teaching TECHNIQUES

IN THE RADIOLOGIC SCIENCES

By Steven B. Dowd and Stephen F. Hulse

Edited by Steven B. Dowd

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A Selection of "Teaching Techniques" Columns Published in *Radiologic Technology*, 1988-1996

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Foreword

A new column debuted in the September/October 1988 issue of *Radiologic Technology*, the peer-reviewed journal of the American Society of Radiologic Technologists. Titled “Teaching Techniques,” it was designed to address topics of concern to radiologic science educators — everything from admissions criteria to curriculum development. The journal had always included articles on education, but most were theoretically oriented, focusing on the abstract rather than the concrete. The “Teaching Techniques” column promised to offer practical, useful ideas that instructors could bring into their classrooms and labs.

Stephen Hulse, a radiography educator who was working as an instructional design specialist for Penn State University, took on the task of writing the column. He brought a pragmatic approach to the art and science of teaching, and “Teaching Techniques” quickly found a large and devoted audience among novice and experienced instructors alike.

When Stephen Hulse retired from writing the column after four years and 18 articles, the ASRT looked for a replacement. Realizing that no single person could effectively fill his shoes, I offered a multidisciplinary approach through the use of the faculty in the Division of Medical Imaging and Therapy at the University of Alabama, Birmingham. Writing responsibilities for the column would rotate among our faculty members, giving each an opportunity to present their ideas (as well as increase their chance at tenure). The ASRT agreed with the multidisciplinary approach, and the UAB faculty took over the column with the March/April 1993 issue.

In early 1996, as the column entered its eighth year, I began thinking about the advantages of collecting all of the “Teaching Techniques” material in one place. If other instructors are like me, they have experienced the frustration of trying to locate a particular issue of the journal from four or five years ago that had an article on test design that they need right now. The obvious solution was to collect all the

"Teaching Techniques" articles in a book format. I also thought new instructors would find such a collection of articles particularly useful.

The ASRT agreed that a handbook for educators would be valuable to the profession and signed on as publisher. Ceela McElveny, managing editor of *Radiologic Technology,* was recruited as copyeditor for the book. My wife Lisa, a skilled and experienced indexer, agreed to help put the book's index together.

It was Ceela's idea to divide the book into four main sections — Instructional Theory, Instructional Design, Instructional Tools and Instructional Techniques. With these sections in mind, I reviewed our collection of more than 30 articles, assigned each to an appropriate section and then wrote brief introductions to the sections. In reviewing the articles, I was impressed by the range of material we covered in the "Teaching Techniques" column during the past eight years. We may not have covered every possible topic, but I believe we did fulfill the goal of the column — providing radiologic science educators with a solid foundation of practical, useful ideas.

The faculty at UAB ended its guardianship of the "Teaching Techniques" column in the fall of 1996, after shepherding 19 articles into publication. Elwin Tilson, the column's new editor, takes over in early 1997.

The "Teaching Techniques" column has served radiologic science educators well.

I hope this book follows in that tradition.

Steven B. Dowd
University of Alabama at Birmingham
August 1996

Introduction: Instructional Theory

Instructional theory refers to the various theoretical underpinnings of education, including theories of motivation and learning. I have no hard evidence to support this notion, but I suspect that most radiologic science educators, being practical sorts, find theory mildly interesting but of little actual value. I encourage those who hold this belief to read Stephen Hulse's article in this section titled "Learning Theories: Something for Everyone." The article does a good job of making obscure theories usable. As Hulse notes, instructors often teach as they were taught, without stopping to think about the methods that will work best. Instructional theories, however, provide groundwork for fertile curricula.

Four articles in this section focus on adult learners — a topic that has special value considering the aging of our student population and the advent of mandatory continuing education. Interestingly, both Hulse and I wrote negatively about mandatory continuing education. My argument with the mandate has to do with the faulty logic that states education is good (I can't disagree there) and therefore everyone should be forced to pursue it (this is where I have a problem). But since mandatory CE is here to stay, we should at least offer it in a form that meets the needs of adults, rather than simply repackaging entry-level education.

I placed Hulse's column on admissions criteria in this section for one reason: The theory behind selecting students is probably no more advanced today than 30 years ago. I doubt if radiologic technology is alone in this regard. But certainly our "inputs" (students, although I hate calling them that) are crucial in determining our "outputs" (graduate technologists).

Many educators would agree that we really don't know what it takes to make a successful student and graduate, although we have our suspicions. But how many of you remember one or more students who were simply atrocious in your radiography program but now are respected chief technologists? Similarly, how many of you recall a student you could have sworn would be the ideal radiologic technologist but who now is a very disenfranchised employee in danger of losing his or her job every day? Admissions decisions can be a slippery slope to climb. I challenge anyone who thinks he or she knows how to select a good student to write up the results of that research … the rest of us would be very interested!

I hope you enjoy this set of articles. Remember, theories give us guidance in times of trouble.

Steven B. Dowd

"Just Tell Them What They Need to Know..."

...and gladly wolde he lerne, and gladly teche.

—Chaucer
Canterbury Tales

"What's so difficult about teaching? You just tell them what they need to know and then give them a test."

That enlightened view pretty much described the educational philosophy of one former colleague. Of course there's much more to teaching than this, and a large part of it is based on understanding how students learn and consciously designing instruction to take advantage of that knowledge.

The learning model we'll be looking at is known as the "Nine Events of Learning" and was first described by Robert Gagné.[1]

1. Gain and Control the Attention of Students

Think for a moment about any prime-time television show. Just before the opening credits is a short segment (called a "teaser") showing a car chase, a fight or some other attention-getting device designed to keep you watching and listening. Every class you teach also needs a teaser to attract and hold student interest and direct attention to the objectives.

Several methods are available, such as asking a question, posing a problem to be solved or telling a story related to the objectives that draws upon the personal experience of the instructor or students. Kenneth Eble[2] tells of teaching a seminar on lecture methods. He began by standing behind the podium, head bent over his notes, droning on in a monotone.

After a few minutes he raised his head and said, "Has anyone ever heard anything like this before?"

"Yeah," shouted someone in the back. "Yesterday afternoon!"

Eble had his teaser. The remainder of the class was spent enthusiastically listing all the qualities of ineffective lectures to discover what contributed to effective ones.

2. Tell the Student the Expected Outcome of Instruction

There's an old maxim in education regarding instructional design:

- Tell them what you're going to tell them;
- Tell them;
- And then tell them what you told them.

When students know the objectives beforehand, they can better organize their thoughts around what they see and hear. If done correctly, students also understand why it is important to learn the material.

3. Stimulate Recall of Relevant Prerequisite Knowledge

Prepare students for success with the current objectives by reminding them of what they already know. Implicit in this is the understanding that objectives follow a hierarchical order, i.e., the attainment of complex objectives are built upon mastery of simpler ones. This provides course continuity by telling students what they have already learned, what they are about to learn and why it's important to learn it.

4. Present Stimuli Inherent to Learning

This is the subject content selected to meet the specific class objectives. It may include, either singly or in combination, the learning of concepts (groups or categories of objects and actions), rules (understanding cause and effect) and discriminations (contrasting and comparing objects or actions). Once again, material must be presented in a logical order, building upon previously mastered material.

5. Offer Guidance

The instructor prompts the student through a series of steps calculated to help him "discover" basic facts and underlying principles for himself. The rate of learning increases because students are less likely to lose time or become frustrated by basing performance on incorrect facts or poorly understood concepts. The goal is for students to make logical decisions based on understanding how different parts of a problem relate to one another. Wild guesses, even correct ones, should be discouraged because they circumvent a grasp of underlying interrelated principles. Remember, knowing "what" is no good unless the student also knows "how" and "why."

Structured guidance can be provided via a carefully constructed sequence of questions leading to a particular conclusion, laboratory experiments where the outcome is known and assignment of specific articles for outside reading.

6. Provide Feedback

Feedback gives a student information about how well his current performance meets the objectives. Feedback has the most impact when it immediately follows the observed behavior, and it can be in the form of a quiz, a test or a verbal comment. The information provided during feedback should be precise, clear and focus on performance. If some of the information is negative, it should not be demeaning.

7. Evaluate Performance

Performance evaluations also provide the student with feedback but generally encompass a larger segment of instruction. Tests, lab practicums and clinical evaluations tell students how they are doing compared to a standard.

8. Provide for Transfer of Information

Students must be able to transfer the knowledge they gain in the classroom to "real-world" situations, with appropriate modifications. Knowledge transfer appears to work best when the underlying concepts and rules have been learned thoroughly. This can be facilitated by using a variety of examples and illustrations in class and making sure that practice has occurred in a setting similar to where the knowledge will be applied.

9. Ensure Retention of Learning

Learning should be reinforced by reviewing the important concepts, rules and discriminations; practicing the performance required; and rehearsing the correct responses.[3]

There's a lot more to good teaching than "telling them what they need to know and then giving them a test." It takes thoughtful planning to design a sequence of events that leads to actual learning.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Admissions Criteria: Eenie, Meenie, Miney, Moe?

Radiologic science educators are lucky. Unlike public school teachers and college professors who have to take what they get, radiologic science educators usually are able to select the students they will teach. But with this prerogative comes the responsibility of being fair and objective.

Fair admissions procedures are desirable for many reasons, not the least of which are moral and ethical considerations. But there is another reason as well: the legal consideration. Rejection of some applicants is unavoidable. But with increasing frequency, the courts are being asked to overturn admission committee decisions in favor of rejected applicants, in the process often revealing poorly conceived or highly subjective admissions criteria.[1] This article examines program admissions criteria with the purpose of looking at applicant information that your admission committee should consider collecting and using as part of its decision-making process.

To begin, an admission procedure must meet several criteria. It must discriminate between qualified and unqualified applicants fairly and objectively, select applicants who are most likely to succeed academically and professionally, and remain cost-effective in terms of time and effort spent in selecting applicants for admission.

Let's first look at some of the general criteria used in schools of health professions.

In a survey of eight health professions including radiologic technology, Dietrich and Crowley[2] found that programs placed primary emphasis on past academic performance, but also relied heavily on standardized testing and personal interviews. Letters of recommendation, student essays and demographic and biographic data were considered to a lesser degree. Interestingly, selection of students by lottery from a pool of qualified applicants also has been reported but is still relatively rare.[2-4] In a national survey of medical technology schools, Garza et al[5] found overall grade point average with a separate evaluation of science grades to be a common practice.

Academic Preparation

Previous academic performance often is a good indicator of how a student will perform in the future. In radiologic technology, Kavanagh[6] calculated Pearson's correlation coefficients for several readily available measures of academic preparation and found the results to be significant. The factors correlated with GPA in a radiologic technology program included high school GPA ($r = 0.71$) and grades in algebra ($4 = 0.61$) and biology ($r = 0.67$). But Kavanagh's study also revealed a relatively low correlation ($r = 0.20$) between high school GPA and clinical GPA. Clearly, clinical competence in radiologic technology depends upon something more than just a good academic background.

Standardized Testing

Standardized testing has become commonplace in all phases of education because of the ease of administration and (when used appropriately) its demonstrated validity and reliability. Perhaps the two most widely used standardized tests in allied health education are the Scholastic Aptitude Test (Educational Testing Service) and the Allied Health Professions Admissions Test (the Psychological Corporation).

In a pilot study performed by the author, a retrospective analysis of 26 students revealed a moderate correlation between SAT scores and radiologic technology program GPA (including a clinical component). Specifically, the coefficients were $r = 0.48$ (verbal SAT score with R.T. program GPA), $r = 0.62$ (math SAT score with R.T. program GPA) and $r = 0.62$ (combined SAT score with R.T. program GPA).

Other authors have examined the usefulness of the Allied Health Professions Admissions Test. Katzell[7] reports that the AHPAT "has shown a high degree of validity as a predictor of first-year GPA in upper division allied health majors." Multiple correlation calculations between first-year allied health program GPA and AHPAT scores exhibit-ed values ranging from 0.84 to 0.31. Katzell points out that where a low correlation exists between preprofessional GPA and allied health program GPA, the AHPAT can appreciably improve the prediction of academic performance.

Leiken and Cunningham[8] confirm the usefulness of the AHPAT as a predictor but suggest that other factors also must be considered. In the admissions model they developed, preprofessional GPA and type of school attended also were examined.

Applicant Interviews

Many health science educational programs use the personal interview as part of the selection process. Gough[9] describes the interview as the most common method of evaluating nonintellectual characteristics. Char et al[10] placed the importance of the interview on a par with preprofessional GPA and standardized testing. Chapman[11] hypothesized that better interviewing techniques would result in selection of more suitable applicants and reduce the drop-out rate from radiologic technology programs. In spite of this, the interview is neither universally used nor respected. Influenced by the constant harassment of threatened political and legal action, the dean of one nursing school did away with applicant interviews, relying solely on GPA as the determining factor.[4]

Still, most people would probably agree with the fellow, who, "after listening to arguments against the use of selection interviews for medical students … rose and stated, 'Gentlemen, if I wanted to get married and you had 20 willing maidens in this room and gave me all the tests in the world about them, I still would like to talk to each of them before I selected one as my wife.'"[12]

Although the interview will continue to play an important role in the selection process, it is not without problems. Shepard[12] identified five potential reasons the traditional selection interview does not predict academic success:

- ***Inappropriate end point measures.*** Interviews cannot be correlated with GPAs and other similar measures. Interviews should be used to evaluate noncognitive, nonintellectual skills.

- ***Restricted rating range.*** Some interview scales use a 4-point range. A 10-point scale may reveal finer distinctions among applicants.
- ***Unreliability among interviewer ratings.*** This concerns the agreement on definitions of traits to be evaluated and the weight certain traits should have in the admission decision. An in-service for interviewers carefully defining each of the traits to be evaluated is a must before conducting interviews.
- ***Interviewer error.*** This includes many interviewer perceptions, such as prejudice, stereotyping, the halo effect, the error of central tendency and the generosity effect. Once again, these problems must be addressed before conducting interviews.
- ***Limited interviewer-interviewee interaction.*** The traditional one-on-one interview format makes it difficult to assess effective communication in small group settings, a quality that a health science student or health professional would be expected to possess. Shepard suggests that group interviews (those with two or more applicants and two or more interviewers) are superior to the one-on-one format.

In creating a job description for student technologists, Chapman[11] lists several characteristics to look for during an interview: attentiveness to people, adaptability, ambition, conscientiousness, dependability, emotional maturity, frankness, friendliness, good naturedness, kindliness, orderliness and quick thinking. He further specifies that the interview must evaluate aptitudes, motivational characteristics, personality strength and limitations, and knowledge and experience.

Several authors have described methods of recording responses during the applicant's interview.[11,13,14] In each method, the interviewer follows a guide sheet with predetermined questions or areas of inquiry. Applicant responses are recorded and points are assigned based on established guidelines. After all interviews have been completed, points can be totaled and comparisons made between applicants.

Letters of Recommendation

Letters of recommendation contribute little meaningful information about the applicant.[4] Most people dislike writing unfavorable comments and, therefore, write only good or noncommittal reference letters, or they write nothing at all. In either case, accurate information is lacking.

The passage of the Family Educational Act of 1974 (the Buckley Amendment) makes this situation unlikely to change. This law allows students and parents to review educational records — including letters of reference — and challenge what they consider to be inaccuracies. Because letter writers cannot be guaranteed confidentiality, few are willing to commit themselves to expressing their true feelings about an applicant.

Weighting Selection Criteria

So now that you have all this information about your applicants, what do you do with it? You begin by digging out all the records of former students — good, bad and mediocre. One by one, begin listing the students' high school grade point averages, class rankings and SAT scores. Continue by entering terminal performance information (final GPA or Registry exam scores) from your program.

Next, you need to assess this information using multiple regression analysis. The only practical way to do this is with a statistical software package and a computer. Multiple regression analysis generates a formula allowing you to "plug in" each of the criteria discussed above and estimate, with known accuracy, an applicant's future academic performance.

Of course, it doesn't end there. Each year you'll have more data on graduating students to enter into the multiple regression program, and each year your formula should get a little more accurate. Is it foolproof? No, but few things are. Statistics always should be applied with caution, particularly in the nonphysical sciences. In the final analysis, only you can weigh all the information and make a decision. But what this method does is give you a firm foundation for making more objective decisions about whom you accept into your program. That in itself should be a great comfort if you ever find yourself on the wrong end of a lawsuit.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Motivating Adult Learners

As coordinator of in-service education for many years, I often was dismayed by the reaction to our department's in-service programs. I would sweat out writing the objectives, pore over the literature to get the latest information, gather appropriate visual aids and coerce experts into speaking to our staff. But more often than I'd like to admit, the reception to in-service programs was strictly "ho-hum." And from discussions with other in-service coordinators both in and out of radiology, I know this was not an uncommon reaction. Why this response to information that should have been important, even exciting to the learners? To answer that question, we must review research done on the topic of adult education. Through the years, a number of educators and learning psychologists have investigated what, how and why adults learn. Some of the results of their research may surprise you.

What Do Adults Learn?

Taken as a group, adults are more likely to be interested in learning information that can be applied in very practical ways, such as solving problems they face in the work setting.[1] After all, most people rarely search for answers to questions they don't have. The challenge for the in-service educator is to consistently show how knowledge can be applied in common situations that confront learners. Gagné[2] suggests asking a question, telling a story related to the program objectives that draws upon the personal experience of the learners, or describing a typical problem that the information presented during the in-service will help solve. Another way to do this is to ask learners themselves how they think they can apply the new information.

You can help ensure that information you're providing to learners is practical by doing a procedural task analysis.[3] There are two benefits to this exercise. First, a complete description of individual steps plus the correct sequence involved in task completion are easily discernible. This data is invaluable for editing and fine-tuning program goals and objectives. Second, important procedural tasks that might otherwise go undiscovered are brought to light. For example, steps in decision making that the competent practitioner uses to select or modify activities are not overtly evident to the casual observer, yet play a vital role in task completion.

Another characteristic of adult learners is that they prefer programs to focus on a single concept or theory.[4] This bias appears to increase with age.

How Do Adults Learn?

Learners in general, and adults in particular, need to be able to integrate new information into an existing framework of knowledge. Information that is totally new — that is, information that does not mesh with any of the learner's previous knowledge or experience — is assimilated very slowly.

Gagné makes two suggestions that may help. First, tell learners the program's goals and objectives. Knowing the objectives helps learners organize their thoughts and puts them in a better position to understand why it's important to learn the material. Second, remind learners of what they already know. Doing this puts the new information into perspective and provides "hooks" for attaching this material to their existing knowledge framework.

In some educational circles, much is made about the presumed dichotomy between pedagogy (child education) and andragogy (adult education).[5] Pedagogy is characterized by teacher-centered authority and a formal organization of subject content. Common methods of instruction include lectures, audiovisual materials and suggested readings.

Andragogy, on the other hand, emphasizes an informal, collaborative learning environment in which instructor and learner work together to develop objectives and program content. Group discussions, workshops and the case method are used to promote learning. Andragogy often is advocated as the "better way" to teach adults. If this is true, then it might seem that the andragogical model would have important implications for in-service education. But applying andragogy in real life has been problematic. Houle and Brookfield[6] explain why: "There is a consistent overestimation of the adult learner's readiness to be self-directing.… [T]he more common reaction is one of confusion, anxiety and often anger. Students will say, 'We paid a high price to come here and we want your expertise.'"

Roelf, in a study cited by Cross,[7] reinforces this finding. Roelf found that adult learners older than 30 were more likely to prefer pedagogical-based instruction. I observed this phenomenon at a national educational conference. Attendees were well educated and held positions of responsibility at their sponsoring institutions, yet virtually all conference sessions were based on pedagogical principles. Men and women who routinely made life-and-death decisions sat quietly in their seats, waiting to be told what they needed to know.

An exception was a session dealing with the application of program planning. Thirty of us crowded into the closet-sized room. We knew we were in trouble when the "facilitator" said, "This is going to be your workshop. You are going to tell each other how to improve program planning at your institution." None of us had a clue about how to go about this. If we had, we probably wouldn't have come. Our initial uneasiness quickly turned to anger. Most of us used the first break as an opportunity to leave.

Does this mean andragogy doesn't work? Not necessarily. Malcolm Knowles, the "father" of andragogy in the United States, always maintained that the choice of a learning model (pedagogy vs. andragogy) is situational, depending in part on subject matter and learner characteristics. As Zemke[4] observes, "Adults have something real to lose in a classroom situation. Self-esteem and ego are on the line when they are asked to risk trying a new behavior in front of peers and cohorts." The lesson for instructional designers is clear:

- Provide enough information for learners to begin to comprehend and synthesize material.
- Involve your learners by letting them draw upon their collective experiences.
- But don't put them on the spot.

Why Do Adults Learn?

Research shows that adults generally will seek out learning experiences when some life-changing event occurs, producing what educators call a "teachable moment." In professional life, this teachable moment often coincides with a job change or promotion. Closely tied to this is the fact that adults are most prone to learn when some immediate benefit can be demonstrated to them, not because learning is seen as its own reward.

Also, there is strong evidence that an important, although secondary, reason adults attend educational programs is to increase self-esteem. Employees should be recognized for their willingness to increase their knowledge. You might, for example, ask them to present what they learned to a group or to implement a new procedure based on what they learned.

Summing It Up

In practical terms, planners who design in-service programs for adult learners should:

- Take advantage of "teachable moments" by scheduling their in-service programs as close as possible to changes in job duties.
- Arrange programs to meet the expressed needs of the learners whenever possible.
- Use task analysis to clearly define the in-service program's goals and objectives.
- Tell learners the purpose and objectives of the program before you start.
- Emphasize a "how-to-do-it" practical approach.
- Demonstrate how the information can be applied.
- Focus on single issues within a given program.
- Remind learners of what they already know about the subject.
- Use a blend of pedagogical and andragogical methods to teach and involve learners.
- Give learners time to sort things out and ask questions.
- Reward participation in in-service programs.

Running an in-service program is not easy. Program content often is mandated by administration or accrediting agencies. But by using these basic principles of adult education, you can plan and organize your programs to help your learners get the facts they need back on the job.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Attracting Adult Learners

Much time has been devoted to the study of adult education, particularly to creating a profile of adult learners. This article examines who participates in adult education, why they participate, how adults learn and what barriers to participation they encounter.

Who Participates?

Adults who take part in educational programs tend to be Caucasian, college-educated and between the ages of 17 and 54. It's interesting to note that, as Cross[1] states, learning is "addictive." That is, the more education an individual has, the more likely he or she is to pursue adult education. For example, a high school graduate is about twice as likely to participate as an individual with less than 12 years of schooling, and those who have attended college are almost twice as likely to participate as those who have only a high school diploma.

And it isn't just that better educated people have more time and money to pursue continuing education. Riessman, cited by Cross,[1] reports that poorly educated people exhibit virtually no interest in gaining knowledge for its own sake, a phenomenon Riessman calls "pragmatic anti-intellectualism." Learning for personal growth and development is shunned in favor of utility and practicality in education. Differences in participation rates between men and women are negligible.[2]

Rates for participation in adult education may depend on how the term "adult education" is defined. Tough,[3] who defined it as "sustained, highly deliberate efforts to learn knowledge or a skill," found that roughly 98% of adults could be considered participants in adult education. The U.S. National Center for Education Statistics defined adult education as consisting of people 17 years of age and older who are "involved in part-time organized educational activities such as college courses, employee training, continuing education and private instruction." Using this definition, the Census Bureau reported a participation rate in 1984 of 26%.[4] Other estimates of participation range from one in three to one in five adults.[1] These variations result in part from differing methods of data collection and inconsistent definitions of what component of the population is considered "adult."

Reasons for Participation

In addition to *who* participates in adult education, it's important to appreciate *why* adults participate. Using a series of interviews with learners he described as "conspicuously engaged" in continued learning, Houle, cited by Cross,[1] identified three types of adult learners:

- "Goal oriented" learners participate in order to be able to do something better or to reach specific objectives. For these learners, activities are not restricted to one particular approach, but are likely to involve synthesis of several methods (reading, traveling, discussion, formal classroom study) to attain objectives.
- "Activity oriented" learners take part in adult education for reasons not related to learning a subject or improving a skill. These learners are interested mainly in the social aspect of the learning environment, such as making new friends, escaping boredom or carrying on a family tradition. Houle reports that most of the people in this category did little or no reading.
- "Learning oriented" learners pursue learning for its own sake. They are characterized by a seemingly insatiable curiosity. Houle described them as avid readers who are engaged in lifelong learning.

Tough[5] used interviews to study why people undertook learning projects, particularly those that were self-directed. He included people who pursued knowledge, skills or information but excluded those whose reason for learning was motivated primarily by the desire of gaining academic credit. Because he did not examine efforts to learn things that were not specific and concrete, Tough's study ignored Houle's activity oriented group of learners. Nevertheless, Tough's research uncovered several important points:

- Learners reported, on the average, between five and six reasons as being "very important" or "fairly important" for beginning a learning project.

• Adults seem to approach learning with the purpose of using or applying the knowledge.

• Three learning patterns among adults are evident:

1. Some learners begin by recognizing that they want to do something better. Using this as a starting point, they search for activities that will help them gain the requisite knowledge or skills.

2. Other learners begin with a basic curiosity about issues that are of particular importance in their lives.

3. A third group of learners begin by realizing they have a significant amount of spare time. They decide to use this time for learning.

• Most people participating in adult education enjoy learning, and this enjoyment is an important ingredient in the continuation of learning. Typically, learners report receiving enjoyment from having learned successfully, from practicing skills they have learned and even just from receiving the content.

Studies by Morstain and Smart, also cited by Cross,[1] tend to validate Houle's typology with one major difference: Whereas Houle assumed that learners retain characteristic motivations for the remainder of their lives, Morstain and Smart recognized that individuals have several reasons for beginning a learning project, and that those reasons may change over time. In this respect, Morstain and Small support Tough's findings that people typically report several reasons for beginning a learning project.

