Opinion

Ingredients of Successful Medical Student Teaching

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Tolstoy begins his great novel *Anna Karenina* with the statement that all happy families are alike, but each unhappy family is unhappy in its own way. Something similar might be said about radiology education, in which the paths to excellence are few, but many routes can lead to difficulty. This generalization applies particularly well to one of radiology's most important educational missions, the teaching of medical students [1]. If we are to provide medical students with the best possible education, we need to study the ingredients of educational success. These ingredients include providing students with clear objectives, enabling them to function as members of a team, granting them substantial control over their success or failure, offering them constructive feedback, providing them challenging learning tasks, and allowing them to contribute meaningfully to patient care. This article reviews these ingredients and provides practical hints that radiology educators can use to enhance student learning.

Clear Objectives

Learning objectives are a powerful tool for enhancing educational outcomes. If students have no targets in view, their learning will be compromised. Most medical students know very little about radiology and may not be able to formulate well-informed learning objectives for themselves. In some cases, the only explicit learning objectives students receive are reading assignments. Although better than no objectives, reading assignments merely tell students where they are expected to learn and provide no idea what they should be able to do as a result. Moreover, mere reading assignments often leave students wondering if readings comprise the only source from which they are expected to learn. Does this imply that clinical time with radiologists is unlikely to provide any worthwhile learning opportunities? Many students organize their learning around what they expect to be tested on, and it is important to ensure that the full range of learning experiences is represented in learning objectives and evaluation techniques.

A common requirement is attendance. Students are expected to attend lectures and to be present on the clinical service to which they are assigned. However, merely showing up is a rather low-level goal. Radiology educators should make sure that the time students spend in radiology is put to good use. To help students come away from radiology with more than a perfect attendance record, it is important to help them understand what they are expected to learn when they are there. A simple list of learning objectives would often suffice. One such item might be: "Through this course, students will be able to assess chest radiographs according to such technical factors as inflation, penetration, rotation, and motion." Despite Woody Allen's adage that 90% of life is simply showing up, we sell students short if we fail to help them define clearly what they should be doing while they are with us.

We could ask students to carry out independent learning tasks as individuals or members of groups. For example, students might develop case write-ups to be used in educating other students. They could be challenged to make meaningful contributions to the clinical work of the radiology department by assuming responsibility for helping to work up particular cases. Ideally, the learning associated with such projects would be especially useful in the medical specialty they plan to enter. For example, a student planning a career in orthopedic surgery might work on a topic in musculoskeletal imaging. Such projects would enable them to avoid the kind of superficial learning that is a mile wide and only an inch deep by spending part of their time delving more deeply into topics of particular interest to them.

Team Work

Perhaps one of the greatest opportunities facing medical school radiology courses is to define teams to which students belong. When third- and fourth-year medical students are on rotations such as internal medicine or surgery,

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they function as team players with defined roles. The team consists of an attending physician, a senior resident, a junior resident, and one or more medical students. In many cases, this team remains together throughout the course of a month-long experience, allowing members to get to know one another and work together to accomplish a shared mission.

When students are asked during their surgery rotation whose team they are on, they provide an immediate response. Asked the same question during radiology, they may respond, "What team?" Instead of contributing, the students may feel that they are merely imposing on faculty members and residents to whom they are assigned. Seeing medical students at the periphery, looking on as the radiologists do their work, is not uncommon. Moreover, radiologists may come and go from day to day, making it difficult for students to develop personal alliances with anyone.

Medical education is not only a cognitive process, it is also a social process. Students' appraisals of their educational experiences take into account more than simply how much they learned from books and lectures. To address this problem, radiology educators should look for opportunities to enable medical students to function as team members. For example, students might be placed in small groups with defined educational goals, such as developing 15-min group presentations for their fellow medical students. The students might be assigned not to a particular clinical service, but to a particular resident, with whom they would be expected to work throughout their time in radiology. They might contribute by helping to work up cases in which additional clinical information is needed. Such an experience would provide students with a stronger sense of camaraderie and residents with a more clearly defined role as educators.

Control over Performance

As performance-oriented people with high expectations for their own achievement, medical students need to feel that they exercise control over how they perform [2]. If the whole evaluation process is a mystery to them, their motivation will be undermined, and they will be more likely to find their radiology experience unsatisfactory. This situation can compromise student evaluations of radiology teaching faculty, reduce student interest in radiology courses, and discourage students from pursuing radiology as a career. For cases in which students are interacting with a shifting cast of residents and staff, they may wonder whether meaningful evaluation is even possible, particularly if most of the people they work with do not know their name. Students may question what they can do to enhance their performance, other than simply show up every day and project a positive mental attitude.

Most radiology courses should evaluate students in multiple dimensions that should be clearly mapped out. A potentially valuable educational strategy would be to invite students to participate in determining their own grade. For example, students might have the option of completing a project as part of their grade. In schools with competency-based curricula, radiology might provide students an opportunity to show one or more competencies. Whenever possible, students should be furnished with examples of excellent, good, and poor performances, including samples of past students' work.

For some students, a course in radiology serves as an important opportunity to explore radiology as a career. Special opportunities might be made available to such students, including the opportunity to meet with a faculty advisor to learn more about the field. Highly motivated students, especially aspiring radiologists, may welcome the opportunity to do a special project as a means of distinguishing themselves as residency candidates.

Feedback

Failure to receive feedback is one of the most discouraging experiences to which achievement-oriented people can be subjected [3]. Conversely, providing more frequent and higher quality feedback is an excellent way of improving students' overall impression of a course and the people who teach it. Timing is an important aspect of good feedback. Medical school courses tend to base students' grades on a single written examination scheduled at the end of the course. Likewise, written feedback from faculty members typically becomes available only after a course has concluded. These practices make it difficult for students to use feedback constructively. It is as if basketball players learned only at the end of the game whether any of their shots had gone through the hoop.

