An Integrated Curriculum in Medical Imaging 7

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7.1 Theory and Principle: Why an Integrated Curriculum in Medical Imaging

This chapter argues that a shift in educational practice is needed to adequately prepare practitioners for practice in medical imaging. Radiology is a rapidly changing, technology-driven field, requiring new forms of multidisciplinary practice. (Engel-Hills 2005) The content-based syllabus was effective as a guide for education programs that prepared novice practitioners to adapt their practice in a slowly changing environment. The challenge of professional education in this discipline today is to develop practitioners with entry-level competence for immediate practice and with the ability for continuous self-directed learning to deal with constant, rapid development. In the current environment, an integrated curriculum is an appropriate pedagogy to equip practitioners to enter this complex, changing workplace.

7.1.1 Definitions

The notion of an integrated curriculum is not a new idea. This form of teaching and learning has received much attention in educational settings at all levels. Lake's (Lake 2003) review article, although referring to the school curriculum from Kindergarten to grade 12, offers a useful overview of curricular integration. According to Lake (Lake 2003), there can be no single definition of an integrated curriculum, as one definition would not adequately describe the complex variations that are possible within the concept of integration. There are, therefore, many terms that relate to integration, including interdisciplinary, thematic, and synergistic teaching. Further, approaches such as community-based, problem-based, and guided discovery learning programs (Reser 2000) are also described as integrated. Thus, while these terms all describe different pedagogical approaches, they are all captured under the

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T. V. Van Deven et al. (eds.), *The Practice of Radiology Education,*
DOI: 10.1007/978-3-642-03234-9_7, © Springer Verlag Berlin Heidelberg 2010

educational approach of "integrated," and are introduced as educational innovations with the goal of fostering student-centered, active learning. (Moust et al. 2004) Through a process of considering definitions of integrated curriculum, Lake (Lake 2003) suggests that this approach prepares the learner for life and for lifelong learning because it is how, in addition to what we learn, that will impact on us as lifelong learners (Haslett 2001). The integrated curriculum can therefore be considered as a broad description of curriculum design that includes problem-based learning (Haslett 2001; McLean 2004), project-based learning (Markham et al. 2003), thematically organized learning (Lipson et al. 1993), work-integrated learning (Adamson et al. 1997), and learning communities (Gabelnick et al. 1990).

The college of medicine at the University of Vermont (UVM College of Medicine 2003) identified three important integrations in the medical education curriculum. The first is the integration of basic and clinical sciences, with the focus on the integration of concepts. This integration does not mean that the clinician or basic scientist has to teach the other's concepts, but rather that the design of the learning experience encourages conceptual integration in order to achieve the curricular goal of educating doctors with the skills and motivation to continually access basic science knowledge. The second integration concerns interdisciplinary teaching, as opposed to traditional discipline-based teaching. The third integration requires collaboration among healthcare practitioners.

7.1.2 Knowledge in Professional and Academic Contexts

The theoretical framework for this chapter is built on related sets of concepts developed by Bernstein (1996, 1999, 2000) for understanding knowledge in professional and academic contexts. These concepts are explained, and the relationship between them is considered with reference to curriculum development in the field of medical imaging.

Bernstein (1996, 1999, 2000) distinguishes between academic and professional knowledge, which he describes as "vertical" and "horizontal" knowledge respectively. Vertical knowledge is associated with traditional academic disciplines; it is abstract and theoretical. In scientific disciplines, such as physics or anatomy, vertical knowledge is hierarchically organized and each knowledge structure is "coherent, explicit, and systematically principled" (Bernstein 1999). Horizontal knowledge, the knowledge that develops through practice, is typified as "everyday, context dependent, tacit, multi-layered, often contradictory across contexts but not within contexts" (Bernstein 1996).

Vertical, disciplinary, academic knowledge is the basic "reservoir" (Bernstein 1999) that radiologists-in-training draw on as they develop a range of professional "repertoires" (Bernstein 1996). Academic medical imaging knowledge is difficult to relate directly to radiology practice because it is based on hierarchical, decontextualized, abstract knowledge about imaging, and not on contextualized elements of practice. When vertical knowledge is drawn on in practice, it exhibits many of the characteristics of horizontality, that is, it becomes "situated" in particular contexts and tasks. Professional practitioners are also able to draw on a collective reservoir of established practical strategies, or they develop new segments of practice which could, in turn, become contributions to the collective reservoir (Bernstein 1996, 1999). Such "circulation" between the academic and practical

domains extends the "reservoir" (the potential for practice of a particular community), and develops the "repertoires" of its individual members.

From the concepts developed thus far, we can construct a model of medical imaging knowledge as both vertical (in its academic form) and horizontal (in professional practice). All knowledge fields comprise elements of verticality and horizontality in different combinations. The interaction of both knowledge types will be necessary in designing a medical imaging curriculum that will both extend the disciplinary base of medical imaging and support its professional development.

Curricular arrangements are a function of the knowledge to be acquired; in professional programs there needs to be a coherent relationship between the knowledge to be acquired and its application. (Bernstein 1999) A metaphor that describes this concept is that of the "T-shaped" curriculum (European Science Foundation 2002) where the down-stroke represents a "reservoir" of disciplinary knowledge and the cross-stroke represents breadth and flexibility of competent professional "repertoires." What is important is that knowledge within a program is "integrated at the level of meaning" (Bernstein 1999).

Theorizing academic and professional knowledge provides insights and understandings that can contribute to effective curriculum design and implementation in medical imaging. The interpretation of the key aspects of integration will differ, as will the specifics of the environment, hence there are many ways in which to achieve a T-shaped curriculum.