Cross[1] summarized the findings of 30 state and national studies about motivations for learning and found:

• Approximately one out of three learners reports that personal satisfaction is the main reason for learning, and half of all learners report personal satisfaction as one of the reasons for learning.

• Between 10% and 39% of learners say they seek knowledge for its own sake. These learners typically are well educated.

• Approximately one out of three adults indicates "escape from routine" is an important reason for learning.

• Nearly two out of three adults indicate a preference for recognition, such as a certificate or diploma, for their learning activities.

How Do Adults Learn?

Although several learning theories — ranging from behaviorism to cognitivism to humanism — have been proposed, none can be applied across the board to all learners in all situations. Nevertheless, some commonalities emerge.

Davenport and Davenport[6] recommend a combination of pedagogical (teacher-directed) and andragogical (learner-directed) methods in adult education because this "middle-of-the-road" approach meets the needs of a larger segment of the target audience. This sentiment is echoed by Geber[7] when she refers to using "an artful balance of andragogical and pedagogical instructional methods" so the instructor "hits the hot buttons of all learners" at least some of the time.

When are pedagogical methods most appropriate for adults? Feuer and Geber[8] cite Malcolm Knowles as identifying technical material and foundational (introductory) information as likely candidates for the pedagogical domain. Cross[1] notes that pedagogical techniques are preferred by those who have progressed the furthest in formal education. This is not surprising given the fact that the majority of organized education is based on pedagogical principles, and those with more education have more experience with and feel the most comfortable in well-structured classes and lectures.

Of course, not all learning takes place in structured classes. Zemke and Zemke[9] report that adults prefer self-directed learning "7 to 1" over classroom-based group learning. Books, tapes and qualified peer-tutors often are cited as useful adjuncts for self-study. Of additional assistance to those involved in self-directed study are lectures and short seminars, because they offer opportunities for learners to talk to experts face-to-face.

Barriers to Learning

Barriers to engaging in adult education can be classified into three groups: situational, institutional and dispositional. In a study by Carp et al, cited by Cross,[1] major reasons listed as situational barriers included lack of time, conflicting home and job responsibilities and lack of child care. Institutional barriers mentioned were inconvenient program schedules, lack of adequate information about programs offered and limited course offerings. The major dispositional barrier was the potential student's lack of confidence in his or her ability to learn.

The issues of who participates, why they participate, how adults learn and what barriers they face constitute the heart of planning for continuing education programs. A solid understanding of these issues provides the basis for producing programs that meet learners' needs.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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If You Mandate, Can You Motivate?

Should continuing education for professionals be mandatory? For radiologic technologists, that question is no longer rhetorical. They now are required to show evidence of participation in continuing education programs to maintain their certifications with the American Registry of Radiologic Technologists.

Nevertheless, arguments both for and against mandatory continuing education continue to rage. Mattran,[1] stating the arguments in favor of mandatory continuing education, points out that it leads to increased professional competence and exposes disinterested participants to information they might not otherwise encounter.

Mattran suggests three conditions for implementing effective mandatory CE programs:

- The professional membership itself, not an external regulatory or government group, must recognize the need for continuing education. By promoting participation in continuing education as the norm for professionals, individuals can be encouraged to upgrade their knowledge and skills, thus simulating the traditional voluntary nature of adult education.
- Educational programs must be designed around the day-to-day realities of the workplace. Programs must be offered at times that are convenient to both employers and employees.
- Educational programs must so completely engage the professional in the desire for continued learning experiences that he or she does not become distracted by the pressures of work and home life.

Rockhill,[2] arguing against the concept of mandatory continuing education, rejects these propositions because of the assumptions underlying them. The first assumption is that knowledge determines performance; the second is that continuing education can provide the requisite knowledge.

Implicit in the thinking of those who favor mandatory continuing education are two learning theories: passive diffusion and queuing.[3] The passive diffusion theory assumes that there exists a concentration of knowledge on the instructor's side, a deficit of knowledge on the student's side, and a semipermeable membrane between the two. Placing the student and instructor in close proximity introduces a pressure gradient. The rate of diffusion of "molecules" of knowledge is a "function of the height of the gradient, the permeability of the membrane and the duration of exposure."[3]

Proponents of the passive diffusion theory believe that in the absence of a pressure gradient, knowledge will "leak out" of the student. There are two solutions for this dilemma: Provide complex and extensive handouts to maintain the gradient after the learner leaves the learning environment, or schedule frequent opportunities to reintroduce the gradient. That is where continuing education fits in.

The queuing theory also has adherents among proponents of mandatory continuing education. According to this theory, learners have a finite number of "boxes" in which to store data. The prevailing view in queuing theory is that data retrieval follows a last-in, first-out sequence. For example, the last bit of information stored is the first to be recalled. Some instructors believe this accounts for higher test performance on material recently presented in class.

Queue overflow, which occurs when more information is put into the learner than can be stored, results in loss of the oldest data. This is an ideal feature for mandatory continuing educationalists, since the old, useless information is replaced by new, functional information. Cook[3] suggests that since there are a finite number of boxes in which to store data, one can get an estimate of the target population's queue volume by examining the number of CE units required each year.

Of course, there are other, less lighthearted problems with the issue of mandatory continuing education. For example, many factors other than knowledge contribute to professional performance, such as institutional goals, financial and managerial support, motivation and staffing patterns.

But there are even more practical problems associated with mandating continuing education, like providing financial aid to participants so that lower-paid staff are not unfairly burdened, scheduling time off so that attendance at CE programs does not have an adverse impact on the participant's family life, and providing child care to avoid discrimination against workers with children.

Even more to the point, mandatory continuing education runs counter to the basic tenets of adult education. Although perceptions of the purpose and characteristics of adult education vary from one observer to another, in general these differing views tend to complement, not contradict, one another.

For example, a composite view of the goal of adult education could be stated as helping men and women improve both themselves and society by:

- Increasing skills, knowledge and sensitivities.[4]
- Gaining competence in lifelong learning skills.[5]
- Changing attitudes and behavior within the context of personal, socioeconomic and cultural development.[6]
- Increasing one's sense of self-control in his or her own life.[7]

Continuing education for adults should be considered a collaborative effort between learner and teacher. Learning is at times self-directed, while at other times it may be directed by teachers or media production teams.[6]

Perhaps Houle[4] expresses it best: Educators are "cooperative artists" who help learners "learn these things for themselves and, by the use of [their] art, facilitate the accomplishment of [the learner's] desired goals."

But when participation in educational activities is mandated, there is no intrinsic motivation for learning. With no motivation, it doesn't matter whether disinterested participants are exposed to information.

Mandatory continuing education is a reality in the radiologic sciences. Only time will tell whether its implementation has benefited the profession and its practice.

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Learning Theories: Something for Everyone

Periodically, we educators must defend what we do, what we teach and why we have chosen particular methods over others. Often we fall back on behaviors and methods we admired in *our* instructors; occasionally we may point to so-and-so's theory of education that we learned in Professor Somebody's teaching methods class. But as professionals, we must have more than a default theory of learning. We need to understand the philosophies of great educators and examine our beliefs about the very purpose of learning.

The Purpose of Learning

The major goals of all learning, even if unstated, are to:

• Prepare students to cope with future situations in their professional and/or personal world.

• Foster a continuation of learning after completion of the formal course of studies.

This concept, known as transfer of learning, occurs when learning in one environment affects a person's behavior in another environment. If transfer of learning did not occur, educators would have to teach students how to perform in every situation they might encounter, a task clearly impossible. Rather, an effective curriculum helps students improve the quantity and quality of material transferred from the classroom to "real life." Unless a curriculum accomplishes this, much of the student's and teacher's time is wasted.

Two crucial issues to examine when designing or revising curriculum to increase transfer of learning are:

• Does the curriculum help students successfully manage future learning situations?

• If so, is the curriculum as effective as it should be in promoting transfer of learning? If not, how can it be made more effective?

Curricular changes have closely followed shifting patterns in educational philosophy through the years. Let's take a look at the major approaches to educational design.

Mental Discipline

The mental discipline approach views the mind as a muscle that should be exercised. Proponents of this approach, which dates back to Plato and Aristotle, emphasize drill and practice combined with strict discipline to buttress the learner's attention, memory, will and perseverance. Transfer of learning occurs through mental exercise, which builds the power of the faculties so they can automatically move into action in appropriate situations. Curricular content is not important as long as it is difficult and unpleasant. Mathematics, science and Latin are typical components of this curriculum. Instructors frequently use physical and mental punishment — belittlement, harassment, denigration — to enforce study habits.

Apperception

Those who subscribe to the apperception theory view learning as a process of implanting in students' minds a great mass of information and concepts organized by a teacher or textbook author. As students integrate new facts with old, they generate new "feelings" that lead to new behaviors. Apperceptionists like Herbart and Tichener measured knowledge retention by administering frequent tests.

Herbart described five steps to maximize transfer of learning:[1]

- Preparing the teaching lesson using detailed lesson plans and assignments.
- Presenting the lesson in a prescribed order.
- Comparing facts, concepts and ideas.
- Drawing generalizations from the information.
- Applying concepts.

Transfer of learning, for apperceptionists, is a matter of simply storing ideas within the mind where they are available for recall. The shortcomings of this approach are:

- Learning is teacher-centered; students tend to be passive, and critical thinking is discouraged.
- There are too many facts to be covered adequately. Often, material is learned only to pass tests and then forgotten, leading to a low transfer of knowledge.[2]
- Problem-centered teaching, which teaches students how to learn, is largely ignored.

Behaviorism/Neobehaviorism

Post-World War II learning theory emphasized teaching by instructional objectives. The behaviorist approach, as exemplified by Skinner, Mager[3] and Gagné, is teacher-oriented and only rarely takes the learner's needs into account. Behaviorism generally avoids speculation about what occurs inside the mind. Teachers concentrate on measuring overt behavior, particularly whether students are able to reach the terminal course objectives. Students' attitudes and commitment to program objectives receive little attention.

In health science educational programs, the terminal objective is successful performance on exams — particularly midterms, finals and national certification exams. These exams consist mostly of multiple-choice questions in which discrete bits of information are tested for recall. Higher cognitive levels such as application, analysis, synthesis and evaluation often are ignored.

Principles of learning Skinner integrated into this approach were:[1]

- Feedback and reinforcement to the individual were immediate.
- Subject responses advance from simple to complex, a phenomenon Skinner termed "shaping."
- Opportunities for wrong responses from the individual are minimized to reduce the level of contradictory stimuli.
- The individual is not rewarded for incorrect or partially correct answers.
- Individuals can move through material at their own pace.
- The behavior expected following completion of the educational program is clearly defined.

Robert Gagné's learning systems model[4] attempts to manage the conditions under which learning occurs. A more moderate view of behaviorism than Skinner's, it considers the needs of individual learners. According to Gagné:

- Terminal objectives must be specified at the outset of curriculum planning, and instructional objectives must be specified for each unit.
- Through task analysis, learning tasks are arranged in a hierarchy from simple to complex.
- Fundamental learning tasks must be mastered before advancing to complex tasks.
- Individuals must be exposed to a variety of experiences to enhance their "mediational" abilities.
- Informal and formal evaluation can provide feedback vital to both instructor and learner.

Hull, whose particular brand of behaviorism is called "drive reduction," says, "The teacher should not be content with teaching one solution to a problem but instead, whenever possible, should introduce a variety of techniques for solving problems."[5] He recommends practice of discrete parts of a sequential act until all parts of the job are equally well learned.

Bandura said learning occurs through observation, such as by imitation of a model, a theory known as social learning.[6] Bandura believes "we learn to imitate because we are reinforced for such behavior." Teachers are models who shape or influence student behavior; the teacher does not have to be older or even in the same discipline to act as a model. Books, artwork and films also may serve as symbolic models. Bandura believed that exposure to highly esteemed models could alter students' attitudes to the point of modifying their behavior in clinical settings and assisting in acquisition of skills.

In behaviorism, transfer of learning occurs through the repertoire of conditioned responses available to the individual. The behaviorist approach is most useful when instructional objectives are unambiguous, achievement can be judged by agreed-upon criteria and a clear imbalance exists between the teacher's and learner's areas of expertise.[7]

Cognitivism

This group of educators looks at schools as composed of groups of individuals with varying needs and skills and views humans as "rule-forming beings." Teachers need to assess the learner's abilities to discover whether he or she is ready to learn. As David Ausubel explains, "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach accordingly."[8]

With this approach, instructional focus begins to move away from the teacher and toward the learner. Bruner's discovery learning method assumes that learners categorize material for use in perception, decision making and conceptualization. He termed the specific arrangement of similar categories a "coding system." Such categorization reduces the complexity of the material and allows the individual "to go beyond the information provided."[9] Learning occurs by the generalization of insights that stem from experience. Bruner's major points are:

- Discovery learning occurs when students do not receive information in its final format but must organize it themselves.
- Students build from specific to general categories in constructing their coding system.
- Exposure to diverse experiences leads to constructing larger coding systems, allowing students to identify and classify new information.
- Educated guessing should be encouraged.
- A spiral curriculum, where students are exposed to similar information in combination with new data, should be used.
- Learners must assume increasing responsibility for their education as their knowledge grows.
- Discovery learning seems most useful for enhancing problem-solving ability and transference of information.

A variant of cognitivism called reception learning was developed by David Ausubel.[6] Reception learning centers around a group of stable, organized concepts. Learning occurs when new information is linked to knowledge already held by the learner. Therefore, for Ausubel the most important factor in learning is what the person already knows. In reception learning:

• Teachers should organize material in a way that is likely to have meaning for students instead of letting students organize the information themselves.

• Before presenting the material, the teacher gives the learner an advance organizer (content outline) that contains complex concepts that will tie into the learner's cognitive structure.

• Teaching that emphasizes similarities and differences between new and recently learned material increases retention of information.

• Teachers should introduce global concepts, then work toward integration of specific information.

Humanism

Current educational thinking looks at the human resources potential of learners. The purpose of education is to provide learners with the tools needed throughout their lives to change and adapt to new conditions and information. The problem-based learning curricula is a response to this particular philosophy.

Maslow maintained that the real world consists of how the learner perceives it and therefore can be known fully only by the learner. Maslow supported student-centered teaching where the purpose of the instructor was to facilitate learning, a process that involves, among other things, empathetic listening. Other aspects of student-centered teaching are:

• Students share responsibility with the facilitator for the content and direction of the course.

• The ability to self-evaluate is an important part of education.

• Differences among students are expected and respected.

• Instructor criticism must be constructive and meaningful.

Knowles[10] was the leading proponent of andragogy, a learner-centered approach to adult education. His views on education were similar to Maslow's:

• Learning involves collaboration between facilitator and student.

• Learners move from a position of dependency upon the teacher to one of self-directedness.

- The adult learner's increasing store of experience provides a profound resource for learning — for themselves and others.
- The need to cope with real-life situations provides the stimulus for learning.
- Teachers are responsible for creating conditions and providing tools to help students discover their need to know.
- Education programs should be designed according to the student's abilities and needs.
- The goal of education is to build increased competence for students so they can reach their fullest potential in life.

Does Anyone Agree?

Although some parts of these learning theories are plainly contradictory, there are some areas of agreement.[6] For example, behaviorists and cognitivists agree that:

- Relationships between stimulus and response are complex.
- Learning requires the identification of relevant stimuli.
- Individuals learn at different rates.
- Tasks must be within the competence of the learner.
- Learning conditions may be arranged to increase the probability the student will make the desired response in relation to other possible responses.
- Motivation is important in producing behavior that leads to the attainment of specific goals.
- Excessive motivation may interfere with reaching goals because it may prevent the learner from understanding complex stimulus-response relationships.
- Learners must learn to evaluate their own performance and modify their behavior if it is inappropriate.

Within the cognitivist group, Bruner and Ausubel disagree about the arrangement of cognitive structures and the method of material organization. Bruner believes information should be arranged in a hierarchy of facts from specific to general; Ausubel believes in beginning with general concepts followed by specific facts, and instructors should carefully arrange and present information to the student in its final form. The best approach in a particular situation is determined in part by the learner's previous learning experiences, intellectual abilities and motivation.

What Can Be Done To Improve Learning?

The last factor, motivation, is central to promoting learning and its transfer. When motivation for learning is extrinsic, such as for the purpose of passing a test, both long-term retention of knowledge and transfer of learning are low. Intrinsic motivation, where learning is viewed as its own reward, results in longer knowledge retention and higher transfer of learning.

How can the development of intrinsic motivation be encouraged? Success is an important ingredient. Although it is acceptable — even desirable — for students to make mistakes as long as they contribute to learning, a string of failures can discourage all but the most dedicated student.

Bigge and Hunt[5] report high levels of motivation in situations students find puzzling. When the situation is necessarily resolved, the motivation for studying disappears. The natural tendency when teaching is to tell students the right answers and not let them leave class until all issues are resolved. This policy may undermine the development of sustained intrinsic motivation. In support of this assertion, Bigge and Hunt cite the Zeigarnik effect, in which students show greater recall of uncompleted tasks than of completed ones. These authors suggest that good teachers will, within certain limits, allow students to leave each class with some unanswered questions.

Active participation by students is much more effective than passive reception. Effective participation is fostered through the application of two principles — skill practice and whole learning vs part learning.

Occasionally, students get the point in a brilliant flash of insight. More often, learning requires lengthy study and practice. But mere repetition by itself does not teach. Repetition may be of benefit when the student reflects on issues such as, "How well did I perform this?" and "How could I do it better?"

Many students use massed practice, as in cramming for a test. Research indicates, however, that distributed practice speeds learning and increases retention of material while avoiding the fatigue and boredom associated with massed practice.

With the behaviorist approach of learning, information is learned piecemeal, with individual facts finally assembled into — one hopes — a coherent whole. Cognitivists, however, believe students learn best by starting with the largest chunk of information they can understand, then moving to the small details. Research does not indicate a clear winner in this argument, except to say that students with higher than average intelligence tend to learn best using the whole learning approach.[11] Of course, some subjects lend themselves to being taught by one method over another.

Making information meaningful, in the sense of helping students see the relationship among facts, principles and generalizations, is another way of increasing learning retention. According to Barrows, education produces its greatest effect when students learn within the context where future tasks will be practiced. "Learning that is driven by challenge of practice and integrated into the reasoning required to evaluate and resolve patient problems promotes structuring of knowledge to support practice."[1]

When students can see how information can be applied by drawing out principles and generalizations in situations that they care about, learning becomes imbued with meaning.

Perhaps Stephen Brookfield[7] summed it up best when he wrote, "Because every group of people engaged in learning will exhibit a formidable diversity of abilities, experiences, personalities and preferred learning styles, it follows that facilitators should be ready to try a range of different approaches. It is important that facilitators vary their methods, have a range of materials (visual and written) on hand and make efforts to individualize their curricula and evaluative criteria when appropriate."

So, what is your educational philosophy? Are you a neobehaviorist? Cognitivist? Or, like me, an eclectic? Whatever your position, evaluate carefully to see if it fits the task at hand. Both you and your students will benefit.

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Introduction: Instructional Design

The obvious first step in developing a curriculum is the design process. Curriculum design is never easy and never static, although many instructors would prefer it that way. A curriculum that does not undergo constant revision in today's changing health care world cannot meet the needs of students, employers or patients. Developing a curriculum requires a knowledge of the discipline and an understanding of how the discipline is changing. Then you can get down to brass tacks and begin the actual work of designing the curriculum.

Two articles in this section focus on the development of objectives — Hulse's "Objectively Speaking" is an overview of the writing of objectives, while his "Instructional Objectives Within the Cognitive Domain" offers sound advice on developing objectives that teach and test at all levels of learning. All instructors tend to teach and test to the lower levels of learning; it is the easiest and most comforting since even the most "difficult" students can show gains in basic knowledge. Developing objectives and learning activities for the higher levels of the cognitive domain is much more difficult and time-consuming.

The article I wrote with my former graduate assistant, Joey Battles, titled "Curriculum Development and Alignment" offers a comprehensive, systems approach to curriculum development and alignment. Joey was enrolled in a master's program that provided him with good information, but didn't tell him how to teach. Like most programs, the assumption was made that good teaching would follow from presenting content. From that dilemma came a solution. I offered to teach Joey in an independent study course how to design a curriculum from scratch and document its progress in an article. Using a basic systems approach, we developed a model for curriculum development we believe will meet the needs of any teacher in the radiologic sciences. Joey is now director of the Medical Imaging Program at Clarkson College in Omaha, Neb.

Another article by Hulse, "Hello … Testing, Testing," covers the elusive theory of testing in a practical manner. I remember very vividly the first time I read Hulse's comment, "As a new instructor, I used to write and type a 50-item test before lunch," since it exactly described how I wrote tests in those busy days early in my teaching career. Hulse describes several other common pitfalls in his article, such as relevance. I recall writing, as a new instructor, an obscure test item that asked students to estimate the intensity of x-rays from a star many light years away based on the inverse square law. Today, I realize how frivolous that test item was. It revealed more my own ignorance of the need for relevant testing than it tested my students' knowledge.

More radiologic technologists need to be educated at the baccalaureate level. With professions ranging from physical therapy to teaching adopting the master's degree as an entry-level standard, we need to recognize that radiologic technology is certainly no less complex than those disciplines and at least offer more baccalaureate programs.

Of course, there are a number of obstacles in advancing any profession. One is the development of appropriate higher-level curricula. Two articles by Janice Hall deal with this topic — the first on the relationship of the baccalaureate degree to clinical practice and the other on articulation. One hears of successful programs here and there, but detailed, written descriptions of these programs are rare. Of course, programs developed at the associate degree level should be done so in a manner that facilitates articulation with baccalaureate programs.

The Joint Review Committee on Education in Radiologic Technology is moving toward an outcomes-based method of evaluating programs. I can remember going on JRCERT site visits where the other visitor asked content questions of the students to "see what they knew." Luckily, this doesn't happen anymore, but our move to outcomes has not been easy. My article titled "Outcomes Assessment Is Vital to Educators" was an attempt to begin the dialogue about outcomes. The danger, of course, is that we can narrowly define outcomes and reach an expected result. The evolution will not be easy for our profession.

Steven B. Dowd

Curriculum Development And Alignment

If you are an experienced instructor in radiologic technology, try to recall the first time you had to decide "what to teach." You knew that certain subjects and concepts had to be covered in class and that you should develop or follow something called a syllabus. But you probably were unclear on the depth of coverage needed and how to achieve the goal of developing a competent, caring practitioner.

Yura-Petro and Scanelli[1] have noted that curriculum must be an educational plan that teaches students "to think and to be and not only to do." The prospect of preparing such a comprehensive plan can be daunting to the inexperienced instructor.

Also consider the relevance of your curriculum. Are you sure it reflects current clinical practice, new trends such as managed care and the needs of your student population? A well-designed curriculum should accomplish all of these goals. This article discusses curriculum and curriculum development and also presents an approach to ensuring that curriculum fulfills its goals — curriculum alignment.

Curriculum

Curriculum has been defined in a number of ways. At its most general, curriculum can be defined as a road map of planned experiences given to learners by a facilitator or instructor.

A good, solid, current definition states that curriculum is all of the experiences that individual learners have in a program of education whose purpose is to achieve broad goals and related specific objectives, which is planned in terms of a framework of theory and research or past and present professional practice.[2] These experiences are documented in the syllabus, which is a formal agreement between student and instructor in terms of what will be taught and the expectations for successful course completion.

Curriculum Alignment

Curriculum alignment is a systems approach to the development and evaluation of curriculum. (See Fig. 1.) A systems approach has three basic components: input, process and output.[3] Similarly, Broski[4] lists three steps in the development of curriculum: define, develop and evaluate. Broski describes the process as one in which continual feedback is given and where one stage may overlap another in a continual chain. Curriculum alignment follows this same process of continual feedback but breaks the steps into eight categories that are basically sequential. As a process of curriculum development and evaluation, this system may appeal more to those of us who are linear thinkers.

Step 1: ***Validate present course content through task analysis.*** Following a narrow guideline such as Registry relevant material would produce graduates who are not adequately prepared for a job or for potential future roles in the health care system. For example, one easily

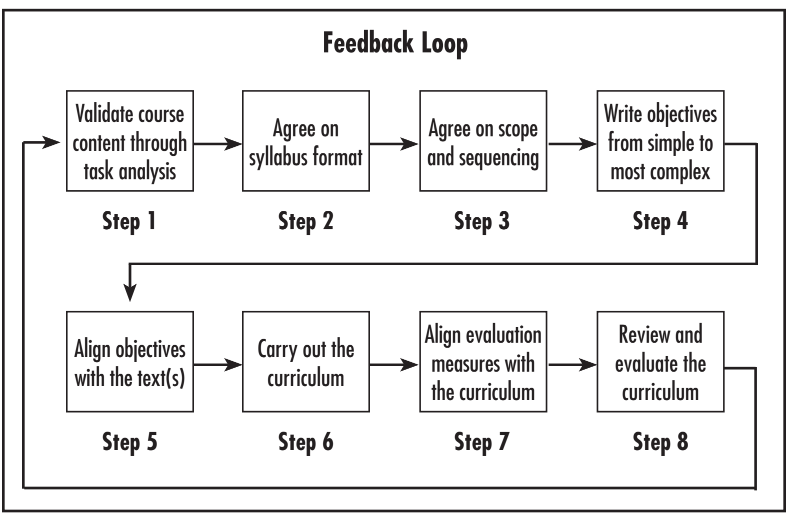

Fig. 1. The curriculum alignment feedback loop. Most textbooks are sold with ancillaries that perform some of these steps, such as an instructor's manual with suggested course outline, a student workbook or a test bank. In such cases, the instructor must "fill in the gaps" to ensure curriculum alignment. (Artwork from: Dowd SB. *Teaching in the Health Related Professions.* Dubuque, Iowa: Eastwind Press; 1995. Used with permission.)

could argue that trends such as patient-focused care could have been foreseen a number of years ago through an analysis of the nursing and health administration literature. If so, patient care curricula could have been altered to include ECGs, venipuncture and many of the patient care tasks that are now performed by radiology nurses. Items to consider during the development of curriculum are presented in Table 1.

