Managing Clinical Education Through Understanding Key Principles

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Background  Traditionally, a practicum facilitated the integration of on-campus learning and practical workplace training. Over the past 3 decades, an educative practicum has evolved that promotes clinical reasoning, including analytical and evaluative abilities, through reflective practice. Anecdotal evidence indicates that the delivery of clinical education within medical radiation science entry-level programs continues to vacillate between traditional practicums and the new reflective practicums.

Purpose  To review the literature about clinical education within the medical radiation sciences and identify key principles for practitioners seeking to reflect upon and improve their approach to teaching and supporting students in the clinical environment.

Methods  A search of 3 major journal databases, Internet searches, and hand searches of reference lists were conducted to identify literature about clinical education in the medical radiation sciences from January 1, 2000, to December 31, 2012. Twenty-two studies were included in this review.

Results  The 5 key elements associated with clinical education include the clinical support model and quality, overcoming the theory-practice gap, learning outcomes and reliable and valid assessment, preparing and supporting students, and accommodating differing teaching and learning needs.

Discussion  Many factors influence the quality of clinical education, including the culture of the clinical environment and clinical leadership roles. Several approaches can help students bridge the theory-practice gap, including simulators, role-playing activities, and reflective journals. In addition, clinical educators should use assessment strategies that objectively measure student progress, and they should be positive role models for their students.

Conclusion  The successful clinical education of students in the medical radiation sciences depends upon the systems, structures, and people in the clinical environment. Clinical education is accomplished through the collaborative efforts of the clinical practitioner, the academic, and the student. Universities should include introductory material on clinical learning and teaching in their radiologic science curriculum.

Working with people cannot be learned solely from textbooks and in classrooms and laboratories. Clinical judgement and acuity can only be learned in the field, and that means with real people.

Christopher Moorhouse

As the use of technology in education increases, clinical education might be one of the few learning opportunities that offers students face-to-face interaction with patients, peers, and educators and facilitates professional socialization. Learning in the clinical environment is different from traditional college-based learning. Radiologic technologists work in complex sociotechnical environments that typically involve radiation risk, and they often work with critically ill patients. Professional learning is further complicated because of rapidly evolving techniques and technologies. Dreyfus and Dreyfus, the authors of *A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition* (later adapted to nursing by Benner), and...
Schön, author of *The Reflective Practitioner Model*, are the major theorists whose works now scaffold traditional clinical education.

Feedback from students indicates a need to further strengthen the approaches to clinical education, including technologists gaining a greater appreciation for the challenges of bridging the theory-practice gap.

Recognition of this need has resulted in more robust educational practices in the clinical setting with an emphasis on competency-based outcomes to ensure that “situated learning” is maximized. Nevertheless, in contrast to nursing, which typically requires the university to employ clinically based faculty in the workplace, the development of entry-level clinical skills in the radiologic sciences is largely a shared responsibility between academics and practitioners. Radiologic technologists’ peers and employers expect them to participate in clinical teaching. However, many teach without receiving formal training in educational theories even though many of these educational strategies are widely recommended as ways to improve student learning and enhance the student experience.

This article reviews the literature about clinical education within the radiologic sciences to establish the current research in this complex and dynamic field. Further, this article aims to identify key principles for radiologic technologists seeking to reflect on and improve their approach to teaching and supporting students in the clinical environment.

The term clinical educator is used to refer to practitioners directly involved in the education of students in the clinical context. The term medical radiation sciences is used to refer to the disciplines of radiography, radiation therapy, and nuclear medicine technology. This review focuses on the clinical education of radiographers and radiation therapists, and for the purpose of this article, the term medical radiation practitioners refers to those working clinically in those practices.

**Methods**

A keyword search of the PubMed, CINAHL, and ERIC International databases was conducted in January 2013 using the terms clinical education AND radiography and clinical education AND radiotherapy. Using the CINAHL database, the keyword search was expanded to related terms. Articles from January 1, 2000, to December 31, 2012, were retrieved. The search was limited to original articles published in the English language.

A Google Scholar search also was conducted to identify additional articles. To increase the likelihood of identifying all relevant studies, the reference lists of retrieved articles were hand-searched. Several radiography and radiation therapy journals are not indexed, so searching also was conducted within specific journals targeted for their medical radiation science content (eg, Radiographer). Twenty-two articles reporting on original research were retrieved and reviewed to determine the current research on clinical education in the medical radiation sciences and to identify key points for practice.

**Results**

The 22 summarized studies are grouped according to the key element associated with each clinical education undertaking. These key elements are:

- The clinical support model and quality of clinical teaching and supervision.
- Overcoming the theory-practice gap.
- Learning outcomes and reliable and valid assessment.
- Preparing and supporting students.
- Accommodating differing teaching and learning needs.

