Challenges Facing Radiology Educators
Mervyn D. Cohen, MB, ChB, MD, Richard B. Gunderman, MD, PhD, Mark S. Frank, MD, Kenneth B. Williamson, PhD

This article summarizes the current challenges faced by radiology educators. These are discussed under the headings of time available for education, financing education, what and how to teach, student evaluation, support infrastructure, and challenges to leadership.

Key Words: Radiology, education, education economics, curriculum

INTRODUCTION

Academic radiology departments have three missions: education, research, and the delivery of clinical services. Although the leadership of strong academic radiology departments has found ways to harmonize these missions, and most departments continue to adequately educate radiology residents, the education mission faces challenges.

History helps us understand these challenges; money is the greatest challenge. In his excellent book A Time to Heal, Ken Ludmerer [1] detailed the threats to the education mission. Between the two world wars, education was the dominant mission of medical schools. However, after World War II, federal spending greatly augmented the research mission of many medical school departments. Then, in 1965, for the first time, the creation of Medicare and Medicaid provided medical schools with income for patients whom they had previously treated without charge. Clinical activities in medical schools began to grow rapidly. From 1975 to 2000, clinical revenues increased by 3500% from $410 million to $14.8 billion [2]. These figures are not corrected for inflation, but they do represent the large change that has occurred. These new clinical revenues have subsidized medical education since 1965, but in the past 5 to 10 years, the combination of reduced reimbursement from government and private insurers and spiraling technology and regulatory costs has rapidly diminished the “profit” from clinical activities that can be used to support the education mission [2].

Our national societies continue to emphasize the importance of education with greatly increased expenditures on education courses and research. The challenges facing radiology educators (radiologists who teach) and radiology leadership are not difficult to identify (Table 1). We need sufficient time and money so that education can remain an integral part of the academic mission. We struggle to create optimal curricula and to create the tools we need to measure and evaluate our teaching methods and results. This article cannot provide solutions to these difficult issues but is intended to draw attention to the problems and stimulate discussion (Table 2). The comments necessarily represent our opinions; true scientific support is unfortunately seldom available in discussions of education.

TIME AVAILABLE FOR EDUCATION

Who among faculty members does not feel that teaching time is being eroded by pressure to increase clinical output? It may be difficult for even the most well-intentioned faculty members to spend sufficient time preparing to teach, when many faculty members feel that they do not have adequate time for education because they feel pushed to their limits just to maintain their expected roles in their departments’ clinical missions [2,3]. Time also needs to be found for select radiologists to conduct research in radiology education.

The imperative to maximize patient throughput has diminished the personal contact between faculty members and students and demoralized many faculty members [4]. It has caused a marked erosion of the clinical learning environment, particularly by reducing the time available for teachers to teach and students to learn. This has created the need for new methods of instruction, knowledge acquisition, and assessment [5]. One possible...
solution may be the use of simulation tools. These can provide a very structured method for the delivery and measurement of an educational objective; they also can reduce costs by substituting for very expensive radiologists. Simulation technology is only now gaining some acceptance in medicine, but it is well established in other disciplines [5]. Simulation tools provide the mechanism for deliberate practice undertaken over prolonged periods of time. Such repetition is essential for the development of skills. Simulation tools can reduce the need for faculty members to engage in the repetitive, time-consuming teaching of simple skills. Examples include anesthesia and sedation simulators [5]. Well-designed ultrasound simulators (UltraSim, MedSim USA, Fort Lauderdale, Florida) are currently in use in our department. Students use real ultrasound consoles and scan mannequins that are surrounded by an electromagnetic field that detects the position of the transducer in space. The transducer position is correlated with three-dimensional image data sets from real patients that are displayed on the console screen. We do need more research into the use of simulators.

Faculty members struggle to be given time to teach because the allocation of adequate time to faculty members to prepare and deliver education is fraught with difficulties. In most instances, faculty members do not generate income during “education” time. Another problem is the difficulty in measuring faculty members’ education time and devising fair metrics for holding faculty members accountable for education time. Faculty members need to be accountable not only for how they spend their time but also for the results of time spent on task in terms of their departments’ missions [3]. Many task forces, commissions, and councils are wrestling with how best to explain what faculty members do with their time [3]. All agree that there should be better ways of accounting for faculty members’ efforts in teaching other than how long a student sits in a classroom, but there are no universally accepted solutions [3].

Time management offers opportunity. Few radiologists are trained in time management. Efficient time use offers opportunity, which could be surprisingly significant.

