of students" (p.46) drove the expanded definition.

For the second side of the two-sided responsibility, we teach our preservice teachers that teachers must plan to offer ample opportunity each day for the students to *show* the teacher they have learned that which the teacher planned to be learned. Again, the decision to expand the definition was based upon a principle of teaching and learning in motivation that states, "When students have knowledge of their learning progress, perfor-

mance will be superior to what it would have been without such knowledge" (p. 46).

General Examples of Classroom Applications

Learning Modalities (DePorter et al., 1999, p. 85-86)

Visual—colored flipcharts, newsprint on walls, diagrams, charts, handouts with key phrases and bullet points, students organize notes with color codes, visual symbols and icons for notations.

Auditory – vocal variation, students repeat key concepts verbally, pair-n-share, create songs, or raps about important information, mnemonic devices, musical cues. Kinesthetic – hands-on props, simulations of key concepts, provided parallel (side-by-side) hands-on assistance, speak individually face-to-face with students, step-by-step demonstrations, plan for movement in the classroom.

Multiple Intelligences (DePorter et al., 1999, p. 98-100)

- ♦ Spatial-Visual: art, geometry, drafting, "Pictionary."
- ♦ Linguistic-Verbal: language arts, "Scattergories."
- ♦ Interpersonal: cooperative learning, group projects, group activity.
- ♦ Musical-Rhythmic: music, create songs or raps.
- ♦ Naturalistic: outdoor and environment, activities in natural settings.
- ♦ Bodily-Kinesthetic: physical, hands-on, movement.
- ♦ Interpersonal: quiet time, think time, reflective reviews, summaries.
- ♦ Logical-Mathematical: math, science, history, puzzles, logic.

Learning Styles (Witkin, et al., 1977)

- ♦ Field Dependent: group activities, social interactions
- ♦ Field Independent: lecture, analysis, individualized work

Special Needs (Teaching Students with Disabilities, 2001)

As teachers plan and deliver content, we are conscious of the alternative formats necessary for giving learners with special needs the opportunity to learn. Preferential seating, variations in printed formats, frequency of feedback, classroom physical and emotional environment, and exam accommodations are a few of the teaching modifications (Newcomb, et al., 2004) necessary to guarantee that all students are given opportunities to learn the criterion material.

Application

"We have found that the most effective teachers…provided a good deal of instructional support for the students…by teaching new material in manageable amounts, modeling, guiding student practice, helping students when they made errors, and providing for sufficient practice and review. Many of these teachers also went on to experiential, hands-on activities…" (Clowes, 2002, p. 3).

By planning for and using a minimum of two of the methods, techniques, or approaches observed by Rosenshine, in a 48 minute period, teachers begin to ensure that we are providing for all students, regardless of learning modality, strength in multiple intelligence, learning style, or special needs, the opportunity to learn.

For example, following a short but engaging interest approach to capture students' attention (Newcomb et al., 2004), the teacher writes on the whiteboard a clearly stated objective for today's lesson such as, "Students will be able to illustrate and explain the function of each compartment of the ruminant digestive system." The teacher then spends the first 15 minutes of class lecturing about the specifics of each compartment, accompanied by colorful, graphically illustrated overheads or PowerPoint slides, and handouts in modified formats as necessary.

Students write the content information into their notebooks. During the next 20 minutes the teacher has planned for a group supervised study where the students are divided into four groups, one for each compartment in the ruminant digestive system, and each group receives 2-3 pages of reading and illustrated materials accompanied by two teacher-generated questions designed to guide and focus the reading.

In addition to the reading, each group will also rotate, one group at a time, to the laboratory area where the teacher has arranged a partially frozen sheep intestinal tract on a table with each compartment labeled. Students can see it, touch it, (smell it!), and discuss it for five minutes per group.

For the next eight minutes of class time, two minutes for each group, a student spokesperson from each group shares the answers from their supervised study while all students write the answers on a teacher-prepared summary page. The teacher then reviews the objective for the day and reminds the students of how they were given the opportunity to achieve that objective during the previous 35 minutes. Finally, for the remaining 10 minutes of class, the students are given a blank sheet of paper and asked to draw the ruminant digestive system, label the four compartments, write one sentence to explain the function of each compartment, and give the finished product to the teacher.