Step 2: ***Agree on the syllabus format.*** A common syllabus format keeps students focused on content coverage and means of meeting course goals. Use of a single syllabus format within a program helps students understand important issues, such as grading policies, and the small nuances that make each instructor's course different. Suggested categories are listed in Table 2.

Step 3: ***Agree on scope and sequence of the material.*** Peer-review is widely recognized as a means of ensuring quality. The process is at its most formal in the submission of manuscripts for publication in professional journals, but the process can work for curriculum development as well.

One effective means of developing curriculum is to form a committee within the program and make it responsible for determining curriculum scope and sequence. For small programs this process can be formalized by asking other educators or clinical personnel to assist in the evaluation process.

Step 4: ***Write the objectives from simplest to most complex.*** Objectives form a road map that not only shows students where they are and where they need to be, but also indicates the best route between those two points. To develop objectives, ask yourself what level of performance you expect from students. Do you expect basic knowledge or task performance? Do you expect a higher level of performance and critical-thinking skills such as evaluation and analysis?

Many recent textbooks written for the radiologic sciences cater to instructors by providing objectives at the beginning of each chapter or in a separate instructor's manual. In fact, some newer textbooks even provide "concordances" that indicate how the material covered in older, established texts is covered in the new text, chapter by chapter. This

Table 1
Items To Consider in the Development of Curriculum

- Clinical practice — local, state and national guidelines (including scope of practice).
- Student level.
- Program type (associate or baccalaureate).
- Registry examination.
- Fiscal and physical resources of the program.
- Time frame (semester vs. quarter; number of credit hours assigned to each course).
- Future trends in clinical practice and teaching, identified through literature review or other means of external scanning.

information is intended to help the instructor who is deciding whether to use a newer text.[5] However, it is not appropriate to assume these objectives were developed in a manner that is specifically applicable to your students or program.

It is easy to assume that objectives are fairly static. This is a dangerous assumption. If constant input is not used, objectives quickly can become dated. For example, consider how a syllabus containing the following objective might be confusing to a student: "Calculate, using the formula 5(N–18), the allotted 'rem bank' for a radiation worker." This objective, left over from an earlier era, clearly needs to be updated in the course syllabus.

Step 5: ***Align the objectives written with the text(s) used.*** Essentially, an instructor at this point will determine whether or not the selected textbook will be able to, in concordance with other learning methods, assist the student in attaining course objectives. Because few textbooks today can meet this criterion, many instructors assign supplementary material through a reference list or by developing a "course pack" of materials.

An instructor also is expected to be a "synthesizer" of material and present conflicting material from a number of sources in a manner

Table 2
Suggested Categories for a Course Syllabus

- Course name and number.
- Number of credit hours.
- Number of clock hours (broken into activities).
- Course meeting dates.
- Instructor's teaching philosophy.
- Course calendar, including due dates of all assignments.
- Course objectives.

that students can understand. Examples include the proper site for wearing film badges and the use of dose-response curves as models for radiation protection.

In our experience, the radiologic sciences seem to attract the type of student who expects "one right answer" to a question. This problem, in fact, may be endemic to higher education. It is the instructor's responsibility to clarify issues while also challenging students think for themselves. This often is a difficult balancing act.

Another problem in using supplementary material is copyright. A number of practices currently used by educators actually violate fair-use practices. We all know or have heard stories about instructors who photocopy chapters out of textbooks and then hand them out for student use. A 1991 federal Circuit Court of Appeals case ruled that such use of material violates the publisher's copyright unless permission is secured in advance.[6] Some instructors mistakenly assume that all of their use is fair use. In reality, copying even single pages for distribution to a class can be considered copyright violation. Although the chances of getting caught are minimal, we cannot expect students to be ethical in their use of material for assigned papers and other course projects unless their instructors are as well.

Step 6: ***Carry out the curriculum.*** Implementation of the curriculum may prove to be the most difficult step in the entire process. Instruction is a dynamic, rather than static, process. What works one year can be a miserable flop the next. Instructors, therefore, should view themselves as action researchers and use the input gained from one course to revise their next course.

Step 7: ***Align evaluation measures with the curriculum.*** In the baccalaureate program at the University of Alabama at Birmingham, students are expected — even in courses taught early in the curriculum — to develop independent projects. Thus, even in a first-quarter course such as radiation safety, students are asked to research a topic related to radiation safety and present their findings to the class.

This type of assignment might not be appropriate in an associate degree program, but students educated at the baccalaureate level should "be able to teach in-service programs"[7] and expect career opportunities in areas such as academia, where research and presentation skills are critical. Because these graduates must present in the clinical setting with the same basic skills as a technical level practitioner, another method of evaluation (a 100-question multiple-choice test) is used as well.

Step 8: ***Review and evaluate the curriculum.*** The revision of current curriculum is an ongoing activity that should occur throughout the curriculum development process. Experienced teachers typically know how to adapt something that isn't working while a course is being taught. Formal review, evaluation and revision, however, typically occur at the conclusion of a course.

The curriculum should be adjusted and refined for the next group of students to be exposed to it. Revisions will construct a strong foundation that future curricula may build upon.

Alfred North Whitehead once said, "Education which is not modern shares the fate of all organic things which are kept too long."[8] Some pundits have paraphrased this sentiment as "knowledge keeps no longer than fish." An instructor who has not paid heed to the many changes in radiation protection guidelines and regulations during the past few years is providing students with a knowledge base that not only is erroneous, but also is potentially dangerous to their future clinical practice.

Conclusion

Curriculum development and evaluation should be viewed as a dynamic process that reflects clinical practice, changes in the professional roles of radiologic science professionals and feedback gained in the instructional process. One potential method of doing this is through the process known as curriculum alignment.

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By Steven B. Dowd, Ed.D., R.T.(R), and Joey Battles, M.A.Ed., R.T.(R)
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Objectively Speaking

By now most of us are exhausted with writing behavioral objectives. Let a conference speaker even hint about writing objectives and across the room eyes will glaze over while lips silently repeat the litany, "A is for Audience, B for Behavior, C for Conditions, D for Degree."

The names sometimes change just to keep us alert, and the "main course objective" becomes a "goal" or perhaps an "aim," while plain garden-variety objectives travel under monikers like "facilitating" or "intermediate" objectives.

But semantics aside, there is an important distinction to be made between goals and objectives. Goals describe an educational outcome in general, nonspecific terms and cover an extended time, perhaps an entire semester or longer. For example, a statement like "The student will successfully complete the ARRT examination," although a commendable goal, is so general that it provides no guidance about how to achieve it.

On the other hand, an objective is a specific statement of instructional intent[1] that attempts to change knowledge as a result of an educational experience.[2] Knowledge is a state of mind that cannot be measured directly. This requires an indirect method of evaluation, that of observing behavior, and hence the term behavioral objective.

The concept of competency-based education fits within the framework provided by goals and objectives. Goals establish the purpose, objectives set the criteria, and the competency exam compares the desired performance (the objective) to the actual performance (the competency). If the competency exam is successfully completed, the student advances to the next objective; if unsuccessful, the student receives remedial instruction.

Writing clear, concise objectives is not easy, as those who have tried can confirm. But more difficult than writing objectives is consistently choosing those ideals that reflect an important and meaningful outcome of instruction. Much too often the objectives we write trivialize information into isolated facts so disjointed that the real importance of knowing such material becomes opaque to the student. How, then, do we know which objectives to select?

There are three main sources of guidance in selecting behavioral objectives:

- Task analysis[3] carefully itemizes each discrete skill found in a competent practicing professional. Because task analysis provides only end goal statements, educators must determine the prerequisite skills required and make them the course objectives. For example, task #41 ("Assist the physician in the intravenous injection of contrast medium using appropriate aseptic technique") would become several objectives covering determination of needle size by gauge, needle safety, assembly of needle and syringe components, infection control and aseptic technique.
- Credentialing agencies and professional organizations also publish behavioral objectives.
- Expert opinion (yours and other educators') should not be overlooked. Expert opinion can be invaluable regarding desirable and important outcomes of instruction.

Armed with the knowledge from having consulted these sources, you can confidently place pen to paper. However, as you do be sure to remember the seven characteristics of good objectives:[4]

- ***Objectives should identify a learning outcome.*** An objective that says, "The student will learn the Caldwell projection of the skull by studying pages 113 to 115" refers not to an outcome of instruction but to an activity of learning. Certainly evidence of whether the student has learned this projection lies not in watching him read about it but in demonstration of this skill.

A better objective might be "The student will correctly position an ambulatory adult for a Caldwell projection of the skull, demonstrating the correct body position, x-ray tube angulation and central ray/film alignment, and will follow accepted radiation safety practices for the patient and technologist." The phrase "accepted radiation safety practices" in this objective could be further defined also.

• ***Objectives should be consistent with course goals.*** I once worked as a consultant for a program director who included English vocabulary words on her students' medical terminology tests. Her objective was "to help the students speak and write effectively."

Forget for a moment that a paper-and-pencil test cannot possibly measure someone's speaking skills. The real problem with this objective is that it didn't match the stated course goal: "To correctly use and understand medical terminology in the clinical setting." When objectives and goals are inconsistent, two avenues of approach are available: You can either change the objective or change the course goal.

• ***Objectives should be precise.*** It's sometimes difficult to strike a balance between too much and too little precision in an objective. Too much, and the objective is in danger of becoming trivial; too little, and it seems vague. So how much precision is enough? Remember, the purpose of an objective is to give different people the same understanding of the desired instructional outcome. The exact number of objectives required to accomplish this for a particular subject depends upon the time available and the content complexity. Nevertheless, authorities generally place the maximum number of objectives for a single course between 12 and 25, with 20 as the most commonly mentioned maximum.[4]

• ***Objectives should be feasible.*** Practicality is the key word here. Constraints that affect the selection of objectives include financial support, staffing patterns, physical resources and length of course time available.

• ***Objectives should be functional.*** Attainment of an objective should benefit both the student and society, either immediately or in the future. The study of radiation protection, for example, is functional because both the student and the patient benefit. It's less clear how an objective covering the historical development of Crookes vacuum tubes could be considered functional.

Instructors should be cautioned to teach what students need to know, not just what they themselves were taught as students or what they perhaps personally like to teach. The latter is a manifestation of "goal displacement," a recognized tendency of established education programs to reflect the expertise and interests of teachers, not the needs of the students.

• ***Objectives should be appropriate.*** Whether an objective can be considered appropriate is largely determined by learner characteristics such as educational background, career interests and developmental level. Of course, program directors always should discuss program objectives with instructors, but this becomes particularly important when the instructor is not a radiologic technologist. Nontechnologists may not fully grasp the scope of knowledge necessary to become a practicing technologist. Examples that come to mind are physicians who teach anatomy "just like they would for medical students" and physicists who want their students to "appreciate the beautiful symmetry of the universe."

As radiologic science educators, we need to remind one another that we're graduating entry-level radiologic technologists, not physicians or physicists. But if we've done our job, our graduates will continue to learn and grow beyond what they were taught in school, gradually maturing in the direction of their particular interests and career goals.

• ***Objectives should be significant.*** Because time and resources are finite, for every objective selected another must be excluded. Therefore, be certain that every objective you select meets the other six criteria in this list.

After working through these seven steps, validate your objectives by asking other educators and radiologic technologists to evaluate them. Members of both groups often can discern problems and oversights in your objectives and suggest realistic revisions based on knowledge and experience.

Much more can be said about behavioral objectives, but these guidelines should help you establish standards against which a proposed outcome can be measured.

After all, one should be "objective" about these things.

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The Baccalaureate Degree In Radiography

A great deal of controversy surrounds the relevance of the baccalaureate degree in radiography. The profession has rapidly evolved into a complex discipline with multicompetent responsibilities and duties. We must educate practitioners who have good patient skills as well as the ability to satisfy the customer-oriented environment in today's health care system. With the current changes in the areas of radiology, it is necessary to enhance radiography educational processes to fulfill the needs of the health care community.

As stated by Dowd, radiologic technologists do not receive the recognition they should as professionals.[1] The U.S. Department of Labor classifies them as technical workers rather than professional workers due to a lack of autonomy and educational preparation.[1] This can be changed by developing a practitioner educated at the bachelor of science level. In 1994, 19 baccalaureate degree programs in the United States were accredited by the Joint Review Committee on Education in Radiologic Technology. The baccalaureate degree in radiography should be viewed more favorably since the profession is growing and changing so rapidly.

I believe the baccalaureate degree opens doors to many opportunities for professional growth, as demonstrated in Fig. 1. The baccalaureate degree facilitates career advancement and provides greater professional recognition and competency to serve patients. As one radiologic technologist stated, "Nobody is going to come along and drop an opportunity in your lap. You have to create your own."[2]

The additional responsibilities of today's radiographer make it necessary to increase the length of the educational program to sufficiently educate students without overwhelming them in the process. The ideal curriculum would offer multiple modalities that could be included more effectively in a baccalaureate degree program.

Many in the profession still believe a baccalaureate degree in radiologic technology will not be beneficial. Perhaps that belief is based on the old paradigm that says, "The way we've done things in the past is the only way."

Although paradigms can be useful, they also can be dangerous if they prevent the community from adapting and changing with the times. According to Walters, "A paradigm shift is occurring in education, and it's important for educators to get a handle on that so that we can be at the forefront, leading by example."[3]

Radiographers usually begin their careers as staff radiologic technologists. Promotions were once based on seniority, and the typical career ladder used to look something like this:

- Senior radiographer/supervisor.
- Assistant chief radiographer.
- Chief radiographer.

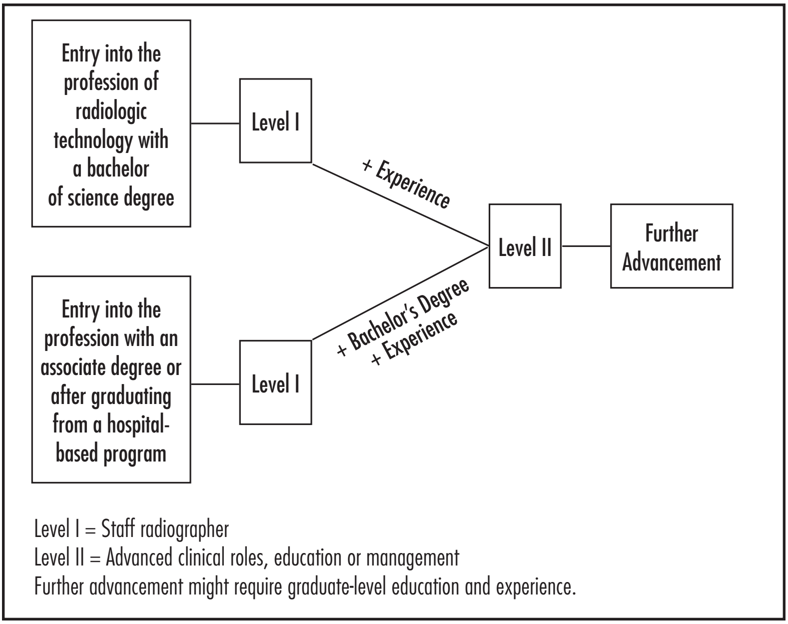

Fig. 1. A baccalaureate degree facilitates career advancement.

Under this system, promotions were based more on experience in the profession than on formal education.

The system of awarding promotions has changed significantly in recent years. Upward mobility now is based primarily on the formal education of the radiographer plus his or her experience in the profession. A radiologic technologist wishing to advance in the profession first must determine what level of education is required. Radiographers interested in career advancement should examine the options available and prioritize accordingly. Today there are more options for advancement than simply supervisor or educator.

A number of bachelor of science degrees are offered for radiographers today. They can be classified as follows:

- The entry-level bachelor of science degree.
- A bachelor of science completion degree with a clinical focus.
- A generic bachelor of science completion degree.
- A bachelor of science degree in one of the radiologic technology disciplines such as radiation therapy, nuclear medicine or ultrasound.

The generic bachelor of science degree is the most common. It is often chosen by a supervisor hoping to become a manager. The entry-level bachelor's degree and the bachelor's with a clinical focus are the two degrees most likely to produce practitioners ready to assume new clinical roles.

Many educational programs are aware of the growing interest in specialization and are beginning to offer curricula in special procedures such as computed tomography, magnetic resonance imaging, angiography and cardiovascular procedures. The University of Alabama at Birmingham (UAB) offers an Advanced Imaging program for registered radiologic technologists who wish to pursue a baccalaureate degree as an avenue of career advancement. Its curriculum is designed to further meet the changing needs of radiographers by giving them the opportunity to specialize in the more sophisticated radiologic procedures.

Students enrolled in UAB's Advanced Imaging program are prepared with advanced academic and clinical experience in CT, MRI and vascular procedures including angiography and cardiac catheterization.

Special emphasis is placed on clinical practice in these areas. Both academic and clinical course work are integrated throughout the program curriculum, along with a component of basic management courses in the health-related professions. The degree and the clinical experience serve as a basis for potential promotion. A number of UAB's clinical affiliates give hiring priority to radiologic technologists who can perform examinations in more than one diagnostic imaging modality.

The Advanced Imaging curriculum is five terms long for the full-time student. Upon successful completion of the professional phase of the curriculum and general education requirements, the student is awarded a bachelor of science degree in radiologic sciences. Completion of this curriculum broadens the radiographer's academic knowledge of complex areas and provides the opportunity to become competent in a selected advanced clinical specialty.

At the same time, UAB is converting its entry-level program from the associate of science to the bachelor of science level. While the Advanced Imaging program offers the opportunity for already-certified radiographers to become competent in advanced modalities, the entry-level bachelor of science program will offer a general curriculum that will include specialization in quality assurance, CT, MRI, angiography and radiography, including courses in trauma radiography, pediatric radiography and fluoroscopy.

The program's philosophy is to provide a strong liberal arts and science prerequisite curriculum, a traditional radiography core and the opportunity to explore advanced roles in radiography. The program's goal is to educate generalists who are able to assume a variety of multi-skilled/multicompetent roles.

The length of radiography programs is an issue facing all educators today. The amount of additional education depends on the radiographer's area of interest. Certificate and associate degree level programs are available for students who want to spend less than four years in college. These programs have been designed to prepare students for entry-level technical competence as routine radiographers and certainly will continue to educate many radiographers for some time to come.

However, there is a need to educate and develop radiographers with higher level skills beyond technical competence in basic radiography. Although radiologic technology is extremely specialized with what seems to be an exceptional amount of content (some associate degree programs require as many as 100 semester hours for completion), recognition as professionals may never come if the profession is not willing to accept a baccalaureate entry-level minimum.[4] Cooper and Ramaeker maintain that the baccalaureate degree should be an indication of a higher level of competence than a certificate or associate degree.[5]

A baccalaureate degree is quickly becoming necessary to develop the radiographer of the future — a radiographer who is able to take on more advanced clinical roles and advance into potential management and educational positions. As stated by Gurley, radiographers cannot stand still while the profession moves forward.[6] It is the responsibility of the radiographer to pursue the education necessary to keep abreast of professional development. Professionalism involves taking responsibility for our own actions and being accountable for them. This is the responsibility of the professional radiographer, both individually and collectively.

Radiographers today have many more options to grow professionally. Whichever option the radiographer chooses, it is important not to be left behind in this rapidly changing profession and industry.

With changes taking place all around us, it is only human for us to be cautious and sometimes perceive these changes as a threat to our own personal security. No profession can completely control its destiny, and therefore every profession should be accountable to the society it serves.

However, a profession that embraces society's view of professionalism — which increasingly is defined by how many of its members hold a baccalaureate degree, a master's degree or higher — is much more likely to succeed. Radiographers who continue their educations throughout their careers have much more to offer to their profession and to their patients.

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An Educator's Guide To Articulation

Education beyond certification in specific modalities seems to be on the rise for radiologic technologists. More and more of them are pursuing associate degrees, and the baccalaureate degree is becoming increasingly important for radiologic technologists who want to advance in the profession.[1]

Fortunately, radiologic technologists with associate degrees can build on the educational skills they've already acquired to advance to a baccalaureate degree. With proper advisement and guidance from educators skilled in articulation, these individuals can make a smooth transition from the associate to baccalaureate level.

It is imperative that students understand what is required to make this transition early in the preprofessional phase, while they are still enrolled in the radiography program at the community college. The prospective four-year student should contact the baccalaureate program and make an appointment with a faculty advisor to ensure that proper criteria such as transcript evaluations and other pertinent admissions information is appropriately obtained. Student counseling is very important so that adequate communication can be established before and after the individual begins working toward his or her baccalaureate degree.

Degree Options

Collegiate programs throughout the United States offer the baccalaureate degree in radiologic technology with core courses in education.[2] Completion of this type of program gives the student a background in radiography and education. Because the radiologic sciences have become much more sophisticated and technologically complex, the profession requires radiologic technologists with skills in advanced imaging specialty areas. Some baccalaureate curricula offer studies in advanced radiographic procedures such as cardiovascular-interventional technology, computed tomography and magnetic resonance imaging. An example of one such program is the University of Alabama at Birmingham's Advanced Imaging option of the bachelor of science degree in radiologic sciences.

Graduates of associate degree programs in radiologic technology have a strong radiography background and may continue their education toward a baccalaureate degree at UAB by majoring in the Advanced Imaging option. The curriculum provides a degree path for the radiologic technologist who has a certificate or associate degree and is seeking skills in advanced imaging specialties.

The articulation guide provided by UAB's Advanced Imaging program to specific community colleges in radiologic technology is designed for students who are considering admission to the Advanced Imaging program after completion of the radiologic technology program at the community college.

The intent of the articulation guide is to provide graduates of the associate degree in radiologic technology with college-level course credits that apply toward the bachelor of science degree in advanced studies in the radiologic sciences. It is developed for individuals who wish to further their studies at the baccalaureate level in the radiologic sciences area.

Specific general education courses offered at the community college such as the humanities, social and behavioral sciences and natural sciences and mathematics can be used to aid in the fulfillment of the prerequisite and core curriculum requirements at the baccalaureate level. A select number of the courses can be transferred from the community college to the four-year institution.

Graduates with an associate degree in radiologic technology who pursue a baccalaureate in radiologic sciences will receive credit hours toward the degree for specified radiography courses. The number of credit hours depends on the credit value at the community college. Generally, a maximum of 96 quarter hours (64 semester hours) can be transferred from a community college. This includes any credits that may be awarded for the radiography courses from the community college as well as transferable general education course work. Once a student earns the maximum number of transfer credit hours at the community college, it is necessary for him or her to transfer to the four-year college or university.

Upon successful completion of the associate degree in radiologic technology, the graduate usually may continue studies without interruption toward the bachelor of science in radiologic sciences if necessary criteria are satisfied. The following requirements generally are included:

- The student must be registered by the American Registry of Radiologic Technologists or be Registry-eligible.
- All prerequisite and previous course work must be completed with a satisfactory grade point average as determined by the specified B.S. program requirements.

After earning an associate degree in the radiologic technology program and providing proof of registration with the American Registry of Radiologic Technologists, the student will receive college credits at the four-year institution toward the baccalaureate degree upon transferring. The award of credit usually will place the individual as an upper level division degree-seeking student. Upon successful completion of the curriculum, the bachelor of science degree is awarded by the four-year institution.

Prerequisite courses such as English, biology, anatomy, physics, physiology, psychology and calculus can be completed at the community college while the student is enrolled in the radiologic technology program.

In addition, UAB provides students with a list of recommended elective courses. Students are advised to contact the community college program director or the Advanced Imaging faculty advisor before choosing an elective that is not listed among the recommended courses.

Specific courses from the community college's radiologic technology program can be applied toward the degree in Advanced Imaging option of the bachelor of science in radiologic sciences. Student transcript evaluations are performed individually to determine which courses will transfer from the collegiate associate degree program.

The following information is emphasized to the student at the community college level:

- All sequence courses (such as Anatomy I and Anatomy II or Physiology I and Physiology II) must be taken and completed at the same institution.
- Math courses that require prerequisites should be completed at the same institution; otherwise, a math placement exam is required to determine eligibility to enroll in a higher level course upon transferring to a four-year college or university.
- After reaching the maximum 96 quarter hours (64 semester hours), it is necessary to transfer from the community college to a four-year institution to continue course work.
- General education courses are transferred after admission to the baccalaureate institution and upon receipt of official transcripts from all colleges previously attended. Radiography courses are transferred only after students are accepted and enrolled in the professional phase of the Advanced Imaging program.

Conclusion

For any degree to be meaningful, it must meet the perceived demands of the occupation. When these perceptions are congruent with the goals of the degree, a unified attainment of objectives can result.[3] Therefore, the radiologic technologist must look at the present and future needs of the profession to make the final decision. He or she must make an assessment of personal abilities, career needs and desired challenges.[3]

It is important to examine the areas in radiology that are available to further educational studies, such as education, administration or advanced imaging. Whatever decision is reached, students must be committed and make every effort to complete their studies. Articulation guides can assist in easing the transition from the certificate or associate degree to the baccalaureate degree.

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"Hello ... Testing, Testing"

Picnics and ants, surf and sand, teaching and testing. Each of these pairs goes together like peas in a pod. Most of us would find it hard to talk about education apart from testing. But because we take this relationship for granted, we sometimes fail to ask ourselves some basic questions about the purpose and process behind testing.