### Table 1. Challenges facing radiology educators
- Creating enough time to teach
- Providing adequate funds for education
- Deciding exactly what to teach
- Learning how to teach
- Developing stable tools for evaluating the quality of teaching

#### MONEY TO SUPPORT EDUCATION

This is a key issue to which there is no easy answer. An academic radiologist’s income depends primarily on the clinical income generated by his or her practice group. Education generates limited income and may be subsidized by grants from medical schools and hospitals. We must understand the true costs of our education programs and know the dollar values and sources of the subsidies. Only with this information can we begin to make our argument for more subsidies. Few departments have specific budgets for their educational activities. At a minimum, it would be helpful to have a mechanism that lets them understand the approximate income and costs of the education they provide. If this is not done, educational divisions will run the risk of being viewed as perpetual parasitic components of departments, continually seeking money and support from the clinical enterprise. A budget will also quantify the support, infrastructure, and resources needed to deliver the education mission.

It is difficult to determine the true cost of the education component of an academic radiology department. A very detailed activity-based cost analysis of the financial operations of a single large academic radiology department was published in 2000 [6]. This study found that 19% of the total costs of the department could be attributed to educational activities and that the cost per direct activity hour of teaching by each faculty member was $339. Lecture preparation and delivery was the most expensive item, accounting for 21% of all education costs.

Should radiologists’ pay per hour for teaching be the same as for their clinical work? Traditionally, in academic departments, no distinction in pay has been made on the basis of time spent in educational activities. Equal pay offers equal respect and recognition for a good contribution to any of the three components of the academic missions. Reduced pay for educators helps relieve the economic burden of education. To recruit and retain excellent teachers, the leaders of academic radiology departments have always felt the need to maintain this equality, but this may not be possible in the future. Faculty members who wish to dedicate significant parts of their time to the education mission may have to be hired with the knowledge that they will be paid at a lower rate than they would earn without a nonclinical commitment [2]. As a result, it may become difficult to recruit MD educators. One alternative would be to make more use of lower paid professionals to do some teaching. This could include nurse practitioners and radiology technologists.

Larger radiology departments may be able to pursue additional sources of income for education. Although some departments are successful, this is difficult because
Table 2. Solution for radiology educators

- Be true to the academic mission
- Elevate the status of education
- Financial independence for education
- Board examinations
- Try ideas for a new structure
- Improve the education infrastructure
- Use simulators
- Be a good mentor

it requires a specific commitment from leadership and the creation of a solid support infrastructure. Numerous opportunities do exist. External income may be generated from educational training or refresher courses and the production of teaching material for radiologists. Some departments have negotiated profitable contracts with radiology corporations to provided them and their customers with very focused training courses. Occasionally, research in education technology may yield patents and licenses that provide financial support for the education mission. Some departments may be able to generate education income; many will not.

WHAT TO TEACH

The education curriculum may be viewed simplistically as lists of all the technologies and diseases students may encounter. The curriculum should be viewed, however, as the collection of knowledge necessary to produce the desired end product: a competent radiologist. We must define the end product to decide what we need to teach, and that is not an easy task. It is difficult to list all the desirable characteristics of a good radiologist, more difficult to rank them, and even more difficult to teach some of these attributes. These include the ability to pass board examinations, possess great clinical knowledge, provide accurate diagnoses, communicate well, have good people skills, become involved in outside affairs, be a good manager, be able to lead, and be politically savvy. We all probably agree that these are desirable attributes, but each of us will value and rank these attributes differently. This will always leave us debating about the ideal curriculum.

Radiology residents frequently feel overburdened and anxious when they reflect on the sheer volume of material that they believe they must master [7]. Indeed, the Accreditation Council for Graduate Medical Education has required that all residency programs provide learning opportunities for each resident to acquire “specific knowledge, skills, behaviors, and attitudes” of six general competencies (patient care, general medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice) and assess residents’ learning of these competencies [8].

Because of the pressure to acquire factual knowledge and the relative ease of accessing that knowledge, Alderson [9] stated that today’s young radiologists often end their training with a gap between superb interpretation skills and an ill-defined sense of their place in the field of radiology and in the health care delivery system in general. Subspecialization may thwart students’ needs to learn the general principles of clinical disciplines [2]. There is clearly a strong need to expand the radiology curriculum beyond pure medical knowledge.