Interpretation of the Application

In the example above, the teacher planned for, and provided to every student, the opportunity to learn the criterion material, as stated in the objectives. All students, regardless of their preferred modality, had opportunities to learn. The lesson included visual, verbal, interpersonal, and kinesthetic modalities for students with different learning styles. For students with multiple intelligences, spatial-visual, linguistic-verbal, interpersonal, naturalistic, and bodily-kinesthetic aspects were included. Field-dependent learners

> All students, regardless of their preferred modality, should have an opportunity to learn.

were provided with group activities, while field-independent learners benefited from the lecture portion of the lesson. Special needs students were provided with modified formats for information, group work and independent work to meet their individual needs. In the example, the teacher also provided students with the opportunity to *show* the teacher they learned the stated objective by engaging students in the closing activity which used both visual (drawing) and verbal (labels and explanations) modalities.

Summary

Is there a more logical ending to a class session than for a teacher to want the answers to, "Did every student have the opportunity to learn, and did I allow them to show me they learned?" Teachers will *provide every* student the opportunity to learn the criterion material when teachers plan classroom instruction that takes into account the learning modalities, multiple intelligences, learning styles, and special needs of the students. Teachers will provide students the opportunity to show the teacher (and themselves!) that they have learned when teachers plan for the final few minutes of class to answer the question, "Did my students learn today what I planned for them to learn today?"

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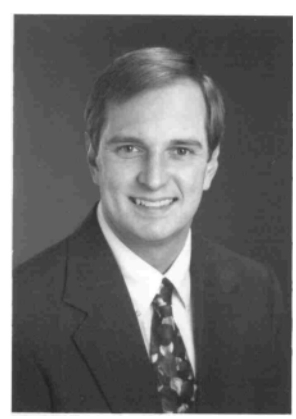

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Are You Feeding or Challenging Your Students: Feeding them Knowledge or Challenging them to Think?

By Harry N. Boone, Jr., Deborah A. Boone, and Stacy A. Gartin

Knowledge is increasing at an astronomical rate. It is estimated that the world's knowledge base doubles every 18 months (Reinhold, 2004). When one limits the analysis to the scientific domain, information is doubling every five years (*Information Today & Tomorrow*, 2000). Even if these facts are an overestimation of the phenomenon, the increase in the knowledge base has dramatic consequences for teachers. Based on these data, the information you teach to a freshman student entering your program will probably be obsolete by the time he/she graduates from high school. If teaching activities are limited to the delivery of knowledge, teachers are wasting their time, as well as the time of their students.

How can teachers be assured that their teaching efforts provide a useful service to their students? The solution is not to teach facts and figures but to use this information to teach students how to think. Many educators believe that specific knowledge will not be as important to tomorrow's workers and citizens as the ability to learn and make sense of new information (Gough, 1991). How should teachers evaluate the degree to which they are teaching higher order thinking skills? One solution is to evaluate all instructional objectives using a "taxonomy of educational objectives" developed by Bloom, Engelhart, Furst, Hill, & Krathwohl (1956).

The key to the successful use of Bloom's Taxonomy to measure higher order thinking skills rests in sharply stated instructional objectives that have been stated in measurable terms. Instructional objectives serve a number of roles in lesson planning that include: 1) providing a sound basis for the instructional materials, content, and methods; allowing the students to organize their efforts toward the accomplishment of the objectives; and forcing the teacher to evaluate the lesson content and determine if it is worth the time and effort to accomplish (Mager, 1984).

Instructional objectives fall into one of three domains of learning; cognitive, psychomotor, or affective (Newcomb, McCracken, Warmbrod, & Whittington, 2004). The cognitive domain deals with the "recall or recognition of knowledge and the development of intellectual abilities and skills" (Bloom et al., 1956, p. 7). Psychomotor behaviors use the mind in combination with motor skills (physical activities). Changes in attitudes, values, and appreciation are incorporated into the affective domain.

Instructional objectives must contain three basic components: performance, conditions, and criterion (Mager, 1984). The *performance* is what the learner is expected to do. The performance must be overt or directly observable. Each objective must describe the *conditions* (if any) under which the performance is to occur. Finally, each objective must describe the *criterion* of an acceptable performance. It is not always necessary to include conditions in an objective nor is it always practical to describe the criteria; however, the more information included in an objective the better it will communicate the desired outcome.

Instructional objectives written in the cognitive domain are often classified using a "taxonomy of educational objectives" developed by Bloom et al., (1956). The taxonomy is hierarchical and often associated with the development of higher order thinking skills. Bloom's taxonomy provides a tool for new and experienced teachers to think about what it means to teach and test for critical thinking (Aviles, 1999; Newcomb & Trefz, 1987). When teachers plan and evaluate their instruction at high levels of thinking, student achievement is improved. The levels of Bloom's taxonomy include knowledge, comprehension, application, analysis, synthesis, and evaluation.