Why Test?

There are at least four good reasons for testing. First, tests can help predict future academic success in college or professional school. Examples that come to mind are the Scholastic Aptitude Test and Allied Health Professions Admissions Test. Second, tests can determine how well students are meeting course objectives. In this sense, tests are diagnostic instruments revealing material that is misunderstood, misapplied or mastered. Third, tests like those administered by the American Registry of Radiologic Technologists serve as "gatekeepers," helping to maintain minimum entry-level competencies within a profession. And fourth, although not often used for this purpose by classroom instructors, tests can evaluate the quality of instruction by checking how well students do in specific areas of the curriculum.

What Test Writing Skills Are Needed?

Pratt[1] suggests three talents vital to successful test item writing:

• ***Strong knowledge of the subject.*** Creating thought-provoking questions with reasonable alternatives demands that the item writer be familiar with common misconceptions associated with the material.

• ***Good writing skills.*** Grammatical clues, confusing sentence structure and poor punctuation make it difficult to figure out what information is being sought.

• ***Creative ability.*** Tests can, and should, measure high level cognitive skills, not just simple recall of knowledge. If students are asked to respond to material identical to what they have seen or heard before, only recall of knowledge is being tested. Evaluation of comprehension and application requires that the student respond to questions surrounding new situations, and generation of novel or unique methods of asking questions can tax the imagination of even the best instructors.

Perhaps the greatest enemy to designing good tests is lack of time. As a new instructor, I used to write and type a 50-item test before lunch. Yet professional item writers for major testing services generally consider an output of five to 15 items a good day's work. Rushing through writing a test almost guarantees that low-level cognitive items will be emphasized over analysis, synthesis and evaluation. It's also harder to generate plausible alternatives to multiple choice questions when you're pressed for time. Ideally, items should be tested over a number of administrations, carefully honing the question and alternatives each time. Barring this, at least show test items to a colleague familiar with the subject and ask for a critique.

Is It Reliable?

Good test design demands other qualities too, such as reliability. Reliability is an indication of a test's ability to measure consistently how well students are attaining curricular objectives. If students of equal knowledge and ability don't receive the same score on a test, or if a student performs differently on similar versions of the same test even though he has forgotten nothing between administrations of the test, we can say that the test is not completely reliable.

How can we increase test reliability? Several techniques can be used:

• ***Increase the number of items on the test.*** Consider the test as a sample of student behavior. The larger the sample, the more accurate the estimation of knowledge. The actual number of items required depends upon the relative importance of the objective and the severity of the consequences of incomplete knowledge or poor performance.

• ***Increase the discrimination of test items.*** The discrimination value of a test question is a measure of its ability to distinguish between knowledgeable students and their less knowledgeable classmates.

Ideally, all knowledgeable students will answer correctly, while less knowledgeable students will miss the question.

- ***For subjective tests and evaluations, increase the number of judges and average the results.*** This method reduces unreliability stemming from individual differences in grading practices.
- ***Evaluate discrete qualities separately.*** Don't attempt to evaluate cognitive and psychomotor abilities simultaneously. For example, if a student is unable to successfully demonstrate a parieto-orbital projection for the optic foramina, is it because he or she is unfamiliar with what the position entails (cognitive ability), or can the student simply not maneuver the patient into the required position (psychomotor ability)? Mixed measurements like this make it difficult to tell.

Is It Valid?

Closely associated with reliability is the concept of validity. In its most basic form, validity simply asks, "Is the performance required during assessment the same performance as that described in the objective?"[2] If the answer is yes, then objectives and test items are congruent and the test item is considered valid. Confidence in the validity of a question can be increased by having objectives and associated questions reviewed by a peer group such as your advisory committee. Dissonance between stated objectives and test items then can be identified and resolved more objectively.

Dissonant objectives and test items can be pretty slippery when it comes to identification. Suppose, for example, that an objective calls for students to "correctly use medical terms in the clinical setting." Can this be measured with a paper-and-pencil test? Probably not. Reading (necessary for completion of a written test) is an entirely different skill from listening and speaking (required to successfully use medical terminology in the clinic). A better evaluation method might be to give an oral exam while keeping an eye on pronunciation as the student converts from medical to lay terms. This duplicates more closely what students are expected to do while in clinic and meets the specifications of the objectives.

But if we give the students a copy of the course objectives, and the course content reflects those objectives, and the test questions are based on the objectives, aren't we just "teaching to the test"? Of course! What's wrong with that? If the objectives reflect important curricular outcomes, what else should we be teaching toward? Tests shouldn't be a game where students have to guess what the instructor is going to ask. Instead, tests should be the logical outgrowth of what the student has seen and heard throughout the course.

A Balancing Act

Tests also need balance. The distribution of questions should reflect the emphasis given during class; important concepts need more test items for adequate evaluation than do minor ones. One way to ensure test balance is to create a test blueprint containing a list of the objectives. Each time you write a question, make a note of which objective is being measured by writing the question number next to it. When you're done writing the test, look at the distribution of the questions. Does it emphasize what's really important? If not, it's time to rewrite.

The Basics ...

Payne[3] identified six general principles for writing test items. They provide a basic outline to follow:

- ***Avoid trivial, obscure, obvious or ambiguous questions.*** These questions are the easiest to write and often occur when the item writer is rushed or a test blueprint has not been followed. Remember to focus on important outcomes of instruction.
- ***Follow accepted rules of grammar and punctuation.*** Don't make students guess at what you're trying to say.
- ***Avoid items containing irrelevant cues.*** This includes providing grammatical clues in the stem and distractors and the use of "textbook" language or some other systematic difference in the phraseology of the correct answer. Tests containing a large number of irrelevant cues probably measure little more than test wiseness.[4]

• ***Avoid writing questions whose answer may give a clue to other questions.*** Once again, you want to test knowledge of the subject, not test-taking ability.

• ***Use test items that have a defensibly correct answer.*** Questions should be objective, and the correctness of an answer should not depend upon the opinions of the person doing the grading.

• ***Use declarative sentences and simple terminology.*** As always, the purpose of testing is to find out how well students are meeting the objectives, not to evaluate their reading and vocabulary skills.

Finally, notify students well in advance of when tests are scheduled, provide clear instructions for each part of the test, give students adequate time to complete the exam and take steps to minimize opportunities for cheating.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Outcomes Assessment Is Vital to Educators

Outcomes measures are designed to ensure that institutions of higher education are accountable to their constituent groups.[1] The goal is to ensure that institutions and educational programs really provide to students the product they are selling. For many years we have assessed student competency; the difference I see is that outcomes assessment is broader and focuses on the long term.

As a Joint Review Committee site visitor, I have noticed some resistance among faculty to the use of outcome measures. In some cases, the resistance is due to lack of time; in others, I believe the resistance is due to a fear of not measuring up to standards. I hope to address both those concerns here.

There is a need to support outcomes measures, as they are:

- Ultimately patient-oriented.
- Designed to emphasize basic skills.
- Process-oriented, allowing educators to develop the process as they see fit.
- A form of quality assurance in education. Just as we advocate licensure of practitioners to ensure that they meet certain minimum standards before exposing patients to radiation, outcome measures ensure that all programs meet minimum standards.[2]

Radiography programs should assess outcomes in terms of knowledge, skills, values and beliefs, interactions and relationships. Specific items that must be assessed include attrition rates, student honors and awards, number of graduates in specific employment settings and percentage of graduates passing certification exams.

Outcomes assessment is a form of research in education. Unlike academic research, I see the assessment of outcomes as applied research, performed to solve a specific institutional problem or potential problem. I believe that outcomes assessment must be simple and must be used for program improvement. It should, however, follow a general research design:

- ***Identify the problem or potential problem.*** A sample question might be: Is ACT score an appropriate admissions criteria?
- ***Survey the related literature.*** This includes soliciting information from other educators.
- ***Define the problem being investigated in clear, concise terms.*** Specific outcomes now must be identified. In admissions, I have included a table adapted from a book chapter by Rezler.[3] (See Table 1.) These include both intermediate and long-term outcomes. The question asked might now be: What effect does ACT score have on first-year grade point average?
- ***Formulate testable hypotheses.*** The question now becomes a statement (ideally a null hypothesis): Students with ACT scores of 20 or above will not exhibit a higher grade point average.
- ***Construct the research design.*** Decide the parameters for rejection or acceptance.
- ***Collect, treat and analyze the data.***
- ***Evaluate the results and draw conclusions.*** Should we now, based on the results, continue to use ACT scores? Should we require a higher or lower score? Should we add another test?

Table 1
Predictors of Success and Outcomes Measures in Admissions[3]

Predictor	Intermediate Outcomes	Long-range Outcomes
Intellectual (Verbal and quantitative ability, knowledge)	Success in first year of school; grade point average, attrition, no delay in progress	Professional knowledge, professional growth
Nonintellectual (Values, attitudes, interests)	Personal interactions; patient care; clinical grades; coping with stress	Similar to intermediate outcomes
Psychomotor	Lab skills, clinical skills	Practice skills

Table 2
Outcomes Worksheet

Predictor: Intellectual.

Measures used: ACT score.

Intermediate outcome measured: First-year grade point average.

Conclusion(s): A *t*-test of means showed that students with an ACT score of 20 or higher had a significantly (p<.05) higher grade point average. Retain ACT as admission criterion based on intermediate outcomes.

Long-range outcome measured: Professional knowledge as indicated by employers on satisfaction survey.

Conclusion(s): Professional knowledge of graduates with an ACT score of 20 or higher was not significantly higher based on a *t*-test of means as rated by employers. (Employers' rating of graduates with an ACT score of 20 or higher was 3.1 on a 5-point scale; rating of graduates with less than 20 score was 3.0).

Action undertaken: ACT as predictor is retained due to good academic predictability. The possibility of using another predictor for long-term/professional knowledge will be explored.

Remember to keep it simple and relevant to the needs of your program. I prefer to conduct many small studies throughout the year and maintain a file of outcomes worksheets that can be used in the self-study. Also, if I conduct two or three small studies a year on a criterion such as admissions standards, then I am better informed and can identify actual problems faster.

Table 2 shows my method for assessing outcomes through outcomes worksheets. I believe this method should be usable for all types of programs. In this case I chose one type of predictor (intellectual) and evaluated ACT score in terms of one intermediate outcome (first-year GPA) and one long-range outcome (professional knowledge as evaluated by employers). Keep these in a file, and you will face your next self-study and site visit with confidence.

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By Steven B. Dowd, Ed.D., R.T.(R)
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Introduction: Instructional Tools

Every worker needs tools, even instructors. However, most of us don't use the tools we have as effectively as we could. Some instructors even fall in a trap of believing that the newest tool is what they need, and only after that tool is purchased for them can they become effective instructors.

The computer is the latest tool in education. Two articles in this section look at the use of computers in the classroom. I wrote one with Richard Bower on the basics of computer-based instruction. It reflects my theory about instructional development that ID = ID. What does that mean? Well, just as students learn that mAs = mAs through the reciprocity law, I believe basic instructional design concepts are valid no matter which medium you use. In other words, the basic components of a good lecture will translate into a good computer program or a good video presentation.

I met my colleague Rita Laws through the Internet, and we were inspired to write the article "The Internet's Role in Education" to explore this technology's potential in radiologic science education. What does the future hold? I doubt if my crystal ball is better than anyone else's, but I imagine that someday the Internet will be the primary delivery system for education. But just as we envisioned in the 1970s that education would be revolutionized by computer-based instruction, we have found that the road is a lot longer than we thought.

Another expansion of technology is the use of video education for distance learning. Stephen Hulse contributed two articles on this topic — one a general overview, the other discussing the very real need for faculty development. Most students still like some type of instructor contact, and for most people, that means face-to-face. Correspondence education or, today, e-mail education, is unattractive to many people because they want to interact with a person. I predict that distance learning will grow in popularity, and if the Internet can do it, an integrated system with video courses, e-mail assignments and Web page graphics holds great promise.

Donna Burr is the laboratory instructor at UAB. She and I decided to survey Southeastern programs (and have since surveyed all programs in the nation) on the use of energized labs. The results are reported in our article titled "Human Resources for the Energized Lab." How a program uses its lab influences how well students will perform in the clinic. The information given to students in class doesn't typically make full sense until they try it in the lab; the lab is an important intermediate step between theory and actual practice.

Speaking of surveys, Stephen Hulse offers common-sense advice about them in his article titled "Good Questions or Data Errata?" I occasionally receive surveys where it is so obvious that a predetermined answer is sought that I wonder why they bothered to conduct a survey in the first place. The advice in Hulse's article holds true for other types of surveys as well, including the dreaded student evaluation form.

Textbooks are perhaps the most basic instructional tool, and many educators want to write one. Based on our experiences, Frederic Martini and I wrote about some of the pitfalls of textbook production in "Getting Your Textbook Published." We both have been involved in several publishing projects that worked very well and a few that hadn't, so we thought we could bring some expertise to those who wanted to try. (As my mother used to say, you can only guarantee not failing if you don't try at all.)

Finally, as budgets shrink, Stephen Hulse's advice about grantsmanship ("Grantsmanship Earns Attention *and* Money") will become more valuable to educators. Many assume that grants can be secured only for "research," but a number of foundations are willing to sponsor equipment purchases or projects designed to improve the quality of teaching. And if we continue to move to more baccalaureate and master's degree programs, we will have to do even more research — which requires funding.

Steven B. Dowd

Grantsmanship Earns Attention* and *Money

Mention the word “grant” to most people and they immediately conjure up images of stuffy academia and major research projects. But today, grants are available from a broad array of funding sources that support both education and health care delivery services. As a director of education or a department manager, all you need to do to receive oodles of money is write a grant proposal. But therein lies the rub. Grantsmanship runs a close second to writing self-studies on the list of things we most dislike to do. It doesn’t have to be that way. With careful planning, you can write grant proposals that attract both attention and, most importantly, money.

Where To Look

Suppose you have an idea for a new method of providing health care or an innovative educational program designed to meet personnel needs. Because there are thousands of organizations that provide grant monies, how do you go about finding one most likely to be interested in your ideas? A good starting place is three references found in most public and virtually all university libraries — the *Annual Register of Grant Support*,[1] the *Directory of Research Grants*[2] and the *Grants Register*.[3] Additionally, if you have online access, you might want to search the online version of the *Federal Register*.

Once you’ve located a possible source of funding for your project, it’s time to write your proposal. It’s important to check with individual agencies for the format required, but most grants follow this outline:

Summary of the Proposal

The summary can be thought of as an abstract for an article. Briefly state who you and your organization are, what you hope to accomplish through implementing your proposal and an estimate of what it will cost. This is the first impression your proposal makes on the reviewer, so make sure it's good. Be concise and avoid jargon.

Introduction

Now that you've piqued the reviewer's interest, expand on who you and your organization are and why your ideas are best suited to receive funding. The key word here is "credibility." Here are some questions the reviewer is likely to ask:

- How long has your organization or program been in existence?
- What relevant experience do you and others listed in the proposal have with the problem being studied?
- Have other funding agencies thought your ideas good enough to provide previous support?
- What do other professionals familiar with the problem have to say about your ideas?
- Have you done a pilot project or prototype and, if so, what were the results?

A few years ago, I applied for two grants from an agency that supports design of computer-assisted instruction for use in medical schools. While preparing these grants, I learned of an upcoming symposium cosponsored by the funding agency. My colleagues and I put together prototypes of the software for which we sought funding and successfully demonstrated it at the symposium. When we wrote the grant, we were able to point to a proven track record of software development and the fact that our software had been received favorably by hundreds of professionals. As it turned out, a number of those who eventually reviewed our grant also were at the symposium. Our credibility was established. The result? Both grants were fully funded!

Statement of the Problem

Now that you've established your credibility, it's time to focus on the problem. Be specific in your narrative and don't overstate the problem. Make it appear to the readers that your problem is manageable with the time and resources being requested. Also, you can use this section to further build your credibility by briefly citing documentation of the problem as described in the professional literature and media coverage. Supporting charts and graphs can be used, but if they are extensive an appendix might be the best place for them. This also is the place to point out why your proposal is the logical connection between the problem being addressed and the funding agency.

Objectives of the Proposed Program

Remember that objectives should describe a measurable outcome of some activity. During a recent review of 60 grant proposals received by an organization to which I belong, I found that fully one-third of the proposals described what the researchers would do during the funding period, not what would result from that activity. Funding was not approved for these proposals because it was impossible to determine what changes or improvements could be expected as a result of supporting these programs.

Here's a checklist for your objectives:

- Who will be affected by this grant?
- What changes/improvements/reductions in cost will occur as a result of this program?
- During what period of time will these changes take effect, and what is the long-term potential for this program?

Proposed Methods

Now is the time to tell the reviewers how you'll go about achieving your objectives. You've already established your credibility in earlier parts of the grant proposal, but now is a good time to reinforce it. Review the pertinent literature and discuss why you have chosen one approach over others that may be available. Ask yourself the following questions:

- Have I described the technical aspects of my program, i.e., its pedagogical design or special equipment needed?
- Are my proposal's methods consistent with current technology and methods?

- How will my proposal handle variations in learner or patient characteristics?
- What personnel are needed for this project and what qualifications and previous experience will they require?

Evaluation

The proposed evaluation method tells you (and the funding agency) how you will know when your objectives have been reached. Kiritz[4] recommends dividing a sheet of paper into four columns labeled Problems, Objectives, Methods and Evaluation. First, list your problems. Match these with the objectives designed to address each specific problem, followed by the methods you will use to reach the objectives. Whatever evaluation method you select, be certain that it follows logically from the information in the first three columns.

Objective evaluations are hard to design. Opinion surveys of program participants or personnel are considered "soft" information by funding agencies, which generally prefer "facts and figures." If you anticipate using any form of statistical analysis, you should consider contacting a statistician for help in designing your evaluation. One caveat, though: Make sure his or her credibility is at least equal to yours, or the entire grant proposal will suffer.

Budget

The budget usually is the most difficult part of preparing a grant proposal. How much is your project going to cost and how long will it take? If people at your institution regularly deal with grants, see them as soon as possible. They can make some valuable suggestions regarding planning. Items you need to include in your budget planning are:

- Salaries and wages for all personnel, including anticipated raises over the length of the funding period.
- The percentage of time each individual will devote toward the project.
- The cost of fringe benefits, including Social Security, insurance, vacation and sick leave.

- Supplies, including paper, computers and postage.
- Rental or purchase of equipment.
- Travel expenses for visits to other sites doing similar work, professional seminars and so on.
- Utilities, including telephone, electricity and space rental.

To help you through this stage, you might consider using PERT (Program Evaluation and Review Technique) or CPM (Critical Path Method) charts. A number of software packages are available to help determine costs and time schedules for complex projects.

Some funding agencies require that the sponsoring institution make a significant contribution to the project, either in the form of matching funds or employee release time. Your proposal should address the availability of these contributions. You also should discuss the issue of continued funding past the expiration of the grant period. Continued funding by your institution shows a high level of commitment and adds to your proposal's credibility.

Finally, remember that grant writing is not a one-person job. It requires teamwork to succeed. Build your team with an eye to creating a pool of expertise, relevant experience and, most of all, credibility.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Human Resources For the Energized Lab

College-based radiography programs use energized labs to bring the clinic into the classroom. These labs are commonly used for positioning, imaging, physics and quality assurance lab assignments.

In 1981, Clements conducted a survey of college-based radiography programs.[1] Of the 134 programs responding to his survey, 78% had an energized lab. Clements' survey was primarily concerned with the equipment found in a lab. Other articles have been written on various aspects of the energized lab, primarily focusing on the development of energized labs and their use in the evaluation of students.[2,3]

For many years, the radiography program at the University of Alabama at Birmingham has employed a full-time laboratory instructor for teaching in the energized lab. We also teach lab courses separately from the regular didactic courses. For example, a didactic course such as imaging has a separate, graded lab course. This method works well for the program and, in a number of cases, the laboratory instructor position has developed individuals who wish to become faculty members at UAB or other institutions. Because tuition reimbursement plans often are available to faculty and staff, the laboratory instructor position serves as an ideal opportunity for an individual who wishes to pursue a baccalaureate, master's or doctorate.

In some other programs, the position of laboratory instructor (also called laboratory assistant) is a part-time job, often in the evening. It offers staff radiographers with a potential interest in education the chance to become involved in the program. An example of this approach can be found in the radiography program sponsored by Kaskaskia College in Centralia, Ill. This program has a total capacity of about 80 students. According to Program Director Gary Stevens, M.Ed., R.T.(R), up to eight part-time employees teach student positioning labs (personal communication, May 4, 1993). As a program director and lab instructor, we were interested in how radiography programs use their energized labs. We were especially interested in how human resources were used and whether full-time faculty or others (titled lab assistant or lab instructor) are being used to teach labs. Does it make more sense to use a perhaps lower-cost instructor for labs, freeing the faculty member for other duties? Would a lab be of more use with a full-time lab instructor?

In site-visiting programs, Steven Dowd, Ed.D., R.T.(R), noticed that many programs were not able to make efficient use of their labs because they lack the personnel to keep the lab open at all times students can use them. The goal of our survey was to examine how energized labs are used in radiography programs and to determine the best use of personnel. The preliminary results from this study will be used for programmatic planning and to prepare for a broader study on energized lab use.

Methods

Twenty-nine programs in the South (five programs from Alabama, six from Mississippi, seven from Tennessee and 11 from Georgia) were identified from the 1992 *Allied Health Education Directory*. Each was sent a one-page survey that asked whether the program had an energized lab and how it used that lab. The survey had been analyzed for face validity by experienced radiography faculty and was considered appropriate for the study.

Limitations of this study include the geographic distribution of the survey sample, which limits generalizability of the results, as well as the small number of programs participating in the study. According to the Joint Review Committee on Education in Radiologic Technology, in 1993 there were 323 U.S. radiography programs sponsored by colleges, universities and vocational/technical schools.[4] An adequate survey of this population would require a randomized sample of 175 programs.[5] This does not detract from the intent of the study, which was to form a preliminary view of the usage of energized labs, particularly in terms of human resources.

Perhaps the strongest limitation in this survey was the lack of a single model for the delivery of radiography education. Although diversity among programs is desirable, it makes comparisons difficult. Radiography programs now focus on the outcomes rather than the process. However, for the decision-maker in a radiography program, comparative data is useful when justifying expenditures to the dean or other school officials responsible for approving budgetary expenditures.

Results

Twenty programs responded to the survey, for a return rate of 69%. (See Table 1.) Eighteen of the respondents (90%) had an energized lab. This is higher than Clements' number and might indicate that more programs have energized labs today than 10 years ago.

The average hours of weekly use were 12.72, with a standard deviation of 8.2. Seventeen of the respondents taught labs within regular academic courses; four programs also taught labs as a separate course. Seventeen of the programs indicated the number of courses in which they use their lab. The average was four. This ranged from one to eight classes.

There were an average of 22.9 first-year students in respondent programs, with a standard deviation of 7.3. The average number of second-year students was 20.2. As an interesting side note, the difference between the classes was 2.7 students, or 12%. If this were viewed as the attrition rate (which of course cannot be determined from this study), then these schools had a lower average attrition than is seen nationwide.[6]

The average number of students in a program was 43.1. The two programs without energized labs had slightly fewer students than the average, 30 and 40. The average number of faculty was 2.86, ranging from six in a program with 43 students to two in 11 other programs. Two faculty members appears to be a common size. Since programs vary greatly in their use of faculty and even in the definition of a faculty member, there is no current way to determine an "adequate" number of faculty (personal communication, Barb Huffer of the JRCERT, May 4,

Table 1
Responses to Survey Questions

Question	Response
1. Does your program use an energized laboratory?	18 yes (90%); 2 no (10%)
2. How many hours per week do you use your energized lab?	12.72 hours average; sd = 8.2
3. How many courses use the energized lab?	4 courses
4. Do you offer specific lab courses?	4 programs
5. Are labs taught within regular courses?	17 programs
6. How many first-year students do you have?	22.9 students average; sd = 7.3
7. How many second-year students do you have?	20.2 students average; sd = 5.8
8. What is the total number of students in your program?	43.1 students average
9. How many faculty members do you have?	2.86 faculty average; sd = 1.16
10. Does your program hire lab instructors?	3 yes (15%)
11. What are the requirements for lab instructors?	3 require R.T.; 1 requires A.S. degree
12. If you do not have a lab instructor, do you need one?	9 yes (53%); 8 no (47%)
13. If you answered "yes" to question 12, what is your faculty-to-student ratio?	1 to 16.6 average
14. If you answered "no" to question 12, what is your faculty-to-student ratio?	1 to 12 average
15. If you answered "yes" to question 12, how many hours per week do you use the lab?	10.1 average
16. If you answered "no" to question 12, how many hours per week do you use the lab?	12.3 average

1993). One of the programs with 60 students had only two faculty members, but it also was one of the programs that hired lab instructors.

Only three of the 20 programs hired lab assistants. Thus, 85% of programs use full-time faculty to teach labs. All the lab assistants were part-time employees titled "lab instructor." Total student numbers in the programs hiring lab assistants were 60, 27 and 32. Requirements for being a lab instructor were basic — in all cases registration as a radiologic technologist and in one case an associate degree was required. For an entry-level position, these requirements seem appropriate.

Of the 17 programs without a lab instructor, nine indicated that they needed a lab instructor; eight indicated they did not. Those indicating they did not need an instructor had an average of 46.1 students for 2.78 faculty, a faculty-to-student ratio of 1 to 16.6. Those indicating they had no need for a lab instructor had an average of 41 students for 3.42 faculty, a faculty-to-student ratio of 1 to 12. However, a t-test of means revealed no statistically significant difference between the two populations. The programs indicating no need for a lab instructor also had a higher, on average, use of the energized lab (12.3 hours vs. 10.11 for those indicating a need for lab instructors).