Recently, medical curricula have increasingly reflected a belief that students should understand concepts rather than just memorize facts [10]. The interpersonal skills of clinicians have been shown to be less refined than their patients might wish. There is a need for better training to ensure competence in communication skills [11]. Teaching faculty members must ensure that the experience of residency training continues to transform novice practitioners into physicians able to think, act, and keep their focus on the ultimate goal of providing the best and most appropriate care for patients [12]. This transformative learning process has eight principles: increased autonomy, increased independence, the ability to separate one’s feelings and opinions from those of others, the ability to critically and respectfully examine the views of others, the ability to set personal and professional goals, the ability to see how one’s actions affect the system in which one works, the ability to balance and choose among conflicting priorities and variable self interests, and the ability to acknowledge one’s role in constructing one’s own reality [12]. An expanded curriculum will include the following topics: personal development, stress management, leadership skills, the business side of medicine informatics (including internet skills), social responsibility (ethics, legal issues, responsibility to the community), service orientation and development of interpersonal skills, and critical-thinking skills [13].

To achieve these goals, the curriculum must be broad-based and extend beyond the mere acquisition and use of factual knowledge. This type of curriculum is difficult to justify in the current environment, in which many students perceive that their success in radiology is determined purely by their ability to pass board examinations. A first step toward adopting such a curriculum would be to move the board oral examinations out of the fourth year to a later date, which would allow students to focus on the broader aspects of their training. Of the 24 national board examinations in the United States, only radiology has its examination during the residency years. The other 23 boards have their final examinations after completion of residency.

In addition, to reduce anxiety and the perceived over-
burden of radiology information to be mastered, stu-
dents should participate in curriculum development as
much as possible. A recent study suggested that physi-
cians benefit from reflection on their progress and de-
velopment of their own learning projects or objectives [14].
Thus, it would be of value to have residents participate in
the creation of their own learning objectives.

HOW TO TEACH

How many radiologists have had formal training in edu-
cation? Or have they just picked it up on the way? Very
few radiologists have had any such training, and more-
over, very few trained educators work in radiology de-
partments (or even in medical schools). We believe that
radiologists need more training as educators, because
most of us are not familiar with current theories and
methods of teaching.

As most of us have no formal education training, we
tend to use the methods we know (i.e., those that we grew
up with). Traditionally, radiology residents learned by
serving an apprenticeship in the clinical environment
(the reading room) and through didactic venues (i.e.,
lectures). Both components of the educational experi-
ence are useful, but are they optimal methods? Reading-
room training evolved many years ago, when a faculty
mentor was the major source of knowledge for a student,
and the corpus of radiology knowledge was relatively
small. Now a faculty mentor is only one source of infor-
mation, albeit of high quality; a much greater volume of
information is easily obtained from books, journals, and
computers.

Reading-room apprenticeships should provide resi-
dents with real-life experience, often called “authentic
practice,” as they work side-by-side with faculty mentors.
This is an essential part of training and, viewed from the
constructivist perspective, facilitates the connection of
new knowledge to preexisting knowledge and experience
[10]. In addition, residents observe how mentors com-
municate, manage time, deal with conflict, decide prior-
ities, and so on. We argue, however, that much time in
the reading room is spent in lower level teaching; faculty
members are sharing factual information with residents
and seeking to evaluate residents’ factual knowledge.
There are no scientific studies to validate this hypothesis,
but we believe that it is important to discuss. This one-
on-one time is very costly, because radiologists are a
department’s most expensive resource. We must ask if
this component of education—the dissemination and
evaluation of factual knowledge—cannot be done more
cheaply and more effectively by other teaching methods,
such as computer-based self-learning and assessment pro-
grams. The time in the reading room might best be used
to probe residents’ understanding of broad principles,
through asking questions that force them to connect
what they see to what they already know [15].

Formal teaching has usually been conducted through
lectures such as “noon conferences.” In many radiology
departments, such conferences are held almost daily and
provide forums for students to learn through case review.
This format, though well established and well liked, has
potential serious flaws. The typical noon conference re-
sembles the rural, small-village school of 50 years ago, in
which one teacher would be responsible for instructing
students of different ages and proficiency levels. Simi-
larly, noon conference attendees may include technolo-
gists, medical students, residents, fellows, and faculty
members. Even conferences limited to residents have au-
diences with huge variations in knowledge and skills.
One may truly ask how a teacher can deliver meaningful
education to such a diverse group of students simulta-
neously. Careful preparation, understanding the specific
needs of each student group, and the prior distribution of
material can help a little to overcome these problems.