An ideal system of feedback would provide students with actionable suggestions on a weekly or even daily basis. To achieve such an objective may require the introduction of computer-based instruction to avoid overburdening the faculty. Perhaps even more important, faculty members should get into the habit of incorporating constructive feedback into their daily routines. One means of doing so would be to make a point of asking frequent questions of students on clinical services to determine if they are truly learning the principles discussed in readings and lectures. Some questions might even be repeated from day to day to ensure that the students are retaining what they have learned. Even more important is to give students a chance to apply what they are learning to clinical care. For example, students who have been learning to distinguish between atelectasis and pneumonia might be asked to help analyze appropriate chest radiographs during the workday.

Challenge

Radiology courses need to present students with meaningful challenges. Assigning learning tasks to fourth-year students that one would normally provide to first-year students is a mistake because the more experienced students find such tasks insufficiently challenging and lose interest. Likewise, assigning first-year students learning tasks that one would normally provide to fourth-year students can prove equally discouraging, because the less experienced learners do not know where to start, find the task overwhelming, and give up.

The appropriate level of challenge is not an absolute quantity but a relative one that needs to be tailored to the learner. On the other hand, there are absolute principles. For example, no learner at any level will find it challenging to sit quietly in a dark room, struggling to feign interest and remain awake throughout a long afternoon. Likewise, simply seeing how many facts students can recall from assigned readings provides a relatively low-level challenge. Better challenges require students not merely to recall information but to synthesize what they know, draw distinctions, and solve problems.

A top-notch course will invite medical students to test themselves as physicians. For example, the students might be asked to look up the results of laboratory studies, to review medical records, and to speak with other physicians involved in the care of particular patients in an effort to help the radiologist determine what test to perform, what differ-

ential diagnosis to offer, and what further evaluation to recommend. Top-notch students can perform an important educational function in the department by reminding faculty members and residents of information they have forgotten and helping them remain abreast of new developments in medicine. There is no reason that students should not be invited to play the role of instructor from time to time, or that faculty members should fail to benefit from what the students know.

Contribution to Patient Care

Perhaps the single greatest opportunity in the curricula of many radiology departments, particularly in courses for advanced medical students, is to get students involved in helping care for patients [4]. Transporting patients to and from the radiology department, returning film jackets to the film file room, and queuing examinations on a PACS (picture archiving and communication system) workstation do not count. On other services, such as internal medicine and surgery, students take histories and perform physical examinations. They track down the results of diagnostic testing and request consultations from other clinical services. They learn to perform procedures, such as phlebotomy and lumbar punctures, and their contributions form a part of the patient's permanent medical record, helping to spare the time and energy of other members on the team. The students also make presentations to their teams and help educate patients. In radiology, by contrast, students may never see a patient, and the students may feel that, during an entire month of their medical school career, they had no opportunity to make a difference in a patient's care.

Many opportunities arise to involve students in day-to-day patient care while they are in the radiology department. For example, students can take brief histories and perform physical examinations on patients awaiting imaging studies or procedures such as biopsies and abscess drainages. Likewise, students can help educate patients about such procedures and assist in their performance. To a medical student, few experiences are more invigorating than acting as a doctor, and in radiology, that means actually getting to do some of the things that radiologists do.

At the very least, radiology should enable students to learn things that they regard as directly relevant to patient care. One way is to emphasize the sort of imaging skills students will need every day as interns, showing them how a deeper knowledge of radiology will help them earn high marks and take better care of their patients. Such skills include recognizing basic but critical imaging findings, such as pneumothorax and pneumoperitoneum, and understanding which imaging examinations to order in different clinical situations. For example, what is the appropriate imaging study in patients with closed head trauma or new-onset seizures, and when should IV contrast material be used? Imaging is an integral part of contemporary medical practice, and medical school courses in radiology should focus more on how to use imaging studies to care for patients and less on how to interpret images.

Even when direct patient contact is not practical, students can get a feel for what radiologists do by preparing cases for reporting. Even two or three cases might keep a pair of medical students busy for several hours as they check previous diagnostic results, review the images, look up possible findings in books or in online resources, and attempt to formulate a report that includes the pertinent findings and an appropriate differential diagnosis. Some students may find such experiences so challenging and rewarding that they choose to pursue radiology as a career. Even those who do not go into radiology may acquire a new level of understanding and respect for radiology, improving the quality of their liaisons with radiology and radiologists for years to come.

Conclusion

The reasons are numerous to enhance the experiences of medical students in radiology courses. Such improvements can enhance the department's teaching reputation, help faculty members find more fulfillment in their academic careers, lure top-notch students into the field, and improve the respect for radiology of future referring physicians. To achieve such objectives, however, radiology departments must make a commitment to medical student education, even if it does not increase departmental revenues or generate as much revenue as clinical activity [5]. Through the judicious use of new educational technology and careful planning of the curriculum, the evaluation process, and teacher scheduling, the costs of improving medical student education can be minimized. The overarching goal of educational reform should be to transform medical students from passive observers to active participants whose contributions are both welcomed and appreciated.

References

1. Gunderman RB, Siddiqui AR, Heitkamp DE, Kipfer HD. The vital role of radiology in the medical student curriculum. *AJR* 2003;180:1239–1242
2. Gunderman RB. Why do some people succeed where others fail? implications for education. *Radiology* 2003;226:29–31
3. Wood BP. Feedback: a key feature of medical training. *Radiology* 2000;215:17–19
4. Afaq A, McCall J. Improving undergraduate education in radiology. *Acad Radiol* 2002;9:221–223
5. Gunderman RB. The fight for education. *AJR* 2001;176:23–26