Conclusions

The high standard deviation in number of lab hours shows non-uniformity in the use of labs, ranging from 4 hours per week to 30 hours per week. Two programs reported lab usage of 30 hours per week. Both had two faculty members; one employed a lab instructor and the other did not. The other two programs reporting the employment of lab instructors used the lab for 14 and 20 hours per week and employed two faculty members. In the cases of low amounts of lab usage, programs using a lab for only 4 hours per week (two did in this survey, with 44 and 37 students in the program) obviously have little need to hire an individual to run that lab. The question must also be asked if those labs are being used enough for student learning.

About half of the programs with a lab instructor indicated that such an individual was needed by their program. On the average, they also had fewer faculty compared to the number of students, which could indicate such a need is real. However, due to the great variance in program delivery across the United States, it is impossible to call one load excessive as opposed to another. Those programs with a "better" faculty-to-student ratio also showed a greater use of the energized lab. The implication is that programs with a smaller faculty-to-student ratio were not able to make full use of the lab and could possibly benefit from a lab instructor. If costs are a problem, a part-time lab instructor could be a cost-effective solution.

We recommend that programs explore the possibility of hiring a lab instructor. This individual can provide good quality, low-cost instruction to students in the energized lab and serve as potential development for a faculty-level position.

This survey also provides educational policy-makers in radiography programs with comparative data for planning in other areas.

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Tune In to the Video Learning Connection

The use of video conferencing in health care education is not new. The Pan American Education and Communications by Satellite was established in 1989 by the University of Hawaii using a NASA weather satellite. This two-way connection was the first of its type to provide regular educational programming via satellite, in this case for nursing.[1]

Teleconferencing can increase opportunities for access to centrally located resources, in terms of both institutional support and professional expertise. But as Wagner and Reddy[2] have noted, the pressure to deliver greater volumes of material to an ever increasing number of people leads to a method of media selection they term "hardware-driven." They define this to mean that decisions regarding program distribution are based on the *a priori* assumption that teleconferencing can address any issue or task equally well. In reality, teleconferencing should be seen as an educational tool, and as such should not be considered any more appropriate under all circumstances than using lectures in every situation. Instead, program goals, objectives and content should be considered before committing to a particular presentation medium.

Wagner and Reddy also describe several steps in designing learning outcomes for teleconferencing. Instructional designers must at the outset distinguish between instructional messages and educational messages. Instructional messages deal with those outcomes of instruction that produce intentional learning or change in performance. Educational messages, on the other hand, broaden knowledge without requiring the learner actually to demonstrate increased knowledge or proficiency. The conscious selection of media that will produce instructional messages can be developed through four stages:

- Consider the specific needs of the individual learner in light of his or her learning capabilities. These include an understanding of learning theory and information and storage retrieval.

- Sequence the instruction to address known or perceived deficiencies in knowledge or performance. Gagné et al[3] describe nine instructional events that are particularly appropriate for addressing fixed or variable task instruction: gain the learner's attention; inform the learner of the objectives; stimulate recall of prerequisite knowledge; present the stimulus material; provide guidance to the learner; provide feedback to the learner; assess the performance; make provision for transfer of information; and provide cues to enhance the retention of the material.

Wagner and Reddy cite Reigeluth's elaboration model for instruction as most appropriate for cognitive task instruction. Reigeluth proposed that instruction should be sequenced from the general to the specific and individual parts of the sequenced instruction should be related to all other parts and to the lesson as a whole, an activity Reigeluth calls "synthesizing."

- The instructional message must be modified to take into consideration such issues as whether a knowledge/skill deficiency really exists, and if so, how and when the knowledge/skill deficiency manifests itself in the learner, how the deficiency can be remedied and what criteria can be used to measure the effectiveness of remediation.

- The final stage involves selecting the instructional delivery system. Of prime concern here is the intended outcome of instruction. Instructional outcomes for abstract subject matter can be facilitated through use of speech and printed text. For concrete subject material, simplified diagrams or photographs, film and television can be used. For other types of information, merely seeing and hearing isn't enough. Learners need to actually apply knowledge in a practical, hands-on situation to obtain feedback about the correctness of their understanding of the material.

Instructional designers who intend to use teleconferencing as the mode of program delivery must consider the unique characteristics of this medium with respect to its ability to reproduce reality. Wagner and

Reddy suggest the best use of the medium is for “special event, ad hoc programming around which a course may be ‘wrapped.’”

Lane[4] reports a media selection model developed using a modified two-round Delphi technique. From this came eight major areas for evaluating teleconferencing:

- ***Educational objectives.*** Are objectives in the cognitive, psychomotor and affective domains clearly stated and appropriate? Is the teleconference content equivalent to an on-campus or in-person version?
- ***Instructional design.*** Is the program planned and organized around a logical sequence, and are a variety of teaching strategies used that are appropriate for the target audience and subject content? Is the content supported through the use of visual aids, and is the language level appropriate for the target audience?
- ***Content.*** Does the course title and description accurately portray the program content, and is the content up to date and clearly presented?
- ***Textbook.*** If a textbook is to be used with the teleconference, does material correlate well between the two? Does the textbook add materially to the quality of the course and to the understanding of the content, or is it redundant?
- ***Faculty guide.*** Is there documentation for faculty and on-site facilitators containing program objectives, content outline and outside reading assignments? Are there methods of evaluation that engage the distance learner in critical thinking?
- ***Student study guide.*** Does the study guide contain objectives, content outlines, a glossary, references and self-evaluation exercises? Does the guide help tie together the key concepts presented in the teleconference?
- ***Video component.*** Does the technical quality of the teleconference meet broadcast standards, and is the method of presentation (lecture, discussion, demonstration) appropriate for the content? Is the instructor skillful in using the video medium?
- ***Program cost.*** Is funding available to adequately support and distribute the program, and can a potential audience be identified?

Do these guidelines hold up in actual practice? To answer that question, let's look at two specific examples of video teleconferencing.

Boyd and Baker[5] used two-way video teleconferencing to reach registered nurses throughout South Carolina in a program leading to a master's degree in nursing. The program was sponsored by the Office of Telecommunications at the University of South Carolina.

Boyd and Baker followed a carefully crafted plan to help ensure the success of the teleconference. They recognized that inadequate amounts of funding, support staff and faculty commitment were barriers to a successful teleconference. They took several steps to overcome these potential barriers:

- The Office of Telecommunications provided a support team of experienced instructional designers who could plan courses based on accepted theories of learning. The office also oversaw program production funding.
- Faculty members were coached on techniques of working effectively in the video medium. This included tips on clothing, advice on the use of cosmetics and an introduction to video production terminology. All were given opportunities to practice in front of the camera and critique their performance.
- Production staff worked with the faculty to produce visual aids before broadcast time. Paper pads were available for faculty to use in place of a chalkboard.
- Course materials were duplicated and forwarded to all students enrolled in the teleconference. The course syllabus, assignments and exercises were the same as those used in the on-campus version of the course.
- The same number of faculty-student contact hours were required for the teleconference as for the on-campus version of the course.
- The faculty who taught teleconferences were experienced at teaching the content. They were the same instructors who taught the course on campus.

In evaluating the effectiveness of the teleconferences, Boyd and

Baker found that the teleconference students had a slightly higher grade point average than the on-campus students who took the same course (3.71 vs. 3.63, respectively). In addition, 10% of the students who participated in the teleconference graduated from the master's program, compared to 5% for the on-campus students. The authors note that, with a few minor exceptions, student evaluations of the teleconferences have been good.

A common concern regarding the use of the teleconference format is that socialization does not occur among students and between students and faculty. Informal observation by the authors, however, found that students worked together in study groups and formed carpools at the teleconference sites. Faculty also met more frequently with students to help overcome feelings of isolation or of "going it alone."

Feedback from the students, faculty and the accrediting agency for nursing programs indicated that the planning paid dividends: The use of teleconferencing increased enrollment in the nursing program and improved the image of the university as a leader in education through technology.

Parkinson and Parkinson[6] reported on the use of two-way video teleconferencing in nursing education at the School of Allied Health at Weber State University. Students for both the on-campus and teleconference sites were given study guides with learning objectives, supplemental readings and visual aids. Additional print materials were mailed to teleconference participants to help offset the decreased faculty/student contact time (33 hours for on-campus students vs. 10 hours for teleconference students). The same instructor taught both groups.

At the conclusion of the course, teleconference participants rated the instructor lower in six out of seven categories — instructor effectiveness, organizational presentation, ability to motivate students, clarification of objectives, promoting learning and satisfaction of objectives — than their on-campus counterparts. There was no statistically significant difference in the seventh category, fairness of examinations.

In the course evaluation, teleconference participants called the course "significantly overloaded" and "too challenging." They also thought the visual aids were unhelpful and the material was poorly integrated. They reported lower overall interest and poorer course attitudes compared to the on-campus students.

Despite the critical nature of the student evaluations, there was no statistically significant difference in grade point averages between the teleconference participants and the on-campus students. The authors suggest this may be the result of two factors: Motivated students can learn regardless of the instructional format, and instructors who carefully plan their courses may be able to present the same information in less time.

It is clear, then, that program planners need to examine the desired instructional outcomes and determine if video teleconferencing is the best way to achieve these goals. Furthermore, careful planning is vital to all aspects of teleconference production. Issues in learning theory, contact sequencing and program production must be addressed to provide learners with quality instruction.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Getting Your Textbook Published

Expert teachers often are dissatisfied with the textbooks they use for their courses. To solve the problem, they usually supplement the text with additional material, some of which they have developed themselves.

What makes textbooks less than adequate? Many factors can come into play, but a few of the more common include:[1]

- The author's inability to explain material at a level students can understand.
- Poor writing or organization that can't be corrected by editors.
- Authorship restrictions, such as the inability of a publisher to provide a certain quality of illustrations.
- The philosophic orientation of the author, whose view of how the material should be presented may differ from the instructor's.

At some point, especially after developing large amounts of supplemental material, an expert teacher may decide that writing his or her own textbook is the solution. There are a number of reasons for writing a textbook — some good, some bad. Schoenfeld and Magnus[2] note the following three aspects of textbook production that should be addressed by any instructor who wants to write a textbook:

- Writing a text is the absolute expression of professing (being a professor). It hones teaching skills and techniques and reaches a wider audience. By writing, you will learn more about your discipline and more about teaching.
- Publishing means selling, and selling means marketing. A textbook author must become an entrepreneur. Unlike trade or academic books, the textbook author must be willing to help promote and sell the book as well as write it.
- Rewards are uncertain. Even a good text can receive meager adoptions and lukewarm reviews. At research institutions, a 2000-word

article may count for more than a 200,000-word textbook. At teaching institutions, however, a textbook author may be "positively venerated." The financial rewards may be staggering (although this is unlikely in a market like radiologic technology) or you may receive years of "negative royalty statements."

If you, as a professor, feel capable of producing a quality product, are willing to let your ideas be held up for public scrutiny and realize that the rewards of textbook production may end up being more intrinsic than extrinsic, then you may want to consider producing a textbook. Payne and Gallahue[3] make the following observation about writing a textbook:

> *Textbook writing should be undertaken for the love of learning, and for conveying knowledge, thoughts, and ideas on the printed page. Textbook writing is all about the process itself, and very little about the product. The rewards of textbook writing are intrinsic and grounded in the creative process of "becoming" rather than the extrinsic rewards of "being."*

Developing the Proposal

Let's say you have an idea for a new textbook and are willing to undertake the challenges of publishing. Before you ever approach a publishing company, you first must develop a book proposal. A well-prepared proposal can save you considerable time should the publisher consider the target market too small for your proposed text.[4] The proposal must convince the publisher that your book will be superior to similar books already on the market. Although you might be willing to develop a textbook as a "labor of love," a textbook publisher will not be interested unless your book has the potential to sell. The goal of a publishing company is to make money, not to disseminate ideas. Even a small publisher must consider profit as the motive, because a publisher who makes no profit will cease to exist.

If you want to develop a book for a specialty market and the big textbook publishing companies show no interest, you may want to consult a university press that specializes in short-run books of less than

1000 copies. You also should investigate the possibility of self-publishing your book.

Book proposals have six main components. Most publishers will provide a format to follow when writing a book proposal, but proposals generally include the following information:

- A market description.
- A competition description.
- A book description.
- An author description.
- Sample chapter(s).

Securing a book contract is highly competitive. It is estimated that of 1000 expressions of interest to write a book, probably 50 make it to the proposal stage. Of those submitting a proposal, only five to 10 are accepted by a publisher and only 30% to 70% result in a finished book.

Usually, the publishing company will ask other educators in your discipline to review your proposal. If you are unable to convince these reviewers that your textbook has merit, it is doubtful that the publisher will offer you a contract. A goal of the proposal, therefore, is to convince the reviewers that they would be willing to switch from their current textbooks to yours once it is published. Let's examine each part of the book proposal:

Market Description

Each publisher has a specific view of the target market or audience for every book. You must be able to convince the publisher that your book will sell enough copies to make the venture worthwhile. This is especially important in a discipline such as radiologic technology, where the market is small compared to disciplines such as English composition or psychology.

Competition Description

If you are unable to describe what is good or bad about the currently competing textbooks on the market, the publisher probably will decide that you are not going to be their choice of author. Another sure "kiss of death" is to claim there are no competing texts to yours at this

Table 1
Items to Include in the Spreadsheet

- Total number of pages and total number of figures.
- Front matter content and length.
- Back matter content and length.
- Number of chapters.
- Features (for example, definition of terms, pronunciations, word roots, additional readings, end-of-chapter questions).
- For each chapter:
  1. Page count.
  2. Figure count (number of figures in black and white, number in color, number of line drawings, number of photographs).
  3. Table count.
  4. Number of terms to be printed in boldface or in a second color (the use of a second color adds to the cost of the book).

time. The logical assumption, from the publisher's point of view, is that if there is no competition there is no market, and if there is no market there will be no demand for your text. When you prepare the spreadsheet or table describing your book (see Table 1), you may want to prepare a second version that shows how your textbook will stack up against the competition.

Another method that worked well for Michael Thompson, senior editor on the collaborative text *Principles of Imaging Science and Protection* (W.B. Saunders, 1994), was to conduct a national survey that asked what was good and bad about texts currently on the market. Based on his data, Thompson was able to prepare a proposal that revealed what educators didn't like about the texts they currently were using and how he intended to develop a book that would meet educators' needs in the areas of physics and imaging.

Book Description

The book description should, in one paragraph, clearly describe the book. Ancillaries and pedagogy also should be described in this section. If your book is accepted, this section often forms the foundation of the marketing plan for the book.

A content outline must be detailed enough to give the publisher an idea of how your book will compete against current texts. In addition to the table of contents, a content outline should contain a brief description of the intent of each chapter.

You should prepare a spreadsheet or table that describes your book. (See Table 1.) The spreadsheet is difficult to prepare, but it forces you to think about the details of your textbook. Be as complete as possible when describing the features of your book, because everything affects the final cost of the project. How many pages of text? Is there any front matter? Back matter? What is the trim size? How many illustrations? Will they be line art or photographs? Will the photographs be black-and-white or color?

By determining these factors in advance, you are doing the publisher's homework and making it easier to prepare a budget for the project. It doesn't matter if you are off a little on page count or the total number of illustrations; what matters is that the publisher has enough information to make a rough estimate to assess profitability (which affects their interest level and your leverage).

Also, doing this advance work proves that you know the ropes, are organized and can be taken seriously. This is important, because a lot of aspiring authors have great ideas but poor organizational skills. If the reviews are good and the publisher needs a book in your proposed market, you're in business.

Author Description

Resumés and curriculum vitae usually are not very revealing. You may be the world's foremost expert on radiographic technique, but that fact in and of itself does not qualify you to write a textbook. You must convince the acquisitions editor that you are capable of explaining concepts clearly and accurately, using the written word.

You already accomplished much of that in the first part of the book proposal, and some of it you will solve by providing a well-written sample chapter. However, in this section of your book proposal you should provide a brief overview of your relevant qualifications. Have you written articles or textbooks before? Have you presented papers at professional conferences? Have you won awards for teaching? Are you recognized in your profession? If so, let the publisher know. Now is not the time to be modest.

Sample Chapter(s)

Publishers may ask specifically for the first chapter of your book, since it will serve as a foundation for the entire text. In some cases, publishers will ask that two chapters be submitted — the first chapter plus another representative chapter. Whatever you submit, make sure that it accurately represents the remainder of the book. If you plan to include boldfaced terms throughout your book, for example, then your sample chapter should show how you will incorporate them. If you intend to use pedagogical devices, do so in the sample chapter with the same amount of detail as you will in the potential book. Don't consider the sample chapter to be a "rough draft," even if the publisher tells you that it's all right to turn in something rough. Your sample chapter should be very polished.

What If My Proposal Is Rejected?

It can take as little as one ambivalent review to sink a proposal. In some cases, reviewers may react with hostility to the very idea of your textbook. The reason behind these reactions is best left to the psychoanalysts. If your proposal is rejected, don't be too discouraged. Most experienced textbook authors have experienced rejection at one time or another — some of them more often than they care to admit. As consumers, you see only their successes, not their failures.

An author has two options if his or her proposal is rejected — either submit it to another publisher or give up. The best authors learn to glean relevant comments from the first set of reviewers and use them to write a better book proposal.

When the Contract Comes

An acceptance from a publisher is exciting, but don't let your enthusiasm lead you into signing a contract prematurely. Examine the details of the contract carefully. For example, don't commit to an overzealous schedule for producing the book. Consider your workplace and personal commitments first. Also, look carefully at the publisher's requirements for ancillaries such as an instructor's manual or accompanying software. Writing an instructor's manual, in some cases, can be as time-consuming as writing the textbook itself.

Henson[4] notes that he used to tell potential authors not to worry about the details of publishing contracts. Today, however, he realizes that it is in the publisher's interest to write a contract that benefits the publisher. He recommends that authors follow these tips:

- ***Don't be afraid to negotiate.*** Although most publishing companies are honest, they have to look out for their own best interests. Work, within reason, to protect your interests.
- ***Ask for a fixed royalty fee.*** Depending on the discipline, the size of the market, the financials run by the publisher, your art contributions and other factors, book royalty rates can vary from 8% to 18%. Lower is much more common than higher, and rates offered to experienced, proven authors are higher than those to newcomers. There also are levels of royalties in many contracts. In other words, the front-page contract rate may apply to U.S. college sales, while another rate — specified in a later subparagraph — applies to foreign sales, direct sales, discounted sales and so on. As separate items, these categories of sales do not count toward any escalation point.

"Sliders" are a common feature of royalty contracts, with the breakpoint often set at the projected first year sales. The contract also may include a "home-run" clause stating, for example, that if the text sells more than 30,000 copies in any one year, the royalty rate jumps to 12% retroactively. In general, royalty rates have been declining due to the large investment — now including multimedia — required in these markets. Also contributing to declining rates is the management of megapublishers by conglomerates concerned with bottom-lining everything. Fifteen years ago, rates of 15% were common; today, those rates are the exception.

Henson believes that sliding scales benefit the publisher rather than the author. Such sales typically promise, for example, 10% royalties for the first 5000 copies, 12% for the next 5000 and 15% for anything above 10,000. Few books are going to sell enough to justify such sliding scales.

In textbook writing, the experts rarely agree on royalty rates. This makes it important to solicit multiple viewpoints. (See Table 2.) For example, Levine[5] considers sliding scales beneficial and recommends that authors lobby for them. In the end, it simply might be a matter of the sales potential of the book. A book with large sales potential has more to gain from a sliding scale than one with a limited potential.

• ***Ask for a grant or a nonrefundable advance to cover your costs of producing the book.*** Ideally, a grant should be provided to the author to produce the book; also ideally, the grant is nonrefundable in the event the publisher decides to "kill" the project. Unlike advances, grants are not extracted from the author's royalties. They cover things like computer hardware, express mailing fees, telephone bills, fax charges and other costs that are directly involved with the preparation and submission of the manuscript.

Neither grants nor advances are intended to reimburse you for your time and effort invested in preparing the text. Your time is considered your "sweat equity" that justifies your percentage of final sales. However, an advance can enable you to defer other income-producing tasks that would compete with your writing time. For example, if you normally earn $10,000 by teaching during summer session or evenings as an overload, you could negotiate an advance of that amount so that your evenings and summers could be devoted to the project. Keep in mind, however, that this money will be considered an advance on your royalties, not a grant.

When considering how large an advance to ask for, use 50% of your estimated first-year royalty revenues as a ballpark figure. Say, for example, that the publisher expects to sell 10,000 copies of your book at

$30 per copy, generating $300,000 in revenues and $30,000 in royalties. A $15,000 advance — 50% of your projected royalties — is a good place to start your negotiations.

Keep in mind that an advance is an interest-free loan — it commits the publisher to you and your project (and you to them!) more securely than a contract alone. If there is no advance, your book contract gets signed and shelved. It then becomes a "no-lose" situation for the publisher, who may assign your book a lower priority. Staged advances are fine incentives — "X" amount on signing, "Y" on completion of first draft and "Z" on submission of the final manuscript. This type of schedule helps keep you focused on meeting your next goal.

• ***Look for hidden expenses deducted from royalties.*** Hidden costs can add up quickly. Few authors realize the cost, for example, of producing an index. For a 250-page book, indexing may cost $2000. You may be required to prepare supplements on demand or else have the cost of someone else preparing them deducted from your royalties. Some publishers even may charge you to calculate your royalty statement. Try to make sure that the publisher pays for reprint permissions. In some cases, these items may not be negotiable. If so, you might want to look for another publisher. Most books don't make money for the author in terms of return-on-investment. You will spend thousands of hours producing a book that may net you $2000 or $3000 a year. However, you don't want to start at a loss.

The Mechanics of Production

It would take many pages to discuss the complicated process of producing a textbook. If your publishing company assigns a good editor to your project, he or she will lead you through the various production phases as they occur, explaining each step along the way. Be sure to educate yourself by reading books about textbook writing, editing, design and production. Also, don't be afraid to continually question your editor. If you are not proactive in this aspect of textbook production, you increase the risk of winding up with an inferior product.

Table 2
Suggested Resources

Textbook Authors Association, P.O. Box 535, Orange Springs, FL 35419
This organization offers several pamphlets on textbook publishing, including one titled "Some Questions To Ask Before Signing a Publishing Contract for a Textbook." The TAA also provides a legal hotline service, offers an ombudsman service to assist in disputes and maintains an author experience file that lists authors who are willing to share their publishing experiences with others.

Henson KT. *The Art of Writing for Publication.* Needham Heights, Mass: Allyn and Bacon; 1995.
Henson probably is the most recognized authority in all aspects of academic publication. This book is indispensable for all faculty involved in the production of scholarly materials. It contains a number of samples that are helpful, including sample proposal and competition statements. This text is especially useful for the publishing novice.

Luey B. *Handbook for Academic Authors.* New York, NY: Cambridge University Press; 1992.
Written by a former university press editor and current academic, this is a good book on writing in general, including journal articles and revising dissertations as books. The last half of the book discusses textbook production. The information is both practical and usable. Included is an annotated bibliography that lists a number of sources.

Benjaminson P. *Publish Without Perishing: A Practical Handbook for Academic Authors.* Washington, DC: National Education Association; 1992.
This book spends a lot of time discussing issues that are only of peripheral interest to academic authors, such as literary agents, but it does contain a lot of useful information. The author is an academic journalist who writes in a journalistic style through the use of multiple interviews.

Conclusion

There is no more internally rewarding project than writing a textbook: You get to learn more about your profession, you can try out your best teaching techniques, and you gain the satisfaction of contributing to your profession. You also may make some money, but that should be a secondary consideration.

As a discipline that is constantly advancing both professionally and technically, radiologic technology needs quality textbooks. Consider becoming one of the leaders in the profession by writing one.

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By Steven B. Dowd, Ed.D., R.T.(R), and Frederic H. Martini, Ph.D.
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Faculty Development For Distance Educators

Today's economics make it increasingly difficult for a hospital or college to justify operating a health sciences educational program for only 10 or 15 students. Administrators are demanding more bang for their buck, often touting distance education technology such as audio conferencing and digitized video by phone lines or satellite delivery as one way to reach this goal. But it takes more than just plopping someone in front of a microphone to make him or her a distance educator. It takes planning and, more importantly, faculty development.

Traditional lecture-based curricula rely heavily on interaction between instructors and students and among the students themselves. Competent instructors continuously evaluate students' understanding of material and, if necessary, re-teach poorly understood subjects. These teachers' abilities depend not so much upon changing the lesson's content as on taking advantage of the continually changing teacher/student dynamic to make sure important instructional points are presented with maximum impact.[1]

Colleges are rife with instructors who were hired not for their excellence in teaching but for their demonstrated competence in a particular profession. Moore[2] reminds us that "course design, program production and academic professing are clear and separate specializations" that require a collaborative effort among professionals from many disciplines.

Instructors skilled at distance education use teaching methods that differ markedly from traditional classroom settings.[3] Instructional problems revolving around teaching methodology, learning styles and feedback mechanisms "explode" in distance learning as audience size increases and face-to-face contact decreases.[4] No technology can overcome poor teaching skills, and poor teaching skills actually can be exacerbated in distance education applications.[5]

Distance education has many potential uses in radiologic technology. Programs that could be delivered via distance education methods include nonclinical coursework, management and teaching seminars and graduate/undergraduate credit courses.

Instructors need help to become strong distance educators, particularly in the area of interactive video. In 1992, the Penn State College of Medicine designed a faculty development program to help instructors cope with this technology. The program involved four phases — planning, development, implementation and evaluation.

Phase I: Planning. The project team was composed of academic and clinical specialists and experts in instructional design, biomedical communication and television production. During this initial phase, the project team met to define the goals and objectives of distance education in health sciences educational programs and to identify potential topics, instructors and target audiences.