This leads us to the conclusion that radiology resi-
dency programs tend to manifest a “one size (still) fits all”
philosophy that limits learners’ opportunity to learn. We
do not adequately allow for different rates of progress
and fail to provide a full range of alternate curricular choices.
Learners progress at their own rates depending not only
on their own motivation and knowledge level but also on
the opportunities we provide. This is not to say that
radiology residency programs fail to provide residents
with elective choices. However, with some exceptions,
such electives are merely opportunities to choose “more
of the same” (e.g., another 2 months in pediatric or bone
radiology). What residents need are electives that allow
(or force) them to explore unique new educational op-
portunities. The Holman research pathway is one exam-
ple of such an opportunity. Many other shorter 1-month
to 3-month electives can be offered with a little creative
effort. These could include informatics, developing a
learning collection, participation in a quality assurance
program, and so on.

Many of education’s goals, such as effective commu-
nication, are intuitive and abstract and thus allow numerous
interpretations. How can the concept of multiprofes-
sional learning become robust if we cannot agree on its
goals [11]? There are few common metrics and bench-
marks for educational interventions. Even if we all agreed
on a defined curriculum, we would still have delivery
issues to consider. For example, faculty members often
give lectures on subjects of their own choosing rather
than subjects that meet the needs of a broad-based cur-
riculum [14]. It is rare indeed to find a systematic curric-
ulum, tailored to the needs of different levels of learners,
that is actually followed in practice. This would require
an unprecedented degree of central control and faculty consensus.

Other goals cannot be a part of a formal curriculum. For example, the cultivation of proper professional behavior requires mentoring and guidance, not course work [4]. The “informal” curriculum has more actual effect on what our residents learn than any list of goals and objectives found on any society’s Web site or program handbook [16].

STUDENT EVALUATION AND OUTCOME

Although we change our education programs continually, we find it difficult to evaluate the outcome of these changes. There is little evidence to guide educators in how to evaluate and improve their teaching programs [11]. Although factual knowledge can be tested through written and oral board examinations, many facets of radiology training are almost impossible to measure objectively. These include analytical skills, interpersonal and communication skills, motivation, and commitment to ongoing self-learning [11]. The evaluation of these facets is done by subjective end-of-rotation reviews and regular meetings of faculty members to discuss student performance.

None of the evaluation methods is perfect, and often, there is poor correlation between different components of student performance. However, in one study, a resident’s average in-training examination score was found to be a very strong predictor of his or her performance on written radiology board examinations [17]. Being a member of the Alpha Omega Alpha honor society was a significant independent predictor of high scores on radiology board examination [16]. These results only tell us that students who are good at examinations are good at future examinations.

Part of a solution might be to ask students to evaluate themselves. However, although self-reported satisfaction is a common variable in educational research, self-reported competence has virtually no correlation with objectively measured skills [11]. Students’ perceptions of the value of a curriculum taught through the presentation of interesting radiology cases were inaccurate when compared with an external measure of performance based on the content of these presentations [18].

Unfortunately, we must face the fact that we have poor metrics for measuring the quality of education. The evaluation of students is not easy. We find it difficult to measure what we do as educators, and what we do measure still focuses heavily on evaluating the students’ breadth of factual knowledge.

INFRASTRUCTURE

The support infrastructure for education includes space, education materials, and technology items. However, these resources are often limited, fragmented, missing, or duplicated.

Space is essential but often inadequate; much of the space originally designed for student teaching and learning has been devoured to make room for research, laboratories, and clinical units [2]. How many departments today have adequate dedicated computer learning space or study space for their residents?

Educational materials include books, journals, videos of lectures, and computer learning sites. How often has a radiology department bought and distributed these materials as part of a preconceived plan rather than on an unstructured, ad hoc basis? How many departments have plans for replacing outdated material? How many departments have plans for evaluating the quality of educational material that they purchase? Educational materials also include files of teaching cases and other databases. These collections are usually developed by individual radiologists who may be reluctant to share their cases to form a coherent departmental collection.

Computer technology support for the preparation of education material may be poor or duplicated, wasting resources. Do radiology departments have formal methods for evaluating and purchasing education support software, such as Microsoft PowerPoint? Are staff members formally trained to use new software programs?

In addition, there is a need for training. Programs to train staff members as educators or to use computer education resources to help with preparation of education material are frequently absent, incomplete, or duplicated across a campus. New faculty members are seldom directed, through carefully constructed curricula, to develop their education skills. There is competition for resources, and perhaps we cannot provide programs that teach all academic radiologists to teach. All departments should consider having at least some faculty members trained in education methodology.