**The Clinical Support Model and Quality of Clinical Teaching and Supervision**

One large study evaluated stakeholders’ views about the factors affecting the quality of and capacity to provide clinical education and training in diagnostic imaging and radiation therapy departments in the United Kingdom. Using a nominal group technique with representation of stakeholders from 8 regions of the United Kingdom, 131 factors were generated. One stated advantage of this methodology was that it provides information about the typical issues faced by the stakeholders on a day-to-day basis. The 131 factors affecting quality and capacity were analyzed, and 5 major categories were derived:
Teaching and learning – learning strategies, quality assurance, management and organization, and motivation.

- Staff attitude.
- Resources – staff, learning resources, and finances.
- Conflicting roles and responsibilities.
- Other factors – external influences, funding authority, communication, and student issues.

One factor—staff attitude, which included motivation and commitment to learners—was the most important factor identified by all 8 groups. Difficulties here were related to organizational factors such as poor employer support for staff, poor job satisfaction, and a lack of incentives (e.g., no student training allowance). The authors concluded that their study provided credible data, in order of importance, about the issues faced daily by practitioners and learners.

Doughty and Hodgson identified 4 clinical support models that included the following roles:

- Teachers – with clinical responsibility.
- Clinical staff – with teaching responsibility.
- Supernumerary employees – clinically based instructors with no clinical workload.
- Joint appointments – those employed both by the clinical organization and the educational institution.

The authors investigated 2 support models used concurrently by one educational institution. On the basis that the roles were driven by the individual, the study elicited the perceptions of individuals (*n* = 9) in either of 2 specific clinical support roles (a joint appointment termed *professional development facilitators* [*n* = 4], or a faculty position with the educational institute termed *link tutors* [*n* = 5]). These individuals were asked about the scope, practice, and value of their roles. Although these roles were reported as being similar, the professional development facilitators identified a wider range of tasks associated with their role than those identified by the link tutor. The study was not designed to determine which role, if any, had a greater effect on the student clinical experience.

Palmer and Naccarato surveyed medical radiation science students and staff to investigate their opinions about the characteristics of good clinical teaching. They defined discrete clinical teaching characteristics within 5 main categories: clinical competence, teaching approach, personality traits, evaluation methods, and interpersonal relationships based on the Nursing Clinical Teacher Effectiveness Inventory. The authors identified similarities between students and staff in rating the importance of clinical competence. Both groups identified characteristics within the category of clinical competence as being in their respective top 10 characteristics. Characteristics in evaluation were rated high by students but low by clinical educators. The relative importance of specific teaching characteristics changed as the students progressed through their program, particularly in relation to evaluation and socialization.

One article described the development of an audit process for a radiography program in the United Kingdom. Price et al developed an audit process to evaluate clinical education in undergraduate radiography against identified standards and criteria that evolved from a framework of generic quality measures. The audit included:

- Evaluating and monitoring students’ experience and satisfaction with the clinical education component of the program.
- Evaluating and monitoring the satisfaction of the clinical staff in regard to the clinical education component of the program.
- Updating information about clinical sites.

The authors found that all sites had the necessary facilities to deliver the clinical curriculum. They concluded that the audit tool was a useful and objective measure of standards. From the student perspective of quality, the culture of the clinical department and the effectiveness of the clinical lecturer within the department were pivotal.

Overcoming the Theory-Practice Gap

Liang et al investigated the perceptions of 23 newly qualified radiographers regarding their preparedness for clinical practice and compared them with the Australian Institute of Radiography standards of knowledge, skills, and values. Through cluster sampling, 53 participants were contacted across 9 public hospitals and 9 private practices within the Sydney, Australia, metropolitan area, and 23 (43%) of those who were
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Contacted completed a questionnaire. All participants agreed or strongly agreed with positive statements of ability (self-assessed) across categories of professional attributes, communication skills, patient care skills, and clinical skills. More role playing in the university curriculum was suggested as a possible improvement, and some difficulties were reported regarding a lack of standardization across the professional development year. The Australian professional development year is a requirement for all graduates from 3-year undergraduate degree programs and graduate entry programs that lack an embedded period of supervised practice.

This lack of standardization across the professional development year was one motivation for the study by Beldham-Collins and Milinkovic, who evaluated learning in the clinical environment during the post-graduation compulsory professional development year. A focus group of graduate practitioners (n = 5) was conducted. This qualitative research included questions about the teaching and learning strategies used in the radiation therapy program. The authors found that a combination of didactic and experiential, learner-centered methods was important. The graduate practitioners reported a desire to develop a deeper understanding of techniques and emphasized that they needed differing amounts of didactic input and guidance depending on the subject matter to gain that understanding. Transfer of learning was assisted by journal writing and feedback forms. Major factors reported to affect the success of the program were time, use of small groups, sequential teaching (ie, from introductory information, to simulation, then planning, to more complex techniques), involvement of facilitators, and department support.