Phase II: Development. Based on a review of the literature in distance learning and the combined expertise of the project team, a faculty development program was created to include three components:

- A workbook describing steps in preparation for teaching a televised course; legibility guidelines for creating graphics; guidelines for selecting clothing and jewelry; techniques for humanizing distance learning; methods for increasing participation by distance learners; suggestions for varying message style to maintain learner interest; and techniques for encouraging feedback from remote learning sites.
- A videotape demonstrating each of the topics listed above, including proper and improper use of techniques.
- A studio session to practice on camera the techniques learned using the workbook and videotape.

Materials developed during this phase were circulated to educators outside the project team for critique.

Phase III: Implementation. Two components of this project were evaluated: Instructor attitudes regarding the faculty development program itself and student attitudes toward the teaching effectiveness of faculty using distance learning technology.

Phase IV: Evaluation. Instructors who completed the faculty development program and taught via digital video or satellite were surveyed using a Likert scale instrument. Factors evaluated included clarity, helpfulness and relevance of the workbook and videotape, utility of the studio practice session and critique from the biocommunication specialists. Students in the studio and at the remote site also were surveyed. Factors evaluated included attitudes about learning via video and satellite technology, the instructor's use of distance learning technology, the instructor's ability to humanize distance learning and integrate remote-site students so they felt like they were part of the class, the legibility of graphics and the usefulness of handout materials.

Initial reactions were favorable. Faculty appreciated concrete suggestions for improving their use of educational technology, and students generally agreed that distance education technology gives them convenient access to experienced instructors.

Will studio learning replace face-to-face classroom interaction among teachers and students? Not in the near future, but an understanding of distance education techniques is a skill that the teacher of tomorrow should have today.

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Good Questions or Data Errata?

All of us, at one time or another, have needed to assess a program, a service or an institution. The logical means of gathering this information is by conducting a survey. Unfortunately, surveys often are viewed as a research tool so easy to use that anyone can do it. As a result, little effort goes into their planning and production. This lack of effort becomes obvious when it's time to analyze the results.

It doesn't have to be this way. Careful planning and the use of eight easy guidelines will make construction of your next survey smoother and provide more useful data.

• ***Specify the survey objectives.*** What do you hope to learn as a result of this survey? Do you want to measure attitudes, actions, interests or knowledge? Defining the information you require allows you to write survey questions that are both specific and necessary. Don't forget to involve other professionals early in the design stage to help ensure that your survey is comprehensive.

How do you know whether your survey is ready for distribution? Zemke and Walonick[1] suggest that you ask yourself these questions:

1. Can you state the purpose of your research in 25 words or less?
2. What do you want to know?
3. Why do you want to know it?
4. Is gathering this information really important?

If you don't have answers to all of these questions, continue to refine your research goals until you do.

• ***Review the literature.*** If the information you seek is common to other educational or health care programs, the chances are good that someone else has studied the issue. You may be able to save time and money by using the results of their survey. Even if their research objectives were different than your own, it's possible that you may be able to learn from their findings or avoid the pitfalls they encountered. If you're lucky, you will find a research tool that fits your needs so closely that you can use the same or similar survey questions.

• ***Write the questions.*** The questions you ask should follow logically from your objectives. If a question doesn't seem to fit your objectives, throw it out. Or, if the question appears to probe some important area of inquiry, rewrite your objectives.

The particular format you select for your questions will depend in part on the type of information you're collecting and the type of analysis to be done. Closed response items take little time to complete and can be summarized easily and thus are ideal if you must analyze your responses quickly. Open-ended questions require the respondent to generate his or her own answers. These questions are useful in providing insight into problems. In addition, they can be quite useful in situations where the researcher cannot anticipate a reasonable number of responses for closed-type questions.

One word of caution here. Likert scales have become increasingly popular, but are difficult to interpret. For example, many succumb to the temptation to average the answers of these 5- or 7-point scales, but the resulting statistical analysis may be meaningless. That's because the "distance" between a response of 1 or 2 may not be the same as the "distance" between 4 and 5. As a general rule, use a "yes/no/don't know" response format whenever possible.

• ***Use simple, direct language.*** Keep questions brief and avoid double-barreled questions, such as "Would you favor offering programs in ultrasonography and magnetic resonance imaging?" If a respondent answers "yes" to this question, how should it be interpreted? Is he or she in agreement with both propositions or only one? Use two separate questions to measure issues like this. Also, avoid ambiguous terms such as "some," "most," "few" and "many."

• ***Determine the sequence of the questions.*** Most surveys begin with easy, nonthreatening questions and gradually become more specific. Stacey and Moyer[2] suggest the following:

1. Personal questions (age, educational level, income) should be asked last. Many respondents do not want to answer personal ques-

tions immediately and may refuse to complete the survey if they are first on the questionnaire.

2. Avoid influencing the respondent's attitudes.
3. Make the survey form attractive, easy to use and interesting.
4. Do not include questions that are intimidating or irrelevant.

• ***Use professional production methods.*** Typeset, printed materials are ideal, but clean computer-generated copy from a laser printer or photocopier is OK too. Maximize the "white space" on your survey to provide adequate room for responses. To avoid confusion, arrange closed response items in a vertical format and consistently place the response space either to the left or the right.

• ***Prepare the cover letter.*** Your cover letter should explain the purpose of the survey and describe how the respondents were selected. It also is an excellent place to provide instructions for answering the questions. Don't forget to include the address to return the completed survey and the deadline by which it should be returned.

• ***Validate the survey.*** Despite your best efforts, you'll be surprised at how many errors go undetected in the planning and design stage. Instead of discovering this after sending out hundreds of forms, test your survey on representative members of your target audience. Analyze the responses from this pilot test. If necessary, rewrite items that are ambiguous and then duplicate the survey for distribution.

Properly planned and executed, surveys can provide a solid basis for rational program planning. The time spent in careful survey design plays big dividends in accumulating accurate and useful information.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Introduction: Instructional Techniques

As would be expected, the largest section of this book deals with the techniques of teaching. Stephen Hulse wrote two columns on the traditional teaching techniques: lectures and presentations. Although we need to concentrate on interactive methods of teaching, the lecture is by no means dead and will continue in some form for many years to come. From the participant's standpoint, what makes a lecture good often is not what is presented (content) but how it is presented (style). Newcomers need to be aware of the pitfalls that can happen in lecturing. One rule Hulse mentions in "Teaching by Lecture" took me years to learn: Don't overprepare, because overpreparing and trying to present too much is as bad as underpreparing.

Hulse also describes clinical teaching in his article titled "Components of Clinical Teaching." Educators tend to overemphasize academic instruction at the expense of clinical instruction and often assume that the techniques used for teaching in the classroom transfer well to the clinic. Although this assumption is partially true, it also is partially false. I long for the day when specific preparation for clinical teachers exists and when their job is seen as important as the program director's.

Interviewing students is an art. I firmly believe in using interviews to select students, as they add another, possibly more useful item to the selection process than grades or test scores alone. In "Questions About Student Interviews?" Hulse not only suggests questions to ask during student interviews, but also explains what traits the questions assess. This helps us design an interview process that is fair to the student, while selecting for important criteria such as motivation.

Four articles in this section written by UAB faculty describe various attempts to make learning more interactive, since we know this is how students really learn. Making learning interactive can be a painful experience, because almost every class has a few "lazy learners" who want everything presented in a lecture format. Still, there are techniques you can use to get students more involved in the learning process. Ann Steves addresses the correct use of questions, Shirlee Maihoff writes about a method called cooperative learning, Bettye Wilson and I discuss case studies and, in an idea piece, I describe some methods for interactive classroom learning.

Caring and ethics are topics that radiologic science educators never tire of, as they know these traits are essential for sound patient care. "Teaching Students to Care" by Ann Steves explores whether caring can be learned, while Bettye Wilson's "Medical Ethics for Radiography Students" describes a possible implementation of ethics instruction, including useful methods to solve ethical problems. Institutional philosophies such as managed care are going to make such issues increasingly important in the future.

Steven B. Dowd

Teaching by Lecture

You must excuse the occasional unstifled yawn among students. You see, by the time they complete four years of college they will have endured almost 2000 hours of classroom instruction. Without question, most of that time will have been spent listening to lectures.

Educators' preference for lecturing is not surprising given three facts: Most of us were taught that way, a lecture appears easy to prepare and present, and lectures are widely accepted by students and peers. But since so much time is spent lecturing to our students, let's look at some of the pros and cons of this popular teaching method. The guidelines here are loosely based on recommendations by Eble[1] and suggest how we might approach the planning and delivery of a lecture.

- ***Use the lecture format appropriately.*** Lectures are excellent for transmitting large amounts of information to groups large and small and for imparting information not otherwise readily available, such as recently discovered facts or original theories. A competent speaker also can use the lecture to stimulate listeners and give insight as to how processes work. But the lecture is a poor place to present abstract, intricately detailed or complex information to students.

Also, lectures generally are not effective in teaching application of information, in developing problem-solving skills or in changing attitudes. These areas are best addressed during a discussion or demonstration so that students can question the instructor and see for themselves how the facts fit together. Supporting information might be distributed as part of an illustrated handout for students to refer to during class.

Speaking of handouts, some instructors believe it is the student's responsibility to take notes during class and therefore do not provide a handout. But research[2] shows that note taking during class actually may interfere with retention of knowledge. In fact, it appears that giving students a guide that outlines the material about to be covered and stresses key concepts and phrases tends to improve test scores.

The main problem with a lecture is it assumes that all students learn at the same rate. Because this is not the case, many students are alternately bored or bewildered. This can be partially overcome if the instructor regularly checks student comprehension during the class.

• ***Teach only as much as can fit comfortably into the time allotted.*** Some instructors are determined to "teach it all." They usually can be identified by their slides and overhead transparencies consisting of photocopied pages of books, their voluminous multipage handouts and their cries of "I just need a few more minutes…" at the end of every class. These instructors are shouldering the entire responsibility for what students learn. But we can never "teach it all"; in fact, I suspect it would be undesirable to do so even if we could, for it would leave no room for students' personal discovery and growth.

Instead, instructors need to identify two or, at the most, three important points in each lecture, carefully supporting each with illustrations and examples. Presenting manageable amounts of information gives students time to assimilate the data and fit it into what they already know and understand about the subject.

• ***Every lecture should have a beginning and an ending.*** This is important. Although it would be nice if students arrived in class ready to take notes, this rarely is the case. Remember that they have a life apart from the classroom. There may have been an incident in the clinic that has everyone excited, or students may be talking about a movie they saw the previous night. The clever instructor bridges the gap between the outside world and the classroom by focusing students' attention on the material to be discussed.

Also, every lecturer should remind students of what they already have learned, what they are about to learn today and, at the conclusion of the lecture, what they will learn next time. This helps students understand how the current material related to what went before and what will follow. The beginning and end of class also is a good time to tie up loose ends, answer questions and correct misconceptions.

• ***Don't be a bore.*** Vary your voice, gestures and physical movements to stimulate the audience and reinforce what you are saying.

Why is this important? Research indicates that students' attention begins to wander within 15 to 20 minutes of the beginning of a lecture.[2] If they aren't listening, they aren't learning.

But, you say, paying attention to voice, gestures and physical movement strikes you as being theatrical. Well, perhaps it is. In two fascinating studies by Ware et al,[3,4] researchers looked at the relationship between style of presentation and student learning as measured by performance on an objective test. The "Doctor Fox Effect," named after the persona created by the researchers, demonstrates that an instructor's style of presentation affects how well students remember facts.

Here's how it worked. A trained Hollywood actor was coached to deliver a lecture to several groups of students. Two factors were varied: lecture content (high, medium, low) and lecturer seduction (high or low). The authors used the term "seduction" to refer to personal characteristics such as charisma, enthusiasm, expressiveness, friendliness, humor and personality. The results? Students who heard the high seduction presentation remembered more of the lecture content. Not surprisingly, the students who attended the high seduction lecture gave a more favorable rating of the instructor than did the low seduction group. So the next time you hear a colleague say, "I just present the material; it's up to the students to learn it," remind them to be enthusiastic and charming in the process.

• ***Know your subject well, but teach it like you just learned it.*** Have you ever had the experience of listening to an extremely competent professional talk about his field of expertise? The kind where you're certain he knows what he's talking about, but you're equally certain you don't know what he's talking about? Or have students ever told you that they know a certain instructor is smart, but that sometimes she talks over the students' heads? The problem may be that the instructor is "too competent" to teach well. How can this be?

According to unpublished data from N. Whitman, learners pass through four levels of competency: unconscious incompetence (the learner is unaware that he cannot do a task), conscious incompetence (the learner is aware of the task, but cannot do it), conscious competence (the learner is able to think through a task step-by-step and do it), and unconscious competence (the learner can do the task without thinking about intermediate steps).

Most professionals-turned-instructors have reached this last stage. But to be effective in presenting a lecture, instructors have to go back to being “consciously competent” by recalling what knowledge they had when they first learned the material and what explanations and information are required to successfully grasp a topic. This is why students sometimes do so well at teaching other students: as students, they are, or are becoming, consciously competent. They know the right vocabulary to use for explanations; they remember what problems they had in comprehending the material; and they can consciously describe the steps involved in arriving at a solution.

• ***Provide frequent opportunities for questions.*** Remember, students’ attention begins to wander about 15 minutes into a lecture. This is an ideal time, then, to change the pace of the class by pausing and reflecting on what has just been covered and asking questions. But this is a time not just for students to question the instructor, but also for the instructor to question the students.

When talking directly to a person, it’s easy to see if he follows what you’re saying by his facial expression and verbal comments. But as the size of the audience grows, it becomes increasingly difficult to confirm that students are actively following and comprehending the material. To overcome this problem, ask students to discuss key concepts in their own words. This is the time to clear up misconceptions and factual errors; if students don’t understand the preliminary information, it’s unlikely that they will understand whatever follows. Questioning during a lecture also can be used to promote individual thinking among students and to encourage them to evaluate what they have heard.

Of course, there are many methods of presenting information other than a lecture. But when a lecture is the best choice, following these guidelines will help your students get the most out of their time in class.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Components Of Clinical Teaching

When all the books are put away, when the last questions about photoelectric effect and latent image formation are forgotten, when a patient's life is on the line, can your students provide competent, compassionate patient care? The question is not rhetorical; we've all seen students who excel in their academic studies fall flat in their clinical assignments. It's this translation of theory into practice that's often the most troubling for teachers and students alike. How, then, should clinical education be approached?

For years, the paradigm of "see one, do one, teach one" pretty much summed up the approach to clinical education. And if radiography were strictly assembly line work and concrete guidelines could be established for all procedures, then perhaps this simple model could be applied. But clinical radiography just isn't that simple; it involves teaching not only complex relationships between objects both seen and unseen, but role modeling of skills and attitudes as well. Any successful approach to clinical instruction must take this complexity into account.

So what are the components of effective clinical teaching? Six discrete elements can be identified:[1-3]

Pre-clinical Practice

No surprises here. The instructor explains the objectives, demonstrates the material in a clear and organized manner, highlights important information and summarizes the major points at the end of each class. Remember, the rule is "Tell them what you're going to tell them, then tell them, then tell them what you've told them." Here's how that translates into clinical teaching:

- Explain the procedure you're about to demonstrate and the anatomical structures that it shows.

- Demonstrate the procedure step-by-step and in a logical sequence, stopping when necessary to make sure all students understand the concepts.
- Warn students of potential problems and pitfalls.
- Demonstrate the procedure in one continuous flow so students can observe how the ideal performance should look.
- Let the students practice in the lab setting and let them make mistakes. Explain the consequences of those errors on patient care and film quality, then have students practice the procedure the correct way.

Teaching Methods

The instructor encourages student participation by establishing rapport, uses nonthreatening questions to probe student understanding, and answers questions carefully and concisely in a manner that shows respect for the student as a person.

I once met an instructor who told me that he got students' attention by yelling and belittling them in front of staff and patients. He believed that students learned better when he "scared their pants off." Ridiculous! There is no evidence to support the notion that students learn better without their pants. Instructors should remember what it was like when they first studied the subject. Carefully define the terms you use and, at least in the initial stages, provide information in easily digested and logically sequenced chunks designed to help students grasp the subject.

Clinical Expertise

"Those who can, do; those who can't, teach." Ever hear that? If you're to maintain credibility with staff and students, you must be able to do every procedure you teach not just moderately well, but exceptionally well. The clinical instructor should be a resource for staff and students alike.

The practice of designating new and inexperienced technologists as clinical instructors "because they're not ready for real teaching yet" should be condemned. Clinical teaching is real teaching. Students are like sponges; they soak up information and attitudes from those around them. Clinical teachers need the same teaching skills, the same depth of knowledge and the same professionalism as classroom instructors.

Subject Knowledge

At its most basic level, subject knowledge means instructors can recommend specific procedures and projections to demonstrate the required anatomy or pathology. But beyond this, clinical instructors must know enough about related disciplines to teach the "what" and "why" of clinical decision making (CDM).[4] Students also need to understand how value judgments and algorithms (decision-making rules) come into play in the clinical arena.

Teaching CDM is not easy; the exact process used to make clinical decisions often is unclear even to highly competent technologists. Ask yourself this question: What process do you use to decide which projection will best provide the needed information given a specific patient condition? Now, how would you explain that process to a student? Unless you or someone else takes the time to do this, CDM will remain a mystery to the majority of students. They will instead substitute rote memorization of facts, which will fail in unfamiliar situations.

Enthusiasm

The instructor ostensibly enjoys teaching and working with students, presents the information in an interesting manner and piques students' interest. An instructor's knowledge, regardless of depth, won't impress students if it is presented in a dry, boring manner.

Prompt, Accurate Feedback

Formative and summative evaluations are essential if students are to understand how well they are meeting course objectives. Student egos are fragile; they need to be told promptly and precisely what they are doing wrong so as to avoid injuring patients, but they must be told in a manner that is not belittling. Unfortunately, instructors often neglect to tell students when they are performing procedures well.

Years ago, I heard self-esteem compared to a bucket filled with water. Every time you criticize a person, you take a little water out of his bucket. If you constantly take water out without putting any back, the bucket runs dry. Be sure to keep students' buckets filled with a healthy amount of helpful assurances and encouragement.

Perhaps the most common method of giving feedback is the clinical grade. Grades, essentially, are a sample of the student's behavior; the larger and more diverse the sample, the more accurate the estimate of behavior. Base your clinical grades on many different sources, such as evaluation of students by technologists, a film critique grade, the clinical competencies grade and the number of competencies completed.

Broad sources of information garner important details about student performance, like how well he or she works with patients and staff (the technologist's evaluation), the quality of finished radiographs (film critique and competency grades), and initiative (the number of competencies completed). With this information in hand, specific areas of performance can be discussed with the student.

Clinical education can be exciting. It's the "real stuff" of radiologic technology. But handled poorly, clinical education becomes deadly dry, an experience to be endured but not enjoyed. And if you don't enjoy what you do, why do it at all?

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Simple Preparations Make for Good Speakers

I once attended a conference in a nearby city. You know the kind — big hotel, big crowds, tiny signs in dim hallways outside big meeting rooms. I found what I thought was the right room and took a seat. Shortly thereafter, the speaker rose and began his talk. I had trouble making sense of it all but, hey, it had been a long day.

About 15 minutes into the talk, though, I realized I was in the wrong room. Apparently so did about 20 other people, all of whom at once made a beeline for the door.

Comparing notes later, we all agreed that we had been victims of an unprepared speaker. This man had the unmitigated gall to get in front of a group of paying customers without having taken time to plan what he was going to say.

I've heard all the arguments from speakers like him before — "I don't want to lose the spontaneity of the presentation" or "I know what I'm talking about, so why should I practice presenting it?" Unfortunately, it isn't only conference speakers who are guilty of poor planning. Those of us called upon to speak at staff meetings, in-service programs or to students often fail to plan what we're going to say and how we're going to say it. But good planning isn't hard and it doesn't have to take long. Here's a short checklist for putting your program together:

- ***Write down what you're going to talk about.*** Don't write a novel; one or two sentences will do. Putting it down on paper forces you to seriously consider the purpose and goals of your talk. It also may help suggest presentation methods and visual aids. Use your goals as a road map to keep you on track. If you find that you're adding material that doesn't seem to fit your original goals, you have two choices: Throw out the material that doesn't fit or change your goals. Don't try to "get it all in." If you have too much material to comfortably fit into one session, then use two.

• ***Determine who your audience is.*** What do they already know about the subject and what's their motivation for attending your talk? People generally learn faster if they can fit new information into their existing framework of knowledge. Help them do this by reminding them of what they already know about the subject. And if your audience is required to attend your program, you'd better be prepared to make it both interesting and relevant. Emphasize the practical applications and benefits of using information you present.

• ***Choose your words carefully.*** Always be aware of the educational background of those you're addressing and choose your terminology accordingly. Although we're used to working with educated professionals, about 50% of the U.S. population reads and understands language at or below the eighth-grade level. This is not to suggest that you should talk down to people. Just use a normal, everyday vocabulary and define medical terms when necessary.

• ***Know your subject.*** The need to thoroughly understand the material you're presenting may seem obvious, but often is overlooked. You need to know not only how something is done but also why it's done that way as opposed to another, what alternate approaches are available, and the pros and cons of those approaches. Try to anticipate your audience's questions. And if you're caught flatfooted without an answer, don't try to bluff your way out. Just say, "I don't know." Then find out and get back to the questioner.

• ***Organize a logical outline.*** Forget the indented outline format Miss Peaseporridge taught you in the seventh grade. The trouble with that outline format is that ideas just don't flow in a nice start-to-finish sequence for most of us. If you think of something to add you have to squeeze it in somewhere by writing really small or drawing arrows. After a while, your paper begins to look like it was mugged by a gang of ballpoint pens. Instead, write the name of your topic in the center of the paper and jot down ideas as they come to you, grouping similar ideas together around the edge of the paper. Finally, number each idea to put it into a logical sequence, recopying the outline onto another sheet of paper if necessary.

• ***Select visual aids.*** People forget 90% to 95% of what they hear within 72 hours of hearing it, but in the same time frame forget only 50% of what they see and hear. That's why the effective use of visual aids is so important. They reinforce what learners hear and help move it into long-term memory.

If you're using radiographs to illustrate a point, start off with several examples of what the position or procedure should look like, followed by several examples of what the position or procedure should not look like. Be sure to point out the good and bad characteristics of each example. This helps your audience apply the concepts that you're presenting.

If you don't have radiographs, you might consider using overhead transparencies. These often-overlooked visual aids can be easily and inexpensively produced simply by placing clear acetate in your copy machine's paper tray. One warning if you're using printed material — make sure the type is large enough to see from the back row.

• ***Get your audience involved.*** Encourage questions throughout your talk. In fact, ask them questions to see if they're following what you're saying. Clear up misconceptions as you go along and leave time at the end of the program for more questions.

• ***Use handouts.*** They don't need to be elaborate. A brief outline of your topic, important facts and figures and a place to put additional notes is all that's necessary.

Presenting a program doesn't need to be a chore, but it does require planning. If done with care, both you and your audience members benefit. They come away with knowledge they didn't have before, and you gain the respect of the audience for having done a good job.

By Stephen F. Hulse, M.Ed., R.T.(R)
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Questions About Student Interviews?

When it comes to evaluating school or job applications, most of us feel comfortable looking at grade point averages and standardized test scores. Yet we all know there's more to a person than a scholastic record; there is a living, breathing person behind that facade of paperwork. An interview seems to be the best way to reveal the real person, but many interviewers are unsure about what to ask.

The interview is used to evaluate cognitive areas of an applicant's background. Payne[1] identifies four characteristics of noncognitive behavior that affect vocational satisfaction: an effective working relationship with peers; enjoyment of job duties and responsibilities; belief that the environment offers opportunities for personal growth; and belief that, as a result of personal efforts, the community is being served.

Payne notes that noncognitive behavior (attitude) is the foundation for motivation. A purpose of the interview is to examine those attitudes that provide the impetus for striving toward specific goals. An individual's attitudes are relatively stable. The beliefs and attitudes revealed during an interview are unlikely to change after the individual is hired or admitted into an educational program.

Fortunately, it is possible to evaluate attitudes. For example, the amount of time spent on an activity is a measure of the importance a person attaches to it. Also, the scope of information possessed about another person, place, idea or thing reflects a person's attitudes. One of the best attitudinal indicators is observation or documentation of an individual's behavior over a period of time.

Legal Considerations During Interviews

The legal climate in which the interview takes place is always a consideration. The courts, and in some cases the U.S. Congress, prohibit certain types of questions. Keep in mind, however, that laws may vary from one state to another. You should stay abreast of legal rulings in your area. As a general rule, if the information is not absolutely essential to evaluate the suitability of the applicant, don't ask for it. It probably has little legitimate use in a screening interview. A few forbidden questions include:

- Inquiries regarding marital status and maiden name.
- Inquiries regarding children or other dependents.
- Inquiries regarding the applicant's age.
- Inquiries aimed at collecting medical or health information, particularly those intended to screen for possible physical disabilities. The interviewer may, however, describe the program's or job's physical requirements and ask if the applicant can satisfactorily fulfill them.
- Inquiries regarding Saturday or Sunday activities. These can be interpreted as investigating the applicant's religious beliefs. Again, the interviewer may describe the job or program's schedule and then ask if the applicant can meet that schedule.
- Inquiries regarding confinement to a mental hospital.
- Inquiries regarding military service, including dishonorable discharge from the military.

Interview Content

Now that we've reviewed a few of the areas where inquiries may not be made, let's examine the areas that can and should be investigated during an interview.