There should be a centralized structure or education center that oversees teaching and learning. The center must provide logistical support for implementation of educational programs and the pursuit of educational research. Tools must be developed to measure the value of education. The education center can provide a common infrastructure for all educational activities [2].

CHALLENGES TO LEADERSHIP

Education must have a purpose and a mission [3]. Although medical schools were once devoted primarily to educating medical students, they have now evolved into complex organizations, many of which place greater em-
phasis on research and clinical businesses than on educating future physicians [2]. Paradoxically, as the size of faculties has increased, participation in the education of students has become a marginal activity for a large percentage of medical school faculties. Medical education, the singularly distinctive mission of medical schools, has become, in many institutions, somewhat of a by-product of their principal business lines of research and clinical service delivery [2]. These missions have jumped to the forefront because the clinical enterprise is by far the major source of income for medical schools, and research is seen to garner prestige for schools, as well as income generated from external grant funding. The principal challenge to academic leaders is staying true to the academic mission, recognizing equal importance for its three components of education, clinical, and research. The education mission is at risk. The core competency of any academic medical department is education, and in the past, learned institutions such as universities and technical colleges were the sole purveyors of education. More recently, we have seen a trend whereby these institutions are ceding this competency to others. For example, many large corporations have developed their own internal education programs for their staff members. More affluent corporations even have teaching campuses that in many respects mimic small university campuses. In addition, we are seeing a shift to privatization in the education industry, with the development of many for-profit educational businesses [19]. Medical schools must rededicate themselves to teaching and regain their dominant role in the purveyance of education.

Leadership must face and solve tenure and job security issues. Although tenure has traditionally provided long-term job security for faculty members successful in research, alternative methods of providing equivalent job security must be created for faculty members who choose to emphasize teaching. This can be done in many ways, including a clinical track with a rolling 2-year contract that starts after 7 years. Faculty members can be attracted to teaching only if they have job security equal to that of other faculty members.

Because faculty members have probably reached the limits of personal autonomy, faculty members’ accountability must be increased, and faculty members must be answerable for their time. Although two essential conditions of job security will surely be preserved, academic freedom of speech and economic security, a third condition that has evolved through practice, independence to achieve broad goals without direction, must be changed. There is nothing inherent in the concept of tenure that says faculty members can do what they want when they want. Because education time is relatively difficult to account for, new methods must be developed for measuring faculty members’ time and success in their educational endeavors.

Leadership needs to continually strive to elevate the status of education in departments. Large radiology departments may consider creating distinct divisions of education, with clearly identified and empowered vice chairs of education. These individuals should be separate from directors of residency training. Residency directors are responsible for the day-to-day operations of residency programs. Vice chairs of education focus on broader issues, such as strategic planning, budgeting, and so on. Other ideas for elevating the status of education are developing research programs in the delivery of education; providing resident electives in education; and giving work recognition awards that give equal weight to teaching, research, and clinical achievements.

Residents are aware that they are increasingly being perceived as part of the workforce rather than as students, and they may resent it. Sometimes, they may be unable to adequately participate in experiences that will best prepare them to be future independent physicians [16]. We must find ways to change the work environment so that residents truly believe that they are being offered the best possible educational experience.

CONCLUSION

Radiology educators face many challenges but do have opportunities for trying to improve the quality of radiology education. There are no simple single solutions, and each institution will find its own unique approach. Important considerations are as follows:

- Leadership must make education a part of groups’ visions and successfully communicate this to faculty members.
- Departments need solid methods for tracking time spent by faculty members in educational pursuits and also need to seek methods to improve the efficiency of their teachers.
- Understanding the true costs of delivering the educational mission will help departments prioritize ideas for changing education and also help plan for methods to increase funding for education.
- There cannot be a unified, standardized curriculum for radiology education. However, each department should have a clear understanding of its own education objectives, with detailed plans for achieving them and a project management team charged with delivery.
- Methods of measurement of the success of education in radiology are difficult.
- Departments should carefully develop their own structures for the delivery of teaching, incorporating new electronic technologies. They need adequate support infrastructures. They should have plans for teaching.
the teachers how to teach. They must also help their residents select good-quality educational material.

ACKNOWLEDGMENTS

We wish to thank Greg Jennings for outstanding help editing this manuscript and Rhonda Gherding for transcription.

REFERENCES


11. Lurie SJ. Raising the passing grade for studies of medical education. JAMA 2003;290:1210-12.