Chapman and Oultram described a comprehensive program to support undergraduate medical radiation science students and to help bridge the theory-practice gap. This program included adapting the undergraduate program to student learning using needs assessments, learning contracts, and additional specialized tutorials and implementing an orientation program and preceptors to facilitate learning in the clinical environment.

Reed described a longitudinal review of a new clinical assessment tool called student initiated clinical activities designed to be authentic and relevant to radiography practice. The assessment tool encourages self-directed learning by providing students with choices of assessment topics, their sequencing and timing, and using negotiation and reflection. The authors surveyed radiography students in their first year of school and the same students when they reached their third year. There was a 100% response rate to the questionnaire from 101 first-year students and 92 third-year students. Overall, the assessment was positively reviewed, with strengths and weaknesses identified. Students suggested improvements, which included creating new alternative clinical activities to choose from as students progressed and better communication with the clinical departments to familiarize clinical staff with the new assessment tool.

Tan examined radiation therapy students’ perceptions of a lecturer’s clinical credibility. Fifteen out of 16 students completed an online survey following a workshop run by a clinical specialist radiation therapist. All viewed the clinical specialist as being clinically credible and believed the specialist added value to the content. All agreed the learning experience would be different with a nonclinical lecturer, although the study was not designed to evaluate this objectively. The author suggested that clinical staff could have greater involvement in the academic component because students view current clinical experience as “important and relevant, impacting their perception of clinical credibility in the lecturer.”

**Learning Outcomes and Reliable and Valid Assessment**

A team of academic and clinical staff researched a new clinical teaching, learning, and assessment strategy for radiation therapy and diagnostic imaging undergraduates. The team defined outcome-based competencies at 3 major levels with corresponding stages and recommended time frames stated within them. Subgroups of the team developed profession-specific outcomes. Supportive strategies such as training for clinical assessors and liaison lecturers for students and staff also were used to advance students’ learning. Chianese and Channon found that this teaching, learning, and assessment strategy identified students who were not achieving the competencies at an early stage.
of the program. Following training, clinical appraisers acted as effective gatekeepers to student progression. Staff and students highly rated a continuous assessment strategy. The report authors also believed the action research process had led to co-ownership of the strategy, which motivated clinical staff to continue with the strategy despite the extra time commitment.46

Ng et al aimed to establish a method of monitoring students’ progress toward and ability to meet both academic and professional competencies throughout a radiography program.47 The authors surveyed academic staff and students in Hong Kong and found differences in the perceptions of staff compared with students’ perceptions regarding the speed of students’ progression. Staff expected students to acquire more competence during the first half of the program, while students reported that competence was developed at a steady pace throughout the program. The authors also surveyed radiography institutions in the United Kingdom, Australia, and New Zealand. Ten out of 35 educational institutions responded to the survey, and a range of assessment strategies for academic and clinical competence was reported; 8 out of 10 institutions had an arrangement for the assurance of integration of theory and practice, in either the clinical or academic assessment strategies.

Clinical assessors’ own experiences as students might affect their ability to assess students objectively. Belinsky and Tataronis surveyed a random sample of 400 radiation therapists in the United States and Canada to determine whether clinical educators’ experiences as students affected how they evaluated students in the clinical setting.48 A total of 167 responses were received, and 85 respondents were radiation therapists involved in clinical education. Results demonstrated a statistically significant relationship between radiation therapists’ positive clinical experiences as a student and their positive attitudes toward the clinical evaluation of current students.48

Leech et al described a method to assess clinical understanding at an early level in the radiation therapy education program through oral examination in an academic setting. Panels of 3 assessors consisted of at least one academic educator and one clinical educator, with one additional academic observer rotating through the panels to ensure consistency in examination and evaluation across the assessing panels. Assessment interviews were based on a structured tool and audiotaped. Although the authors recognized the fundamental mismatch between method of delivery and method of assessment (ie, the oral assessment aimed to evaluate clinical knowledge, skills, and attitudes), they observed advantages of this method, including consistency and quality control and collaboration between clinical and academic staff.49

Preparing and Supporting Students

Halkett et al introduced and evaluated a short program about communication skills and taking patient histories to inform and support third-year undergraduate students upon clinical placement.50 The authors conducted 3 workshops, one of which included role-playing with actors. Twenty-seven of 36 students completed questionnaires before the workshops, following the workshops, and after clinical placement. Students’ confidence levels in communicating with patients were statistically significantly different for 7 items after they participated in the workshops and after their clinical placement. Components of the workshops reported as enhancing a student’s entry into the clinical placement were feedback from the actor/patient and facilitator and the role-play.50

However, students might be confronted by more basic obstacles during their time of clinical placement. A small U.S. study used questionnaires and group discussion to assess the influence of an educational intervention on the knowledge, attitude, behavior, and intention of radiation therapy students to use safe patient handling and movement during their initial clinical education experience. The authors found that although students’ patient-handling knowledge improved following the educational intervention, their overall knowledge of, attitude toward, and intention to use safe patient handling and movement did not change. Students perceived several barriers to safe patient handling and movement in clinical practice, including that the recommended practices were not routinely used by clinical staff, resistance to change, and their role as students.51

Dungey investigated the personal development of radiation therapy students as a result of treating cancer
patients. Twenty-one out of 30 young adult second-year radiation therapy students completed an open-ended questionnaire. Four themes were identified:

- Concern for family and friends.
- Emotional aspects of treating cancer patients.
- The feeling of a sense of pride in their profession.
- A development of a greater awareness of themselves as individuals.