Chapman[2] identified four basic areas to be evaluated during the interview: motivation (the inner sense of purpose that causes people to establish and strive for goals); intellect (the ability to think through and understand the implications of personal actions and decisions); knowledge (the scope of information and understanding); and personality (the distinctive qualities that, collectively, make a person an individual).

The personality factor, of course, is open to charges of subjectivity. We should not select students merely because we like them or because they have personalities similar to ours. Instead, we should evaluate them on whether they can fulfill the obligations involved in preparation for an entrance into a profession. The way a person interacts with others, particularly in stressful situations, is especially important in radiologic technology. This is a function of personality, and it must be evaluated if the best candidates are to be selected.

In addition to the four factors described by Chapman, an applicant's maturity also should be evaluated. Maturity is defined by Ballinger[3] as the realistic assessment of one's strengths and weaknesses and, when appropriate, being able to put the needs of others before one's own needs. Also important is the selection of realistic goals in light of personal abilities and limitations.

The following questions have been developed and tested in actual interviews to facilitate measurement of an applicant's personal characteristics:

• ***Why did you apply to this program?*** (Assesses motivation.) In most parts of the country, students have a choice of several programs. Did the student apply to your program because it was convenient? Because of its reputation? Was it recommended by someone? Has the student applied anywhere else? The interviewer is searching for a measure of the student's commitment to radiologic technology.

• ***Why do you want to be a radiologic technologist?*** (Assesses motivation, knowledge and intellect.) Does the student exhibit an appreciation of what job duties are involved in radiologic technology? Did he or she investigate other health careers before choosing radiologic technology?

• ***What salary do you expect to earn as a radiologic technologist?*** (Assesses motivation, knowledge.) Are the student's expectations realistic, or are they overly inflated?

• ***What will you do if you are not accepted here?*** (Assesses motivation, maturity.) Will the student pursue the goal of becoming a radiologic technologist by rectifying academic deficiencies (if applicable) and reapplying for admission later? Or will he or she change career goals? Students may be able to improve their chance for admission if their science and math course grades are improved. This may require enrolling in a community college.

• ***If you had a choice of any career, what would it be? Why?*** (Assesses motivation, knowledge.) What other careers has the student considered? Are there any similarities between the "ideal" career and radiologic technology? Has the student selected radiologic technology because of careful evaluation of personal abilities and found them to be compatible with this profession?

• ***Where do you see your career five years from now?*** (Assesses motivation, knowledge.) Is the student aware of avenues for advancement in radiology technology? Does the student want to advance into education or management or move into a specialty area in diagnostic imaging or radiation therapy?

• ***What subjects did you enjoy the most and the least in high school? Why?*** (Assesses intellect, motivation and maturity.) Did the student follow an easy course of study punctuated only by an occasional science or math course? Can the student explain why courses taken in the past were important for a successful career?

• ***What did you enjoy or find interesting about your last job?*** (Assesses motivation, personality.) Does the student like to work with people? Enjoy responsibility? Look forward to challenges?

• ***What experiences in school or at work have you had that will help you as a radiologic technologist?*** (Assesses intellect, knowledge and maturity.) Can the student identify and describe experiences that have contributed to personal growth? Does the student possess enough self-knowledge to understand the relevance of both pleasant and unpleasant experiences?

• ***What kind of activities would you like to avoid in a job?*** (Assesses intellect and knowledge.) Has the student considered job-related activities that are unpleasant and applied them to a career in radiologic technology?

• ***What sort of experiences do you find frustrating?*** (Assesses maturity, intellect, personality.) Does the applicant become frustrated following minor incidents? Could a compromise be worked out or an alternate method of reaching the desired goal be found? Could the implications of reaching a compromise be understood?

• ***Tell me about your strengths and weaknesses.*** (Assesses maturity.) Is the student self-aware? Can he or she accurately describe strengths and weaknesses? Are the descriptions consistent with the student's academic record and observations of the interviewer?

• ***What accomplishments in your life make you the most proud?*** (Assesses motivation.) What does the student consider important in life? Does it include personal growth? Are the accomplishments of any significance?

• ***What makes you want to do well in school or at work?*** (Assesses motivation.) Is the student motivated externally, by an instructor or supervisor, or does he or she possess inner goals that promote a striving for personal knowledge and growth?

• ***Why should we accept you?*** (Assesses maturity, motivation, intellect, knowledge and personality.) By this point, the student has been led through each of the preceding questions and has had the opportunity to explore and describe important life experiences, personal qualifications and goals. This question gives the student an opportunity to summarize this information. Can the student organize his or her response in a cogent manner?

However you decide to handle interviews, be certain all applicants are asked the same questions. This makes objective comparison easier and helps defend against charges of interviewer bias.

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Using Case Studies To Teach Radiography

Case studies have long been used in schools of business, law and medicine. According to Donham,[1] "The distinguishing characteristics which make the case system of teaching law, in the hand of a competent instructor, an instrument of great power is the fact that it arouses the interest of the student through its realistic flavor, and then makes him, under the guidance of the instructor, an active rather than passive participant in the classroom."

The continuing increased interest in teaching cases stems from an increasing appreciation of the value of narrative or naturalistic forms of thinking as opposed to abstraction and generalization.[2] Narrative forms of thinking reflect the ways individuals actually organize their experiences and develop professional knowledge. This is not a new concept; in 1954 Dewing[3] noted, "Human thinking and the new human experience are indisolubly bound together. If we teach people to deal with the new experience, we teach them to think. In fact, power to deal with the new and power to think are pragmatically the same."

Professional knowledge in radiography consists largely of the accumulation of experiences in the form of concrete cases, primarily clinical experience. Didactic education is simply a first step to a higher goal of successful clinical practice. Experienced professionals develop knowledge of the kinds of problems they are likely to encounter, what these problems mean in relation to practice, what usually causes them and which approaches are likely to be productive in solving them. By providing experience with a variety of concrete cases, the case method expands and sharpens students' understanding of the profession.

Teaching via case method also provides models of how to think professionally about problems. Students learn critical-thinking skills — how to use theoretical concepts to illuminate a practical problem. They learn how to spot the larger issues implicit in what might seem to be a minor decision. Teaching by the case method helps students learn how to think productively about concrete experience. The case method thus enhances their ability to learn from their own experiences.

Although cases may seem relevant to the teaching of topics such as ethics, medical law and radiographic film evaluation, the connection may not be so clear to radiographic procedures, which seems to be more of a skill-based knowledge than one requiring reflection. However, to be professionals, radiographers must be able to create knowledge as well as use it.[4] Perhaps one reason why students have problems with the alternatives presented to them in clinic is because they have not been taught to think in terms of alternatives, only in terms of ideal solutions.

Strengths of Case Studies

Well-developed teaching cases:

- Provide experience with important clinical dilemmas.
- Illuminate the human intentions, feelings and misinterpretations that often are the core of problems.
- Provide models of how expert practitioners think about actual clinical dilemmas.
- Increase students' repertoire of strategies by showing them how to approach problems.
- Help students learn to identify issues and think as professionals.
- Provide emotional preparation for an unjust world.[5] As we all know, the world of the clinic is rarely ideal; there are, however, effective solutions to problems.

Students enjoy learning from cases, which appeal to the universal delight in a good story. Explains Howard Becker,[6] a well-known sociologist, "I have become more and more convinced of the importance of stories — good examples — in the presentation of ideas. I used to be irritated when students told me that what they remembered from my sociology of art course was the story of Simon Rodia.... I wanted them to remember the theories I was so slowly and painfully developing.

Later I decided the stories were more important than the theories."

Case studies also are valuable to instructors. Biddle and Anderson note,[7] "Correctly used, the case study method will allow students to draw many conclusions, some of which the instructor may not even be aware."

Limitations of Case Studies

Teaching via case study is not a systematic means of transmitting facts or organizing knowledge. Similarly, case studies cannot give students practice in skills. The case method supplements, rather than replaces, other methods of teaching. Thus, in courses such as positioning and procedures, the case method is best reserved for advanced teaching, after the student has basic knowledge and some experience in performing procedures.

Some faculty find it hard to locate good case materials. Many are not sure how to go about teaching a case and fear that classes will degenerate into a pointless exchange of personal opinions.

Published cases or written sources are not the only sources for teaching cases. Students often bring up stories of their own experiences from clinic. Educators can turn these anecdotes into cases. Students' anecdotes invite fuller description and consideration of the situation, and the methods of case teaching can guide the discussion with an analytic framework. Instructors might, for example, ask their students questions such as:

- What are the issues here?
- What alternative strategies might you consider?
- What is at stake here?

In short, a "case" is not necessarily a piece of writing; it is a way of framing problems and analyzing experience. Cases can begin with as little as a one-sentence description.[8]

Developing Your Own Teaching Cases

As we know, radiography does not consist of one set of clinical skills. Clinical practice varies between practitioners and by region.

Educators can develop their own cases to prepare students for the particular problems in a local context. The Harvard Business School publishes a text that teaches how to write a case study.[9] Educators also can use case-writing as an assignment to develop students' skills of reflective inquiry. However, students must possess a certain maturity before they can write their own cases, including a knowledge of content and experience in solving case studies.[10]

To prevent case discussions from becoming superficial exchanges of opinions, educators must think through what they are trying to accomplish — what issues the case illuminates, what theoretical concepts it illustrates and what understanding the case can develop.

It often is helpful to divide a case discussion into two stages: problem analysis and problem solving. What often cripples problem solving is an incomplete analysis of the problems surrounding the issue. According to an old saying, a problem well-formulated is a problem half answered.

Sample Case Studies

The number of possible case studies is limited only by the imagination of faculty and students. The following are a few examples.

- ***A student comes to class and says, "According to Sally at Riverside Medical Center, the way you teach us to do oblique lumbar spines is wrong. She says that PA is the only way to do them."***

This is an example of an anecdote that can be turned into a case study. One method might be to ask students to determine all the potential positive and negative aspects of performing oblique lumbar spines in the AP and PA positions. A chart on the blackboard or the overhead screen could document all the pros and cons. Another method might be to ask students to come back with a technologist's opinion to the next class, and begin discussion from there. Remember the basic considerations in an anecdotal case study: issues, alternative strategies and stakes.

- ***Patient condition or pathology may engender negative comments from students. Certain conditions may hinder the effective***

performance of radiographs that are otherwise considered to be "easy." Students may come to class stating that they "hate" to do certain exams due to factors that render them less than the ideal methods taught in laboratory.

These students can be led in a discussion of alternative procedures that will demonstrate the same radiographic signs of suspected pathology. An assignment may be given where each class member or a group is asked to bring in a list of procedures used to demonstrate the anatomy. For example, a left lateral decubitus position of the abdomen to include the diaphragm may include the same information as an erect abdomen — and in the case of frail elderly patients, may be easier to perform.

- ***All textbooks have their positive and negative aspects. A student may indicate to you that he or she does not believe that a particular position or procedure was described well in the book, or you may note that yourself.***

Turn this situation into a case study by comparing how other textbooks describe that particular position or procedure. Then use the two-stage approach of problem analysis and problem solving.

First, analyze the problem: What are the positive and negative aspects? How could these descriptions be improved? Next, solve the problem: Consider developing your own "Suggested Method of Describing ________________________________ Position." For an example of how to proceed, see the article by Frank, Kravetz and O'Neill,[11] in which the authors took a similar clinical problem — one that originally had been identified by students — and devised a solution for teaching the material.

Conclusion

One critique of positioning and procedures courses is that they often are taught in an idealized manner that does not reflect actual clinical practice. Using case studies can help bridge the gap between theory and practice by presenting material in a more naturalistic fashion — in other words, in the manner that actual practitioners use to think and problem-solve.

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Medical Ethics For Radiography Students

Instruction in medical ethics has been a part of the curriculum guide for radiography programs for several years, yet many educators seem to be unsure how to construct an ethics course or how to teach ethics. Educators must make the content understandable and useful and convey the intent of ultimately helping the professional radiographer to become proficient in ethical decision making while understanding and abiding by the ASRT Code of Ethics.

To design and teach an ethics course, an educator should examine exactly what should be conveyed to the student. Many may, at first, rationalize that an ethics course must help the student develop the caring, helping attitude so vital to health care practitioners. Steves[1] suggests that many instructors are not stressing skills that permit students to develop into practitioners who are sensitive to the patient. Steves also believes that it is the responsibility of the educator to prepare students for both the technical and caring aspects of being a practitioner of the discipline studied.

Patterson and Vitello[2] discuss societal trends that have resulted in a renewed emphasis on the study of ethics. They further state that society is asking for greater accountability from all professions. Health care, including radiography, is not excluded. It is the responsibility of the radiologic science educator to design and instruct an ethics course that meets the needs of both students and society.

It first is imperative that a course in ethics for radiologic technology students contain some medical law material. In fact, courses typically are called “Medical Ethics and Law” based on JRCERT requirements. The day-to-day ethical problems faced by the practitioner have as high a percentage of legal consequences as ethical ones. Problems related to negligence, informed consent, malpractice and child abuse are ethical as well as legal issues.

Dowd[3] explains why students should study medical law in his statement: "Radiographers must have a basic knowledge of medical law in today's health care environment. Today, radiographers are recognized as health care professionals. There is an increased responsibility that goes along with this recognition. Today's patients are customers and expect high levels of service. In past years, physicians and/or the hospital were responsible for the care they delivered."

Dowd also explains that data from the national database of medical malpractice filing shows a trend, during the past several years, toward radiographers being held legally liable in lawsuits related to radiography.[2]

An attorney who also is a radiologic technologist (a J.D., R.T.) is possibly the best source for legal issues that impact the health care delivery of radiological services. Another possible source of information on the ethical/legal issues within radiology may be the legal staff of any medium to large teaching hospital. While not as knowledgeable about radiography as the J.D. who is a registered technologist, these attorneys specialize in health care law.

Any ethics course should be constructed around certain core subject matter.

First, the course should contain an expanded area of terminology. The definition of the term "ethics" and all associated terminology (i.e., morals, mores, values, rights, privileges, etc.) should be explored. Students must understand all terminology used to adequately comprehend basic ethical concepts.

Within this area, the instructor may include lecture material on how members of society derive the values affecting ethical decisions. Although other people play an important part in shaping our values, they do so in the context of the roles they play in different areas. These areas have been termed "value sources"; four of which have been identified by Guy[4] as:

- ***Experience.*** Experiences in life such as love, marriage, birth, death and work all shape our values according to events, positive or negative, occurring within these experiences.

- ***Culture.*** Our culture, ethnicity or the environment in which we were raised or in which we live promotes derivation of values by creating within us ideas of what is acceptable and what is not.
- ***Science.*** Science, which we generally rely on as being factual, shapes our values by providing "truths" that cause us to value or devalue certain aspects of existence.
- ***Religion.*** The presence or absence of religion teaches us either to believe in the reward and punishment system of right and wrong or that there is no eternal payment for our actions.

Although we essentially derive our values from these four areas, there are certain core values necessary for functioning in society today, 10 of which also have been identified by Guy[4] and are listed in Table 1 along with a brief description of each.

The historical aspects of ethics and the theorists who dedicated their lives to the study of ethics is another subject area that should be included in an ethics course. An examination of this area provides the student with a foundation upon which to build. Imperative to any historical ethics component within the course is the need to explore consequential (teleological) and nonconsequential (deontological) ethical theories.

Teleological theories are goal-based theories that focus on the outcome that produces the most good for those involved. In health care, this theory can be used to promote, among other things, euthanasia. It is conceivable, under teleology, that the end of life for a terminally ill individual who is suffering and causing emotional and financial strain for the family is good; the end thus justifying the means.

On the other hand, deontological, duty-based theories probably would prohibit euthanasia because health care providers, especially physicians, are duty-bound to protect life.

The types of consequential theories — egoism and utilitarianism — should be studied as to their meaning and role in moral decision making. Immanuel Kant's Categorical Imperative, W. D. Ross' Prima Facie Duties and John Rawl's Maximum Principle of Justice should be stressed under nonconsequential theories.

Table 1
Core Values[4]

Core Value	Description
Caring	Thoughtful, attentive and scrupulous
Honesty	Truthful, straightforward and trustworthy
Accountability	Responsible and obligated
Promise keeping	Keeping of commitments
Pursuit of excellence	Motivated to strive toward being the best that one can be
Loyalty	Faithfulness and allegiance
Fairness	Open-minded and avoidance of favoritism
Integrity	Avoidance of conflicts and resistance of pressure
Respect for others	The ability to recognize everyone's right to privacy and self-determination
Responsible citizenship	Acting in regard to societal values

And since religion serves as a source of values and guides ethical decisions for many professionals, Saint Thomas Aquinas' Natural Law Ethics and the Roman Catholic Interpretation should be mentioned. Each of these theories may then be applied to health care and professional ethical decision making.

The instructor also needs to define the types of ethical problems likely to require the attention of the student and professional radiographer. To date, four problem types have been identified:[4]

- Ethical dilemmas.
- Ethical dilemmas of justice.
- Ethical distress.
- Locus of authority issues.

Any discussion of these problem areas must include their application to health care delivery. For example, the reporting of suspected child abuse by the radiographer is a locus of authority issue because it involves reporting the suspicion to the proper authorities.

Several authors have suggested models for ethical decision making. Educators should examine several ethics texts, rather than relying on a sole source, to determine which one works best. Educators should provide students with a general outline for solving complex problems and a simple step-by-step process for making ethical decisions.

Dowd,[3] Guy,[4] Golden[5] and Purtilo[6] all have recommended noteworthy step-by-step processes for ethical decision making, as shown in Table 2. Although each of these ethicists differ slightly in the decision-making process, two steps are included in each: assessing, sensing, gathering and defining the problem; and analyzing, reviewing, completing and implementing the course of action. Thus, the first step to solving an ethical problem is determining the type of problem encountered and the last step is making a decision and implementing it based upon the collection and analysis of the information in between.

Whether educators use one of the outlines presented in Table 2 or formulate their own, they should be careful to use one set of guidelines. This helps alleviate any confusion that may be promoted by using several different methods, while also allowing the students the opportunity to work on solving problems using the same method.

Educators also should explain the ASRT Code of Ethics fully within the context of the ethics course. Each of the 10 ethical principles in the code should be dissected to determine the meaning and application to professional practice of each principle.

For example, the code's third principle states, "The radiologic technologist delivers patient care and service unrestricted by the concerns of personal attributes or the nature of the disease or illness, and without discrimination regardless of sex, race, creed, religion or socioeconomic status." Upon dissection, this principle serves to guide the duty of the technologist to perform the requirements of the profession without bias in any form. It admonishes the professional to put aside any personal feelings regarding anyone or anything when performing the duties and services inherent to the profession.

Those duties and services are described elsewhere within the code and in the Scope of Practice for Radiographers. The principles of

Table 2
Suggested Models for Ethical Decision Making

DOWD

1. Assess the problem.
2. Isolate the issue.
3. Analyze the data.
4. Develop a plan.
5. Institute the plan.
6. Analyze the outcome.

GOLDEN

1. Sense the conflict or problem.
2. Formulate the conflict or problem.
3. Search for a possible solution.
4. Act or implement the solution.
5. Review and evaluate the results.

PURTILO

1. Gather relevant information.
2. Identify the type of ethical problem.
3. Determine the ethical approach to be used.
4. Explore all possible solutions.
5. Select your solution and complete your course of action.

GUY

1. Define the problem.
2. Acknowledge the context in which the problem arose in order to identify all stakeholders involved.
3. Identify the values that are at stake.
4. Select the values that must be maximized.
5. Choose the alternative that maximizes the essential values and minimizes as few values as possible.
6. Assure that the consequences of the decision will be ethical in regard to both its short-term and long-term consequences.
7. Implement the decision.

Table 3
Course Outline

I. Ethics — An Introduction
   A. Historical perspective
      1. Theories
      2. Theorists
   B. Modern perspectives
   C. Definitions (ethics, morals, values, mores, etc.)
II. Developing Personal Ethics
   A. Sources of values and assessment of worth
   B. Core values that may be used for ethical decision making (caring, honesty, accountability, etc.)
   C. Values clarification
III. Professional Ethics — Examining the ASRT Code of Ethics
   A. The use and intent of professional codes of ethics
   B. Discussion of each area in the ASRT Code and its relationship to professional practice
IV. Professional Ethics and Institutional Constraints
   A. Hospital codes of ethics
   B. The Patient's Bill of Rights
V. Ethical Problem-solving Techniques
   A. Types of ethical problems
      1. Ethical dilemmas
      2. Ethical dilemmas of justice
      3. Ethical distress
      4. Locus of authority issues
   B. General outline for solving complex problems
   C. Five-step process to ethical decision making
VI. Informed Consent
   A. Definition
   B. Radiographer's role
VII. The Impaired Colleague
   A. Definition
   B. The radiographer's responsibility
VIII. The Special Patient
   A. Types of special patients (elderly, children, terminally ill, contagious, etc.)
IX. Case Studies in Ethics
   A. Cases involving scenarios in which the R.T. may be involved, such as whistle-blowing, organ retrieval, care of infectious (HIV or hepatitis) patients, DNR orders, etc.
X. Medical Law — Basic Concepts
XI. Medicolegal Issues for Radiographers

conduct relate to one another and to the scope of practice, which then relates back to the curriculum. Ethics, like other radiography courses, is part of an overall educational plan for the professional radiographer.

Finally, the educator should invent and/or compile ethical case studies likely to be encountered in professional practice and then allow students the opportunity to solve the problems. This will provide background information necessary to aid them in adhering to the ASRT Code of Ethics and in solving problems related to ethics throughout their professional careers. Interactive computer programs for instructional purposes also may be used by the instructor to promote student learning and problem-solving exercises.

The content areas described here and shown in the basic course outline offered in Table 3 in no way constitute everything that should be addressed in an ethics course for radiography students. They do, however, represent critical areas of inclusion. The instructor ultimately will develop an ethics course that provides meaningful information. Reaching this point is a challenge, but it is one that every educator can meet.

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Cooperative Learning Is Active Learning

Recently, students enrolled in a class that used cooperative learning evaluated their experiences this way: "Less time needed to study at home … more interaction with the professor … puts a little life into empirical knowledge … hope to have more teamwork in future classes … gets students to interact with one another … I pay more attention in lecture so that I can help my team … makes classes more interesting."[1]

Are these the types of comments that students make about your classes? For most instructors the answer is no. But if you want your students to experience these types of positive outcomes, cooperative learning may be the way to achieve it.

Cooperative learning (CL) can be defined as a learner-centered instructional process in which small, intentionally selected groups of three to five students work interdependently on a well-defined learning task. Students are held accountable individually for their own performance and the instructor serves as a facilitator/consultant in the group-learning process.[2]

According to Cuseo,[2] cooperative learning can be defined operationally in terms of six procedural elements which, when implemented together, distinguish it from other forms of small-group learning in higher education. I will discuss each of these six elements in detail.

Intentional Group Formation

Cooperative learning typically begins with the selection of group members based upon predetermined criteria designed to create positive effects in small group learning. Examples of these criteria include class standing, learning styles or even gender. Criteria may vary by instructor and purpose. The instructor must give careful consideration to who is in each learning group in an attempt to create the optimal social learning environment.

Continuity of Group Interaction

In contrast with traditional small group discussions or "buzz" groups, which usually group students sporadically for a relatively short period of time, CL groups typically meet regularly over an extended period of time. This creates the opportunity for social cohesion and bonding to develop among group members and allows for continuity of interaction among the group members.

Interdependence Among Group Members

Rather than simply allowing students to interact in small groups and then hoping they will work in a cooperative manner, CL incorporates specific procedures designed to create a feeling of group identity among students and collective responsibility for one another's learning. Several procedures may be used to increase the likelihood that a sense of positive interdependence develops within CL groups. They include:

• ***Group creation of a common product at the conclusion of the CL experience.*** Each CL group is expected to create a formal product that represents a concrete manifestation of the group's collective effort. This product could be a worksheet, a compendium or chart, or an overhead transparency that can be shared with other groups. The objective of working toward a clearly defined, common goal is essential for keeping individual students focused on the group goal.

• ***Assignment of interdependent roles for each group member.*** A sense of individual responsibility to the group may be strengthened if each member has a specific role to play in achieving the group's final goal or product. For example, members could be assigned the following roles: a manager who assures the group stays on track and that all members actively contribute, a group recorder who keeps a written record of the group's ideas, a group spokesperson who is responsible for verbally reporting the group's ideas to the instructor or to other groups, and a group processor who monitors the social interaction or interpersonal dynamics of the group process. Such role specialization assures that each group member has an explicit and well-differentiated responsibility to the group throughout the learning process.

• ***Team building activities designed to produce a sense of group identity and social cohesiveness.*** Activities could include icebreakers or warm-up activities when the group is formed, such as name-learning or personal information learning activities. The underlying rationale for these activities is to create a social and emotional climate conducive to development of an *esprit de corps* and sense of intimacy among group members. This allows them to feel comfortable in future CL tasks that will require them to express their personal viewpoints, disagree with others and reach consensus in an open, nondefensive fashion.

Individual Accountability

Although procedures for ensuring interdependence and cooperation among group members are essential elements of CL, students are graded individually. Recent educational research consistently supports the importance of personal accountability and individual grading for realizing many of the positive outcomes of CL.

Development of Social Skills

In contrast with the strictly academic goals of most small group work in higher education, a major objective of CL is the development of students' communication and human relations skills. To achieve this objective, CL incorporates the following procedures:

• Explicit instructions on effective skills for communicating and relating to others are given to students prior to, and in preparation for, their involvement in small group learning activities. This should include skills on empathic responding, active listening, constructive disagreement, conflict resolution and consensus building.

• Students are provided with opportunities to reflect on and evaluate the process of social interaction. Students are asked to look at how this has affected their learning. Questions might include: Do you find that you learn more or less when you verbalize your thoughts to other group members? Do you learn more or less when there is disagreement between yourself and another group member? Do you learn more or less when you question the reasoning of other group members?