History of Bloom's Taxonomy

By the middle of the twentieth century, educators found themselves in a rapidly changing and unpredictable culture. Because of the changes, many educators found it necessary to move toward an educational system that emphasized a generalized way of solving problems that could be applied to a wide variety of problems (Bloom et al., 1956). Bloom stated "that unless the individual can do his own problem solving he cannot maintain his integrity as an individual personality" (p. 41).

Bloom's Taxonomy

Bloom identified a taxonomy for classifying instructional objectives written in the "cognitive" domain. The levels of the taxonomy include:

Knowledge - remembering of previously learned material; recall (facts

Three Components of an Instructional Objective

Objective: Given 15 feet of rope and an instruction sheet, each student will construct a rope halter within 30 minutes.

Performance: Construct a rope halter

Conditions: Given 15 feet of rope and an instruction sheet

Criteria: Within 30 minutes

or whole theories); bringing to mind. Verbs include: describe, duplicate, find, identify, label, list, locate, memorize, name, order, recall, recognize, relate, repeat, reproduce, show, state, tell, and write.

Comprehension - grasping the meaning of material; interpreting (explaining or summarizing); predicting outcome and effects (estimating future trends). Verbs include: classify, compare, demonstrate, describe, differentiate, discuss, distinguish, explain, express, find more information about, identify, indicate, interpret, locate, outline, paraphrase, predict, put into your own words, recognize, report, restate, review, select, summarize, translate, and visualize.

Application - ability to use learned material in a new situation; apply rules, laws, methods, theories. Verbs include: apply, calculate, choose, classify, complete, construct, demonstrate, dramatize, employ, examine, illustrate, interpret, manipulate, modify, operate, practice, put into practice, relate, schedule, show, sketch, solve, use, and write.

Analysis - breaking down into parts; understanding organization, clarifying, concluding. Verbs include: advertise, analyze, appraise, calculate, categorize, choose, compare, contrast, criticize, deduce, differentiate, discriminate, distinguish, examine, experiment, explain, identify, investigate, organize, question, separate, and test.

Synthesis - ability to put parts together to form a new whole; unique communication; set of abstract relations. Verbs include: arrange, assemble, collect, compare, compose, construct, create, design, develop, devise, discuss, formulate, hypothesize, imagine, invent, manage, organize, plan, predict, prepare, propose, report, schematize, set up, support, and write.

Evaluation -ability to judge value for purpose; base on criteria; support judgment with reason (no guessing). Verbs include: appraise, argue, assess, attach, choose, compare, criticize, debate, decide, defend, estimate, determine, discuss, estimate, evaluate, judge, justify, predict, prioritize, rate, recommend, select, support, value, and verify.

Summary

Are you preparing your students for the real world by teaching them the essentials of higher order thinking skills? The power to think and solve problems should be the student outcome desired by all teachers (Whittington, 1985). Higher order skills of analysis, synthesis, and evaluation are essential to education at all levels (Paul, 1985). Higher order thinking is a continuum and requires knowledge, information, comprehension, analysis, and synthesis (Sultana, 2001). Bloom's taxonomy can provide the basis for developing curriculum and instructional techniques that meet this challenge (Fain & Bader, 1983). The taxonomy and the ability to generate a full variety of questions are all that an intelligent teacher needs to teach critical thinking (Paul, 1985).

Overt -vs- Covert Performances

Covert: Upon completion of the unit, the students will understand the difference between incidental and subsidiary motions.

Key: How will you know/measure understanding?

Overt: Upon completion of the unit, the students will list and compare the uses of incidental and subsidiary motions.

Key: You can observe (read) the list/comparison.

Many of you have probably heard the statement, "Give a man a fish; you have fed him for today. Teach a man to fish; and you have fed him for a lifetime." The saying can be modified to describe today's educational situation. "Teach your students by providing facts and figures and they will be successful for a few years. Teach your students to think and learn on their own and they will be successful for a lifetime." As you prepare your daily lesson plans, use Bloom's taxonomy to develop instructional activities that require your students to develop the higher order thinking skills that will lead to a lifetime of success.

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Examples of Bloom's Taxonomy

Knowledge: Upon completion of the unit, each student will identify in writing the parts of a beef cow.

Comprehension: Upon completion of the unit, each student will be able to compare the muscling of the principle meat cuts in the front and rear quarters of a beef animal.

Application: Given a retail cut of meat, in 100 words or less each student will use their knowledge of muscling to justify the retail price of the cut.

Analysis: Upon completion of the unit, each student will verbally compare and contrast the major breeds of beef cattle.

Synthesis: Based upon their description of an ideal beef steer, the students will design a crossbreeding program that will give the desired results.

Evaluation: Given four beef steers, the students will correctly judge the animals and provide an oral defense of their decision through a set of oral reasons.