The author determined these students were developing a new set of values, beliefs, and goals partly as a result of their contact with cancer patients. Some students had found a “strong sense of who they are as an individual with a sense of identity,” while others would “actively struggle for a sense of who they are as a person as they searched for ways to cope.” The author suggested that the latter group of students needed support to develop appropriate coping mechanisms to participate fully in the clinical environment as students and later as radiation therapists.

Williams and Decker used one-on-one interviews to explore the experiences of all final-year mature students (aged at least 21 years when beginning the program; n = 12) enrolled in a diagnostic radiography program at a university in the United Kingdom. They found that although mature students were highly motivated, they experienced difficulty balancing clinical and academic workloads and home life. They felt their maturity was of assistance to them in the clinical environment; however, some sacrificed other aspects of their lives to complete the program and often did not seek support. The authors recommended that mature students should be “forewarned and forearmed” about the demands of the program, and that a “24/7 peer support environment” would be valuable; however, the practicalities of providing and moderating such an environment were not discussed.

Two studies reported on students who have additional challenges in the clinical environment. Murphy surveyed students to explore the clinical experiences of radiography students with dyslexia and its potential effect on their practice. A response rate of 31% (n = 37) was achieved by their postal questionnaire of a sample of U.K. radiography students. Using a self-reporting scale of clinical tasks, they found “little or no difference” between students with dyslexia and students without dyslexia. They also conducted interviews with 10 student radiographers, 8 of whom have dyslexia. The interviews revealed 6 distinct themes:

- Visualization of the disability.
- Self-protection.
- Strengths and talents.
- Time.
- How the label of disability affects other’s perceptions of the individual.
- Adjustments and support.

The students with dyslexia took extra responsibility for their own learning, were very aware of the potential for mistakes, particularly with fatigue, and some had developed complex coping strategies to overcome difficulties. The authors made recommendations, including providing course materials electronically in a standard format, using a portable media player (ie, an Apple iPod) as a resource, adding time to conduct tasks, offering one-on-one support for specific tasks, and introducing regular breaks to reduce fatigue.

Bolderston et al explored the clinical environment experiences of undergraduate radiation therapy students for whom English is a second language, as well as the experiences of staff members who teach these students through a qualitative study using focus groups of these 2 cohorts. Six students were included in one focus group, and 5 staff members or clinical coordinators were in the other. Major issues identified were categorized into 3 themes of “communication,” “differences,” and “dealing with it…” The authors made a number of recommendations: to allow extra time, assist with improving English proficiency, use the expertise of the institution’s staff, improve confidence, provide social support, build respect and trust, use different learning approaches, and ensure the message is clear.

Accommodating Differing Teaching and Learning Needs

Ward and Makela identified 3 types of clinical learning styles among 349 radiography students, using a single self-report questionnaire completed by students with a minimum of 30 hours of clinical experience. The respondents were from 38 programs in the United States and Puerto Rico. The clinical learning styles identified were:
- Task-oriented – prefers to test ideas and draw on intuition and feelings during clinical learning situations.
- Purposeful – prefers to plan, actively integrate theory and practice, focus on results, and trust in theoretical concepts.
- Tentative – prefers more prescriptive and result-oriented clinical learning experiences and moderation in other learning style elements.

Although the students in general integrated theory and practice, those with a purposeful learning style were significantly more likely to do so. Statistically significant differences were observed for sex, age, and level in the program among the 3 groups of common learning styles.

Cottrell observed differences based on the students’ year in the program and explored learning and teaching themes embedded within second-year and third-year reflective journals from one Australian radiation therapy university program. The 3 most common issues identified by the second-year students were technical skills, communication, and environment, whereas the 3 most common issues identified by the third-year students were knowledge, technical skills, and professional development. The author stated that these themes are linked to the students’ stage of development and experience in academic knowledge and clinical practice. The students’ confidence differed also, and “the impact of staff comments, both negative and positive, were shown to have a direct effect upon confidence and motivation to learn within the clinical environment.”

Professionalism was identified as a major underlying theme for all students, including interactions with and between staff, staff and patients, or other students, and students’ own growing professional identity.