Table 1
Differences Between Cooperative Learning and Traditional Learning[5]

Cooperative Learning Groups	Traditional Learning Groups
Positive interdependence among group members	No interdependence among group members
Individual accountability	No individual accountability
Heterogeneous membership	Homogeneous membership
Shared leadership by all group members	One appointed leader
Group members are responsible for one another	Each member is responsible for himself/herself
Task and process are emphasized	Only the task is emphasized
Social skills are taught directly	Social skills are assumed and ignored
Instructor observes and facilitates	Instructor ignores the groups
Group processing occurs	No group processing occurs

- Effective interpersonal behavior displayed by students within groups is acknowledged and reinforced by the instructor, then shared with the entire class to be modeled after or exemplified in future group interactions.

Instructor as Facilitator

Cooperative learning involves the instructor as a facilitator and consultant in the group learning process. The instructor does not sit in on group discussions, but instead circulates among the groups offering encouragement, reinforcing positive demonstrations of cooperative learning, clarifying task expectations, catalyzing dialogue or issuing timely questions designed to promote elaboration and higher-order thinking.

The instructor needs to be cautious not to be overly influential or authoritative, but rather to serve as a learned peer. This allows the instructor to interact with the students in a much more personal, informal and collaborative manner than would be possible with a traditional lecture. Table 1 summarizes the differences between cooperative learning and traditional learning.

According to Johnson and Johnson,[3] more than 1207 studies have compared the relative efficacy of cooperative, competitive and individualistic learning on individual knowledge and proficiency at the college level. Overwhelmingly, CL promoted higher individual knowledge and proficiency than did competitive or individualistic learning. In other words, research comparisons show that CL students learn more, retain information longer, develop superior reasoning and critical thinking skills, feel more support and acceptance and like the subject matter and the instructor more!

In an article on cooperative learning and problem solving, Smith[4] states that the power of the CL environment is amazing. Students formulate and solve difficult and practical problems without complaining. They learn and grow through struggling with their peers. Smith states that the underlying rationales for this extraordinary outcome include:

- Whoever organizes, summarizes, provides elaboration, justification or explanation also learns. The person who performs the intellectual work — especially the conceptual work — learns the most.
- More learning occurs in an environment of peer support and encouragement because students work harder and longer.
- Students learn more when they're doing course work they enjoy.

To get started using CL, instructors should try evaluating a case study. This task is a useful learning experience and a favorite activity of students. With radiation therapy students, for example, evaluate a case study with value clarifications around issues of death and dying.

The task needs to be clearly structured in terms of what the students are expected to produce. Tools that can facilitate the task may include visual charts, sentence starters, sequential diagrams or specific questions with spaces for answers. A clear understanding of the task will free students to organize their thinking and their written responses.

In conclusion, the coupling of technology and cooperative learning can be a dynamic match. They have similar interests, as both are dedicated to active learning and both provide immediate feedback. I believe that cooperative learning is the heart of a change in paradigms of teaching that emphasizes active, rather than passive, learning.

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Ideas For Interactive Classroom Learning

Like most instructors in technical disciplines, I spend a lot of my class time lecturing. However, I also recognize that students learn best when they are actively involved in their learning. I am certain this is why most students, in exit interviews and other commentaries, routinely cite labs as their favorite educational experience.

When I began teaching, I shied away from teaching methods such as discussion learning because I believed that I would sacrifice content. My greatest fear was that I might not get through all the material, and thus would sacrifice the students' preparation for the Registry exam.

As I matured as an instructor, I lost that fear. I gained faith in my own ability to get through all of the material. Also, the Registry exam has become geared more toward critical thinkers in radiography. This makes specific content coverage less acute, though still important, and increases the importance of students understanding material and being able to problem-solve specific situations.

This article discusses interactive lessons for teaching radiation protection and radiobiology. Most texts cover the theory of these subjects well but do not, in my opinion, cover the clinical/problem-solving aspect of these disciplines well. In early courses, I noted that students were able to repeat back the material. However, I never really believed that they understood the material. I think adding more activities has helped.

Icebreaker Activities

The first day of class, I always start with a 20-question, true/false pre-test. This allows me to assess students' previous knowledge of the subject and gives me guidelines for assessing their ending knowledge in a subject. Also, it is a good way to begin the discussion of what will be covered in the class. If the test is representative of the material that will be learned, the pre-test is an excellent correlated activity to the discussion of the content in the course syllabus.

Since radiobiologic information is used to make value judgments that translate into radiation protection practice, I use an activity titled "Values, Science and Radiation Effects."[1] It is a multistage, combination lecture/activity method of teaching students that there is no "one right answer" in the topics of radiobiology and radiation protection. Experts make decisions based on sound scientific data, but there may be more than one possible answer. One example is the controversy regarding the appropriate age to begin screening mammography. At what age do the benefits of mammography outweigh the risks?

Pro or Con?

A similar activity is called "Pro or Con?" In this activity, students must prepare a debate on one side of an issue. A group of about three students is given 5 minutes to argue a point. Another group argues the opposite side, and then each group is given a final minute to present counter-arguments. Two weeks after the debate, students hand in a short paper that outlines both sides of the debate. Some of the topics I have assigned in the past include:

- Should pregnant radiation workers be restricted in any way?
- What is the appropriate age to begin mammography screening?
- Is radon monitoring worth the cost?
- What are the pros and cons of food irradiation?
- Will continued education lead to improved radiation safety?

Radiation Risks: The BEIR V Report

One of the most important risk estimates in recent years has been the BEIR V Report,[2] which has gained fairly widespread acceptance but is just now being discussed in our literature.[3] The report's authors developed risk estimates for leukemia and non-leukemia cancers based on a single exposure to 10 rem, 1 rem/year from age 18 to 65, and 100 mrem/year lifetime for males and females. (See Table 1 for samples that may be used in class.)

Table 1
Risk Estimates

MALE ESTIMATES (All figures rounded to the nearest 10)

	Total No. of Cancers	Leukemia	Non-leukemia
Normal incidence	20,510	760	19,750
One exposure, 10 rem	770 excess cases	110 excess cases	660 excess cases
Average years of life lost	16		
Normal incidence	20,910	780	20,140
1 rem/year, age 18 to 65	2,880 excess cases	400 excess cases	2,480 excess cases
Average years of life lost	15		
Normal incidence	20,560	790	19,760
100 mrem/year, lifetime	520 excess cases	70 excess cases	450 excess cases
Average years of life lost	16		

FEMALE ESTIMATES (All figures rounded to the nearest 10)

	Total No. of Cancers	Leukemia	Non-leukemia
Normal incidence	16,150	610	15,540
One exposure, 10 rem	810 excess cases	80 excess cases	730 excess cases
Average years of life lost	18		
Normal incidence	17,710	650	17,050
1 rem/year, age 18 to 65	3,070 excess cases	310 excess cases	2,760 excess cases
Average years of life lost	17		
Normal incidence	17,520	660	16,580
100 mrem/year, lifetime	600 excess cases	60 excess cases	540 excess cases
Average years of life lost	Not given		

I hand out this information and use it for open-ended discussion: What are the risks? What are the differences between risks for men and women? How can this data be translated into practice? What weakens this data as a comparison? (Answer: It was whole-body data.)

The Linear Model

Many risk estimates are based on the linear-dose response model. Although this model has many weaknesses, it is used in radiation protection practice and guidelines because it is the most conservative model available. Starchman and Hedrick cite the following as a weakness of the linear model: If 100 aspirin are 100% fatal, then a linear model will see two aspirin as fatal to 2% of that same population.[4] This can be used in discussion: What is the weakness of that model? Is a threshold valuable? Why do we not assume a threshold for radiation protection purposes, even though one may exist?

Clinical Practice Models

As I mentioned earlier, many good texts describe the theory of radiation protection. Few describe the clinical practice of protection well, in my opinion, for two reasons. First, most texts in this area are written by physicists who are familiar with us, but not all aspects of our daily practice. Second, it is difficult to cite specific examples for practice because clinical settings vary widely. I require students to develop specific examples of how radiation protection can be or is practiced in their own clinical settings. This is valuable because it makes students think about how the theory is practiced in their clinical setting. It also helps students with specific recommendations for practice and sets the class up to brainstorm further methods for protection.

Other Activities

The following are activities I have used at certain times for specific reasons. For example, you wouldn't want to compare film badge readings between students if one student had a very high reading, as this could cause embarrassment to the student. On the other hand, it helps to clarify what a "high reading" is.

- Compare students' film badge readings in class, perhaps on a month-to-month basis.
- Have students develop an ideal radiation protection policy for the program, including a pregnancy policy.
- Hand out a cancer risk sheet that asks students to indicate their risk of cancer based on a variety of factors, including personal and environmental. When discussed in class, the risk sheet makes students aware that there are many risk factors for cancer.

• Ask students what kind of information about radiation a radiographer should be able to provide individuals, including patients, the general public and other health professionals.

• Have the students think about what radiographers should do if they work in a facility that routinely requires them to hold patients or does not make use of other generally accepted radiation protection practices, including alternative projections such as PA vs AP.

Conclusion

The ideas mentioned here are, of course, only general guidelines designed to stimulate additional questions and thinking about radiobiology and its practical application, radiation protection. One side benefit I have noted is that often the students taught me something about the educator's role as protectors of the radiologic health of the population. I believe that letting students make these kinds of decisions in class will help them become better problem-solvers in the world of work, leading them to discover additional means of radiation protection for patients and improving the professional status of radiologic technologists.

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Teaching Your Students To Care

A standard question posed to students interested in the radiologic sciences is "Why did you choose medical imaging?" The common answer is "I want to work with people" or "I want to help people."

Once a student is enrolled in the medical imaging curriculum, however, the emphasis is placed on technical skills. Most instructors do not stress skills that permit the student to develop into a practitioner who is sensitive to the patient.

McKenna Adler[1] defines this aspect of the practitioner's role as "caring." Goldin[2] suggests that a practitioner can demonstrate caring to the patient by providing emotional support, explaining the procedure in a manner the patient can understand, permitting the patient to express emotion, actively listening to patient concerns and responding in an empathetic manner and recognizing the patient as a unique individual rather than just another case. Certain aspects of these behaviors can be taught.

Initially, many students do not realize the extent of the professional responsibilities they will be asked to assume or that "helping people" means more than technically competent performance. Educators have a responsibility to prepare students for the technical and the caring aspects of the practitioner's role. How, then, can educators teach students to care in a manner that will "help people"?

Students first need to understand the human dimension of the practitioner's role. Curtis and Steves[3] developed an instructional module to help students deal with the interpersonal aspects of clinical practice and to offer a foundation for the development of caring behaviors. The module consists of three parts: patient psychology, communication skills and the patient-professional relationship.

The first section, patient psychology, is intended to sensitize the student to the plight of the patient. Factors that influence patient behavior and common reactions to illness are key topics that instructors may present in a lecture-discussion format. Obviously, the more clinical experience students have had, the better equipped they will be to actively participate in class discussion.

Dowd has suggested using popular movies as an instructional method to help students understand what it means to be a patient.[4] Films such as "Whose Life Is It Anyway?" or "The Doctor" provide fertile ground for discussing how health care professionals can relate to patients on a personal level. These films depict positive and negative attributes of the professional role and sensitize students to the emotional impact they and the procedures they perform have on patients.

Effective communication skills also are essential. Instructors should review elements of verbal and nonverbal communication and active listening. A discussion about barriers to communication is a particularly important aspect of this segment. In a high technology, high throughput discipline such as medical imaging, scarcity of time and preoccupation with equipment can be tremendous barriers if practitioners do not make an effort to communicate with patients. Furthermore, these two obstacles sometimes may be used to excuse actively listening to patients.

Lastly, the instructor defines the patient-professional relationship. To make the definition more relevant, this relationship is customized for diagnostic imaging practitioners. For example, compared to nurses or therapists, the relationship between the medical imaging practitioner and the patient is relatively brief and occurs for a specific purpose. Therefore, practitioners need to develop a rapport with their patients quickly. Along with the time constraint is the unfamiliar technology and intimidating equipment that may present a barrier to communication before the procedure even begins.

Interactions between patient and practitioner are grouped into five areas:

- Greeting the patient.
- Explaining the procedure to the patient.
- Listening to the patient's questions, concerns and requests.

- Recognizing the patient's physical and emotional needs.
- Responding appropriately to those needs.

Undeniably, a helping relationship is a complex one in which the whole is not the sum of these five parts. However, breaking the process into identifiable parts is helpful to a student who is just beginning to deal with the interpersonal aspects of clinical practice.

Greeting the patient may seem to be a straightforward part of the interaction between patient and practitioner. Nevertheless, the instructor should remind students that an impression is formed within the first few minutes of meeting. Negative impressions are difficult to overcome and may affect the rapport between the patient and the practitioner. Students need to be cautioned that patients may interpret the question "How are you?" in a medical or therapeutic context rather than a social context. If this question is asked, the student should be prepared to listen and respond to the information the patient is sharing.

To help students explain procedures to patients, use class discussion to identify key elements of a procedure explanation along with suggestions for modifying the explanation based on a patient's ability to understand. Patients typically have questions after a procedure is explained to them.

Students new to the clinical setting often fear patients will ask a question the student cannot answer. Instructors can compose a scenario describing the circumstances under which a patient is sent for a particular exam. Students then are directed to ask people not associated with health care to read the story and ask questions based on the information given. As students report their results in class, this exercise demonstrates frequently asked questions, basic anxieties or concerns shared by patients and common misinformation about imaging procedures. The results can aid students in refining their own expectations.

Students need to be aware that patients' questions are sometimes more than requests for information. They can contain clues to underlying concerns. Peloquin and Davidson[5] cite suggested readings that can help students develop active listening skills. Discussion questions may include: In what way did a character in the reading not listen?

What did that person not hear? How could this person have responded differently to demonstrate active listening?

Recognizing and responding to patients' physical and medical needs are well-defined tasks. Emotional needs, however, are more difficult to identify. Unspoken requests for psychological comforting require practitioners to distinguish content from feeling. Several authors suggest role-playing to give students the opportunity to practice recognizing and responding to situations they may encounter in practice.[3,5] It allows students to apply concepts and strategies introduced in the lectures and group discussions and provides a nonthreatening environment in which to explore possible therapeutic responses.

Dowd[6] has pointed out that caring as a professional behavior involves feelings, moral thought, the ability to express one's humanity, interpersonal interactions and therapeutic interventions. Some educators believe it is not possible to teach students to care about patients. However, educators can develop instructional activities that encourage reflection about others' perspectives and assist students in improving communication skills — the first steps in becoming a caring professional.

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Test Statistics

As difficult as it can be to write a good test, it can be equally difficult to interpret its results. What do you do after you've administered and corrected a test? Of what significance are the scores? Did students do well (or poorly) because the questions were too easy (or too hard)? Does the test reliably measure student knowledge?

Answers to these questions will help improve your tests through the use of descriptive statistics and item analysis. Although these methods were pioneered for norm-referenced testing, they still have applications in today's mastery learning environment. Many of these functions can be performed on a computer or scientific calculator, but it's still useful to understand how these evaluations are accomplished.

The purpose of testing is to find out how well students are meeting curricular objectives. But if a test has low validity or reliability, it's impossible to accurately assess student knowledge. The main issue to be addressed here is "how well do the items of this test measure the objectives, in terms of both subject matter and cognitive skills, that [should be] measured."[1]

Ideally, test items should be reviewed by a committee of content experts. Admittedly, it's hard to objectively quantify the validity of a test; that's one reason it's best to have a number of people look at and evaluate each test item. This is an excellent function of your educational advisory committee. On the other hand, reliability — the degree to which a test consistently and accurately measures students' attainment of objectives — can be quantified rather easily. The methods we'll look at are the Spearman-Brown and Kuder-Richardson methods.

Spearman-Brown Method

The Spearman-Brown method divides the corrected test into odd and even halves. Each half is scored as though it were a separate test. Next, the correlation coefficient is calculated using Pearson's product moment formula (the one generally available on scientific calculators).

The coefficient obtained determines the full-length reliability of the test by inserting it into the Spearman-Brown formula:

$$R = \frac{2r}{1 + r}$$

where R = total test reliability and r = correlation between odd and even halves of the test. Let's say that the correlation between odd and even halves of a test is 0.75. Putting this into the formula, we have:

$$R = \frac{2 \times 0.75}{1 + 0.75}$$ Solving for R obtains: $$R = \frac{1.5}{1.75} = 0.86$$

A reliability coefficient of 0.70 or higher allows a norm-referenced test to be used with confidence. For criterion-referenced tests, 0.50 is considered acceptable.

Kuder-Richardson Method

Another method to estimate test reliability was designed by Kuder and Richardson. This formula, known as KR-21, can be stated:

$$R = \left(\frac{k}{k-1}\right)\left(1 - \frac{X(k-X)}{kS}\right)$$

where R = test reliability, k = number of items on the test, X = mean of the raw scores from the total test and S = variance of the raw test scores from the total test. (Variance is the standard deviation squared.)

Suppose we gave a 50-item test and the mean score was 43 and the variance was 25.0. Putting these values into KR-21, we have:

$$R = \left(\frac{50}{50-1}\right)\left(1 - \frac{43(50\text{-}43)}{(50)(25)}\right)$$

$$R = (1.02)\left(1 - \frac{301}{1250}\right)$$ Solving for R obtains: $R = (1.02)\,(0.76) = 0.78$

Once again, the reliability coefficient is greater than 0.70, so we can use this test with some degree of confidence.

Tests that exhibit low reliability can't be used to evaluate student performance. Serious attention must be given to improving the quality of individual test items. This is where item analysis plays a role.

Item Analysis

Item analysis lets you evaluate the difficulty and discrimination indices of a given test item. And, for a multiple choice test, it can tell you much about the effectiveness of individual distractors.

There are four basic reasons for using item analysis:[1]

- To select the best items for inclusion on a test.
- To identify poorly written test items.
- To identify content areas or skills where the class as a whole could benefit from review.
- To identify areas of weakness for individual students.

It was said earlier that reliability calculations were developed primarily for use with norm-referenced tests, and the same is true for item analysis. In spite of that, item analysis can be used to advantage in evaluating the quality of tests in criterion-referenced tests as well, particularly the typical classroom test. One more thing: If you thought calculating test reliability was tedious, item analysis is worse. In fact, for any serious test analysis a computer is an absolute necessity.

There are three components of item analysis: item difficulty, item discrimination and distractor effectiveness.

Item Difficulty

Item difficulty is a measure of the percentage of students answering a question correctly. Values for the difficulty index range from 0% (very difficult) to 100% (very easy). The difficulty index can be used to alert the instructor about potential problems. Questions answered correctly by the majority of the class should be examined for grammatical or other irrelevant clues. Remember the purpose of testing is to measure subject knowledge, not test-taking ability.

Conversely, if most students answer a question incorrectly, it may indicate that a content area was inadequately covered in class or that the test item was ambiguous or confusing. In either case, item revision is required.

The "ideal" discrimination index for norm-referenced tests is 50%. Research indicates that tests composed of items at the 50% level will maximize test reliability. However, if you're following Bloom's hierarchy of objectives, it is impossible not to have items of varying difficulty. This will result in lower estimates of reliability using the KR-21 formula. Here are two suggestions when you are faced with this problem: Select those items with a difficulty index between 30% and 70% and apply KR-21 with caution.

Item Discrimination

Item discrimination is a measure of a question's ability to differentiate between high and low achievers. Values range from –1.00 to +1.00. If all the high scoring students and none of the low scoring students get a particular question right, the discrimination index would be +1.00. If all low scoring students and no high scoring students get a question correct, the discrimination index would be –1.00. This question actually discriminates against the more knowledgeable student.

One more point about discrimination: Very difficult or very easy questions usually have a low discrimination index. In actual practice, all test items should discriminate positively in a range from about 0.40 to 0.60.

Distractor Effectiveness

In examining your corrected tests, be alert to those distractors that are chosen rarely or not at all. Distractors having a low selection frequency contribute nothing to the difficulty or discrimination of the question. These distractors should be rewritten or discarded.

After you've completed your item analysis, what should you do next? Here's one suggestion: Rescore your test and eliminate any questions that exhibit a low or negative discrimination index. The result should be a more reliable test. Of course, if you eliminate a large number of items you run the danger of not measuring some important outcomes of instruction, and content validity would be affected adversely. A better alternative is to build a question pool and construct your tests from that.

Is item analysis a panacea for improving tests? Not at all. Item analysis does help identify questions that need to be revised or thrown out. But be cautious about placing too much faith in statistical methods of test analysis. In the end, all they can do is provide you with a basis for more objective determination of whether you are getting an accurate estimate of student knowledge. Used appropriately, item analysis is just one more tool you can use to sharpen your teaching and testing skills.

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By Stephen F. Hulse, M.Ed., R.T.(R)
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Use Questions To Improve Class Discussion

The discussion method is any teaching technique that uses two-way communication between students and the teacher and among the students themselves as a way to share ideas, opinions, conclusions or experiences.

Instructors use such techniques for a variety of reasons. They may wish to assess the level of students' understanding about lecture material. Through class discussion, instructors often can discover common misunderstandings about key concepts. Instructors also can use discussion to guide students in the application and analysis of their current knowledge in relationship to other contexts.

Research has shown that, compared with the lecture method, the discussion technique helps students achieve higher levels of reflective thinking and creative problem solving. Exploring values and changing attitudes may be accomplished through discussion.

Also, discussion forces students to become active participants in the learning process. Studies prove that information obtained through active discussion is better retained than information obtained through the traditional lecture.

Planning Your Questions

Leading a class discussion, like any other teaching activity, requires good planning. The key components of a productive class discussion are the questioning strategy of the instructor as well as the questions themselves.

When planning your questions, consider your purpose for incorporating questions into your class discussion. Your purpose will help determine what level of questions you will ask.

Of course, the best questions are those that require students to think. Asking questions that require only the recall of factual information supplied in yesterday's lecture discourages student participation, because the answers appear in the textbook or in the lecture notes. Recall questions may have some value as a review of the previous lecture material or introduction to new material, but their use should be limited.

When developing questions, focus on truly important content or issues. Questioning students about trivia may mislead them about what the key concepts and problems really are.

Be precise in phrasing your questions. Ask questions that require more than a simple "yes" or "no" response, unless you intend to follow them up with other questions that further explore the student's reasoning skills.

Be careful not ask questions that are too broad or general. These may take your discussion in a direction you had not intended to go. Also, make sure that your questions do not contain an "implied response." This type of question discourages participation because students may believe the answer is obvious.

Try to predict how students will respond to your questions. For example, consider some of the typical misconceptions held by students that might lead to an incorrect answer. Anticipating student responses may help you rephrase a question that is ambiguous, too broad or too restrictive in its scope. Your questions should give students enough latitude to express a response in their own words.

Also, as you plan your responses, consider that your students may not answer correctly or may not respond at all, and design an approach for handling either of these circumstances.

Writing your questions out in the order in which they will be asked will give you flexibility. If you think of better questions during the class discussion, you can quickly substitute them for your planned questions. Having a preplanned list, however, will assure that you address the important material in a logical order. The order of your questions may be related to the sequence of lecture material, from specific to general, or from lower level recall questions to higher level analysis or synthesis questions.

Leading a Class Discussion

Planning your questions is only the first part of a successful class discussion. Leading the discussion, how you present your questions and how you respond to students, is the second. To encourage participation, always pause and wait for a response after asking a question. Students need an opportunity to think about their response. Initially, the silence may feel awkward to both you and your students, but allow 8 to 10 seconds for students to respond. The waiting period will show that you expect a response and that you are patient enough to wait for one.

Be careful to ask only one question at a time. A series of questions may be confusing to students and they may not respond if they do not have answers for all of the questions. Attempting to clarify your first question with a second or third may change the meaning of the initial question.

Use a variety of types of questions, especially open-ended and divergent questions for which there is no single, correct answer. These types of questions allow students to fully explain their responses. If students appear to be having difficulty elaborating their answers, you can assist them by asking for clarification, asking them to support their opinions with reasons or facts that support their position, or by asking several questions that may prompt an expanded response. Often, students need explicit direction in applying the knowledge they already possess to unique situations.

At the same time that you are attempting to develop yourself into an adept questioner, you also are seeking to develop your students into eager, participative responders. The way you field students' responses will affect the quantity and quality of future responses. Some suggestions for acknowledging student responses include:

• Use strong, positive reinforcement when students offer a correct or thoughtful response.

• Try to find part of the student's response to praise. If that is not possible, thank the student for responding and ask if anyone else wants to respond or comment on the first student's answer.

• If the student's response is inadequate or incorrect, pause to see if another student will respond with the correct response or a better response. Avoid reacting with "Yes, but...." Instead, ask how the student arrived at his or her answer. It is important to use this technique for both adequate and inadequate answers.

Making comments and building on the student's response demonstrate that you have listened to the student's remarks and value the points that he or she expressed. This technique reinforces the concept that teachers and students learn from each other, and also creates an atmosphere of support, acceptance and respect.

If you are uncertain about the quality of your classroom discussions or your skills as a questioner, tape record several classes to assess how you use questions and how your students reacted. Then apply the techniques outlined in this article and record your results to see how you have increased the effectiveness of your questioning skills and the participation of your students in the active learning process.

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Teaching Techniques in the Radiologic Sciences

A Selection of "Teaching Techniques" Columns
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In today's rapidly changing health care environment, what is the best way to educate radiologic science professionals of the future? This book is a comprehensive exploration of the many facets of radiologic science education, ranging from admissions criteria to curriculum development to computer-assisted instruction. Full of practical ideas for the classroom and lab, it is an indispensable resource for radiologic science instructors and valued reading for any educator in the health-related professions.

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