Professionalism also was a theme of a Conway et al study about role models. The authors recruited 13 final-year radiography students to complete semistructured, 1-hour interviews covering 3 major topics: the ideal traits of role models, the student’s perception of role models seen while on clinical placement, and the future direction of role models within radiography. Thematic saturation was reached with 13 students, which means that no new themes arise after analyzing the interviews, and no further participants were required. Key concepts identified were approachability of the radiographer; communication, clinical knowledge, technical, and patient care skills of the radiographer; radiographers with a negative work ethic; radiographers who were student focused; radiographers who were capable of sharing experiences and including students in direct patient contact; and the clinical setting at which the radiographer worked (public or private).

The authors noted that “when the students spoke of radiographers as role models, they spoke of their learning experiences as a whole and the development of their selection of role models.” They theorized that students chose a role model who was naturally appropriate for the stage of learning that he or she had achieved, and they suggested that the process of selecting role models changes as students move into their careers.

The articles previously summarized are original studies published in peer-reviewed journals. Additional literature contains guidelines and recommendations published by professional bodies and other organizations regarding clinical education in the medical radiation sciences.

**Discussion**

Preparing students to become medical radiation professionals is a multifaceted process; clinical education is a core component that interconnects with the academic component and enhances students’ personal and professional development. The organizational culture in which clinical education occurs also is likely to be of significance. Some of the major relationships and knowledge flow in relation to the education of medical radiation professionals is illustrated in the Figure.

Although much of the research in this area does not yield strong evidence for generalization to all clinical settings within which students are placed, the scope and methods of the research as a whole is intriguing and is discussed according to the 5 elements identified in the results section.

**The Clinical Support Model and Quality of Clinical Teaching and Supervision**

Little detailed information is available on the organizational structure of clinical education. Some observations are made regarding the overall organizational
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Providing quality clinical experiences for every student is an expectation of stakeholders, but the reality of managing this in the unpredictable clinical environment and possibly with limited resources poses a major challenge for clinical coordinators and supervisors. Various factors that can influence the quality of clinical education include:

- Approaches to teaching and learning.\(^{27,29,60}\)
- Attitudes of clinical staff.\(^{29,61}\)
- Resources,\(^{29}\) including the quality of the staff’s clinical experience.\(^{50}\)
- An individual’s clinical competence.\(^{28}\)
- Conflicting roles and responsibilities between clinical and educational workloads.\(^{29,50}\)

In addition, students can experience workplaces differently, depending on their personality and learning styles.\(^{62}\) Chianese and Channon and Coffey et al recommended that students be exposed to a variety of experiences and clinical sites so that they might become flexible and adaptable practitioners upon graduation.\(^{9,46}\)

Apart from differences in infrastructure, procedures, and processes between clinical institutions, cultural differences also are reported between the patient demographic\(^{42}\) and patient care\(^{55}\) in public and private institutions. The culture of the clinical department and clinical leadership roles appear to be significant factors that affect the student’s experience of clinical education.\(^{41,63}\)

In a review of the characteristics of leadership that influence clinical learning in nursing, the role of the unit manager was identified as “integral in developing the capacity of nursing staff to enhance the learning environment for students.”\(^{63}\) Differences in the perceived influence and scope of practice of professionals in clinical support roles have been identified in separate clinical support models used concurrently by the same educational institution.\(^{39}\)

Currently in Australia, university lecturers are responsible for clinical support, typically with limited

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**Figure.** Major relationships and knowledge flow in relation to education of medical radiation professionals. Image courtesy of the authors.
resources. At Monash University in Melbourne, staff are designated to undertake clinical visits while students are in clinical instruction. This typically occurs usually once a semester unless there are extenuating circumstances and additional support for students or clinical staff is required to address unexpected issues. The university relies upon a close working relationship with each clinical organization and trusts that the clinical staff supervising the students will provide a suitable environment to maximize learning.

To facilitate this relationship, the Faculty of Medicine, Nursing and Health Sciences and the Department of Medical Imaging and Radiation Sciences at Monash University provides online resources and face-to-face workshops to develop the teaching skills of the staff at all the affiliated clinical centers. These online resources consist of a self-directed learning package titled “Supporting Students Through Clinical-Based Learning” and “Clinical Guidelines for Radiographers.”

Similarly, in Ireland workshops about clinical education, involvement of clinical staff in planning the clinical program, and strong cooperation between academic staff and clinical staff assist in improving the quality of clinical education in radiation therapy in the absence of dedicated personnel. A clear need remains for specific roles in liaison and leadership in clinical education.

Lekkas et al provided a useful distillation of the various clinical education models in use today. They concluded that there is no gold standard of clinical education. It is impossible to determine which model is applicable given the complex settings within which clinical education is delivered. Moreover, they determined that the precise effect of student placements upon workplace productivity is unclear. Nevertheless, they agreed that the planning and preparation of clinical education is critical regardless of the model of education used.

**Overcoming the Theory-Practice Gap**

Clinical placements provide the opportunity to integrate theory and practice; however, the difficulty students face in applying their acquired academic knowledge to their own clinical practice (ie, a theory-practice gap) is commonly recognized in the literature. In the literature reviewed, this problem is considered from the student’s or new graduate’s perspective and examines measures introduced by academic or clinical faculty trying to bridge the gap. The clinical scenario is reported to sometimes hinder a student’s ability to practice the theory learned. For example, 2 studies illustrate that best practice in manual handling of patients during preparation and treatment by radiation therapists occasionally is not modeled or encouraged in the clinical environment.

Approaches to bridging the theory-practice gap include:

- Clinical simulators
- Skills labs and role-playing
- Reflective diaries, journals, and practice
- Case-based learning
- Task-based learning
- A combination of needs assessments, learning contracts, and additional specialized tutorials
- Instruction by clinical educators with formal training in education
- Alignment of anticipated learning in practice with the curricula

Students place a high value on learning from individuals with clinical experience and who exhibit good clinical decision-making skills; to be perceived as valid teachers and role models, academic staff might spend some of their time in clinical duties or participate in a regular clinical rotation.

Well-designed assessments might provide motivation for students to integrate theory and practice. Students with a purposeful learning style were more likely to integrate theory and practice. However, the clinical educator likely plays a significant role in facilitating—or even promoting—this integration for all students.

Perhaps we can aspire to an educational environment in which a continuous theory-practice spiral replaces the theory-practice gap, to paraphrase Dewey. This would involve a continuous interrogation of understanding and realignment and integration of knowledge and practical skills in an iterative and concurrent cycle of action and reflection with experiential learning and role modeling as core components. This type of environment could eventually lead to the subconscious integration of key knowledge, skills, and attitudes and a progression toward expert practitioners.
Learning Outcomes and Reliable and Valid Assessment

Assessment and feedback influence student learning. A variety of clinical assessment styles are reported in clinical and academic environments.

It is well established that assessment should match the teaching method and the learning expected; Biggs called this constructive alignment. Therefore, practical assessment should be based in a clinical environment, although it is suggested that a hybrid virtual environment or role-playing might create this setting to a satisfactory level in the academic environment. Various approaches to clinical assessment are evident. The U.K.–based Society of Radiographers described the aims of a robust assessment, and Kilgour reviewed the strengths and weaknesses of assessment strategies in the context of radiography clinical education.

Ensuring identical clinical experiences for all students in unpredictable clinical settings is impossible; however, designing and implementing reliable and valid assessment strategies is one way to ensure equitable experiences. Assessment must reliably and fairly measure competence. Clinical educators should understand the limitations of assessment tools and recognize that the best approach is to use a combination of tools. A common problem faced by clinical educators is facilitating and evaluating students from different programs with different assessment tools and strategies. Australia has implemented a national initiative to facilitate the assessment process and to align assessment with the criteria described by the Australian Institute of Radiography’s Competency Based Standards for the Accredited Practitioner. A student clinical assessment form was developed for radiation therapy and is being investigated for radiography. Training clinical educators to assess and provide feedback to students is necessary, and the rollout of the student clinical assessment form included a multimedia and on-site training package for clinical educators. Regular evaluation of the package through practitioner surveys ensures that the form is updated and remains an effective tool.

Formative and summative assessment strategies are commonly used. Regular formal and informal feedback also is important throughout the clinical experience so students become aware of their strengths and weaknesses. Direct observation of students is important, and clinical educators should provide positive and negative feedback where appropriate based on observed behaviors. Well-managed feedback promotes self-reflection and self-assessment—valuable traits for lifelong learning. One such formative approach is negotiated statements in which “records of students’ weekly discussions with appraisers are documented in partnership and used to devise action plans for the following weeks.” Constructive feedback leads to students’ increased satisfaction with clinical placements and the quality of supervision they receive. In addition, feedback from students helps improve clinical assessment. Students also should provide constructive feedback to clinical educators about their supervisory strengths and weaknesses.

One difficulty for clinical educators is recognizing and assisting failing students, but early assessment can identify students who are at risk of failing. Although it can be personally difficult, clinical educators have a responsibility to students, patients, and to the profession to provide constructive feedback to students, to act as effective gatekeepers to progression, and to facilitate students’ development.

Descriptors of competence exist, and the importance of recognizing and assisting a failing student at an early stage is emphasized, but no specific descriptors on what constitutes the failing student are available. This gap is recognized in radiation therapy, albeit with room for improvement, as evidenced in a 2011 publication on fitness to practice.

The Role of the Clinical Educator

For the purposes of this discussion, the elements preparing and supporting students and accommodating differing teaching and learning needs are combined under 2 main headings: the role of the clinical educator and student learners.

Some have criticized clinical education in radiography for being too task-oriented and not sufficiently student-oriented as well as not promoting problem solving or reflective practice. Historically, the most widely used approach by clinical educators in the medical radiation sciences was the traditional didactic approach. However, the advent of papers on reflective practices at
the undergraduate level together with formal education for clinical educators in educational theory and practice suggests a paradigm shift is occurring. It can be difficult for clinical educators to balance their clinical workload with student education and support, and students have reported suboptimal supervision. A further challenge for educators is making sure their own experiences as a student, whether positive or negative, do not influence the objective evaluation of the current generation of students. Finally, clinical educators should be facilitators of reflective learning so that theory and practice can be integrated.

Kilminster and Jolly conducted a review on effective supervision in clinical practice settings and concluded that “the quality of the relationship between supervisor and trainee is probably the single most important factor for effective supervision.” Williams and Webb reported their findings on the competencies required by clinical supervisors in radiography under 3 main categories: teaching skills and techniques, interpersonal style, and professional competence. The authors found that radiography students valued clinical educators who encouraged personal growth and whose interpersonal styles positively “affected their self-confidence, anxiety, and the acquisition of new skills.” These students also appreciated good role modeling.

Ward and Makela’s study demonstrated that no matter which clinical learning style students had, all students seemed to have a preference for structure over improvisation, and the authors recommended that:

Educational interventions that encourage planning and focus on desired results and use of theory as a guide may improve the integration of foundational knowledge taught in the classroom with skills learned during clinical practice.

Complementary to the findings of Palmer and Naccarato are reported changes in the clinical educator’s approach to teaching as students progress through the program (ie, from a pedagogical and teacher-centered facilitative approach to an andragogical, adult learner-centered approach). Three functions of supervision—management, education, and support—are commonly recognized in the clinical education literature. Kilminster et al provide a framework for effective supervision in postgraduate medical education, which has many points of relevance for the medical radiation sciences.

Clinical educators should be actively involved in the design of the clinical education program. Many recommend that all staff should participate in clinical education. Formal feedback from representatives of the clinical organizations that provide placements to students, perhaps through participation in course management and course advisory board meetings, would be beneficial.

Each student and clinical educator must clearly understand the learning objectives; these can be encapsulated in a learning contract and revised as appropriate. Learning objectives also can provide instructors a reference for assessment and feedback.

Instruction within the clinical environment must be undertaken sensitively, being mindful of any patients or visitors present. Learning opportunities can be identified by the student—prompted by a reflective process—or by the clinical educator. If role modeling is a significant factor in student learning, as reported by Walker et al, then all staff are inherently involved in clinical education, and an emphasis on positive role modeling by all staff might be conducive to an excellent learning environment.

Student Learners

A recognized limitation of the didactic approach is that students are encouraged to be passive learners. This is not consistent with best practices in adult education, where student involvement and empowerment are fundamental, nor is it likely to lead to good practice in lifelong learning.

Students might enter the medical radiation sciences as undergraduates or graduates with different learning approaches and priorities (ie, students’ own life experiences will influence their learning). People exhibit different learning styles and might use various learning strategies at different stages in their education. Sometimes, learning strategies can be profoundly influenced by the educator’s assessment strategies. In addition, students in the clinical environment might be balancing their clinical workload with their academic workload, and they might be dealing with intrinsic
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Peer Review

Factors such as dyslexia, responsibilities, cultural factors, or experiences and emotions. However, students can benefit from assistance in developing coping strategies to deal with stressors and emotions.

It is well established that a “deep” learning style is necessary for understanding and is essential to bridging the theory-practice gap. A major factor in deep learning and critical thinking is the ability to organize information for comprehension and investigation; this skill can be assisted by well-structured teaching with clear learning objectives combined with reflection. In the medical radiation sciences, deeper learning can be encouraged by ensuring students have a range of experiences and environments that challenge their knowledge, skills, and attitudes and require the development of problem-solving skills. However, for each new environment the student encounters, he or she can regress to being a “novice,” and this can “shake their confidence . . . [and] lead to de-motivation.” These situations should be managed by ensuring that students are comfortable with the new environment before challenging them further.

Reflective practice is important but is not sufficient in itself; supervisors must provide feedback. Cottrell reported on the most common issues experienced by student radiation therapists through an exploration of the content of their reflective journals. The author noted that students at an earlier stage were more focused on the technology and integrating with the professional team, while those nearing qualification were more confident about their technical abilities as well as their professional communication with their colleagues and patients. This bodes well for a model of peer-assisted learning in which students with practical skills teach students at an earlier stage in the program, leading to the more experienced students having “increased self-concept, heightened communication and mentoring skills and self-knowledge.”

Another study similarly noted that students reported benefitting from additional education about communication skills more than midway through their program. A module consisting of workshops on communication and history-taking was delivered during the third year of a 4-year program in which the first 2 years were mostly theory-based with some clinical experience, and the final 2 years had a greater clinical component. The optimal timing of this module remains to be seen, and the question is whether the majority of students at an earlier stage in the program will be prepared to focus on communication, which is a more professional subject than a technical one.

A similar trend away from focusing on technical skills and to adopting a more holistic approach was noted in a study on role models in radiography. Role models are a significant part of clinical education, particularly in terms of professional socialization. However, there is conflicting evidence about the benefit of students’ adoption of role models in medical radiation science clinical education.

In one study, although the qualities of role modeling as a health care professional and as a clinical educator were rated highly by the clinical educators, the students did not rate role modeling highly. The authors suggest the advanced stage of the students’ education as a possible explanation. Moreover, it also could be argued that the term health care professional would not be rated as highly by these students as medical radiation professional. Another explanation is that because medical radiation professionals often work as a team, students construct an ideal role model by selecting particular traits from different individuals.

Students value medical radiation professionals who are patient focused and provide excellent patient care. The literature seems to agree that medical radiation science students select role models from among clinical rather than academic educators. Similarly, one small study suggested that students rate the validity of academic teaching by a clinician higher than that of their academic lecturers. The notion that students value learning more from clinical educators also was found in interviews with final-year radiography students and previously was observed by Rosie and Murray, who argued that perhaps clinical educators should have the main responsibility for linking theory and practice.

Nevertheless, the literature does not support a return to a traditional practicum. Rather, over the past 30 years an educative practicum has evolved within medical radiation sciences promoting clinical reasoning, including analytical and evaluative abilities, through reflective practice. This means a partnership between stakeholders in the enterprise is essential.
Conclusion

In keeping with other health professions, graduates entering the medical radiation science workforce are expected to practice as autonomous health care professionals. Given the rapid turnover of techniques and technologies in today’s clinical practice, practitioners must possess transferable skills and the cognitive ability to update their knowledge base. Principles are what matter now, rather than prescriptions of practice methods that could soon be redundant. A clinical practicum involves numerous variables; nonetheless, at its most rudimentary level, successful education of students in the medical radiation sciences depends upon the systems, structures, and people in place, and education should be a joint undertaking among the clinical practitioner, academic educator, and student.

Seven key principles that underpin a consistent quality clinical experience are derived from the literature. These encompass collaboration between academic and clinical educators, formal training in education for clinical educators, establishing a good student-supervisor relationship, facilitating learning, implementing reliable and valid assessments, and regularly auditing the clinical education program (see Box.)

A cursory examination of Web sites of universities offering undergraduate programs in medical radiation sciences demonstrates that a genuine effort is being made to increase practitioners’ skills in relation to the management and delivery of effective clinical education (eg, the Advancing Clinical Education programs at Monash University, La Trobe University, and Deakin University in Australia). However, although it is recognized that practitioners who are well-prepared for their roles as clinical educators can enhance a student’s learning and professional socialization, it appears that medical radiation professionals are generally ill-equipped for roles as clinical educators. Arguably a greater effort should be made by universities to include an introductory series of lectures dealing with clinical learning and teaching principles within their medical radiation science curriculum.

Learning in the clinical setting does not end with the acquisition of a basic qualification. As students, practitioners should develop skills and attitudes to facilitate lifelong learning. Academic and clinical educators need to equip today’s students with a strong foundation to further expand and extend the profession throughout their careers and to contribute to the evidence base in the field of medical radiation sciences. Interdisciplinary learning is increasing, and in an environment in which a variety of skills, knowledge, and tasks must be coordinated, medical radiation professionals could be involved in the pre- and postgraduate education program with input from stakeholders is essential.

Box

7 Key Principles for a Practicum

- Planning and preparation of clinical education is critical regardless of the model of education used. Clinical educators should be involved in the design of the clinical education program where possible. The roles and responsibilities for clinical education should be clearly outlined, and clinical and academic educators should agree on them.

- Clinical educators should have formal training in education and be facilitators of reflective learning.

- Students and educators must develop good relationships with one another; the quality of this relationship is probably the single most important factor for effective supervision.

- The clinical environment can be challenging for students. In addition to professional development, students might also be undergoing considerable personal development.

- To become flexible and adaptable practitioners, students should be exposed to a wide variety of experiences encompassing various clinical sites.

- As students progress through stages of learning, they have different teaching and learning needs. Clear learning objectives should be articulated and understood by students and educators; these may be encapsulated in a learning contract, revised as appropriate, and be used as a reference for assessment and feedback. This is particularly important for students with a “tentative” learning style.

- Student learning and motivation are influenced by assessment and feedback. These should be designed to reduce the “theory-practice gap” and to promote lifelong learning. Assessment should incorporate formative and summative strategies, include a variety of tools, and be sufficiently reliable and valid. Clear expectations must be set, particularly in relation to the standard required to pass.

- A regular audit of the clinical education program with input from stakeholders is essential.
education of those in their own profession as well as other professions, placing increased and varied demands on clinical practitioners.

Every profession must strive to innovate and improve, and the research base on the complex topic of clinical education in the medical radiation sciences demonstrates that this profession is investigating and developing strategies that ultimately will lead to a more robust clinical experience for students.

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