7.2 Practical Issues

An education program in the health sciences is best offered through the collaboration of higher education and healthcare institutions, with a conferred qualification that acknowledges the expertise and knowledge needed for practice and leads to a license to practice. Integrative scholarship applied to radiology encourages a comprehensive understanding of clinical and academic components and promotes interpretative thinking and learning for practice in a changing environment. Hence, it is suggested that an appropriate education program is designed through the identification of outcomes as a foundation for a well-planned and delivered integrated curriculum (Harden 2001) provided that the curriculum that is described in terms of "outcomes" includes knowledge-based outcomes and value-based outcomes as well as competencies. This is an effective means to establish a fully functional and integrated team that collaboratively achieves a quality service for the attending patients.

The integrated curriculum with the elements of: (1) a design that combines the learning areas through a thematic organizing principle; (2) a plan to demonstrate the relationship between concepts, principles, and topics; (3) a structured but flexible schedule; (4) the use of small-group learning activities; (5) the use of a wide range of information resources; and (6) an emphasis on assignments and integrated assessment (Lake 2003), is able to achieve the development of competence in complex forms of practice. The range of strategies for integration can be applied to the entire curriculum, a single aspect of study within a curriculum or any module or part and can be delivered to small and large student groups (DiPasquale et al. 2003; Bebb and Pittam 2004).

7.2.1 Planning an Integrated Curriculum

In the context of medical education, Harden (2000) describes 11 points of integration on a continuum between the extremes of subject-based teaching and a curriculum that transcends disciplines. Fogarty (1991) describes ten levels on a continuum of integration. These approaches are presented in Table 7.1. The general trend of the continuum is toward more integration, although as Reser (2000) points out, Harden's (2000) continuum may not be entirely hierarchical and integration can exist in all the levels. This would be true for the Fogarty (1991) continuum as well. These continuums are helpful in selecting an integrated curriculum suited to each unique context.

In planning for such an integrated curriculum the first step is for a joint team of educators and practitioners to identify the professional learning outcomes that must be achieved by those registered for the program (Harden 2000). The learning outcomes will focus on performance which can be described as doing with understanding, and will include actions, attitudes, and behaviors. The aim is professional competence and the outcomes must therefore be determined by those who know what the practitioner must be able to do. The outcomes are transparent and known to all involved including the student. There are no surprises in a fair system, and students can prepare themselves well for assessment tasks.

7.2.2 Implementing an Integrated Curriculum

To be successful in achieving the outcomes, the professionals in training will need to engage in learning activities that foster the integration of knowledge, understanding, skills, and clinical competence. The next step is therefore to design and plan a curriculum that prepares the novice professionals toward the achievement of the predetermined outcomes. An integrated curriculum has curriculum activities to enable learning of underpinning knowledge that is both foundational to future learning and core to the discipline. It also has workplace engagement that promotes the integration and transfer of cognitive knowledge, clinical competence, and generic skills (Engel-Hills 2005). Teaching learning and assessment activities must be selected to guide and support students to achieve the outcomes (Biggs 2002). The curriculum must be structured to present the learner with the opportunity to experience the real-world environment where they develop values, attitudes, and behaviors for practice as a member of an integrated healthcare team. The curriculum must further educate for a vision of development in order that practitioners entering the workplace optimally utilize the resources available and offer the best care to all patients. Alignment is essential in order that the curriculum activities and assessment methods build toward learning and involve "doing" so that students demonstrate achievement of the learning outcomes (Biggs 2002). Assessment is criterion-referenced with a focus on measurable outcomes that must be achieved.

Table 7.2 summarizes the characteristics of an integrated curriculum and provides motivation for the use of this curriculum design as appropriate for medical imaging programs.

Table 7.1 A comparative continuum for curriculum integration

11 Steps for integration Harden (2000)	Explanation	Ten views for integrating Fogarty (1991)
	Learners filter learning through the expert's lens, personal connections result in external networks of experts in related fields	Networked
	Disciplines are part of learner's lens of expertise and the learner becomes immersed in a personal learning experience	Immersed
Trans-disciplinary	The field of knowledge is the focus as the curriculum transcends disciplines and the disciplines are part of the real world experience	
Interdisciplinary	Themes as the focus with no reference to individual subjects or disciplines	Integrated
	A Metacurricular approach threads thinking, social and study skills as well as technology and multiple intelligences through the various disciplines	Threaded
Multidisciplinary	A theme is used to connect the concepts, topics, and ideas in each subject as the theme or problem is viewed through the lens of the subjects/disciplines	Webbed
Complementary	Theme-based integrated teaching sessions supported by subject-based teaching	
Correlation	Subject-based teaching with regular integrated teaching sessions	
Sharing	Joint planning and teaching to produce shared concepts, skills, and attitudes in two or more disciplines	Shared
Temporal coordination	Coordination of topics examined from different perspectives such that similar ideas are taught to coincide within the separate subjects	Sequenced
	Multiple skills; social, thinking and content-specific skill within each subject	Nested
Nesting	Content drawn from different subjects to enrich the teaching	
Harmonization	Consultative planning achieves connections between subjects that are separately taught	Connected
Awareness	Subject-based teaching and assessment but with communication between academics	
Isolation	Subject-based teaching and assessment	Fragmented

Table 7.2 Characteristics and rationale for an "integrated learning curriculum"

Characteristics	Rationale	References
Meta-learning	Learning how to learn, and thus becoming lifelong learners, is the only way in which students and practitioners will be able to adapt to rapidly changing technology	[29]; [30] (Hendry et al. 1999; Malhotra 1996)
Transparent learning objectives	These are minimum competencies for practice in medical imaging	[31] (Harris et al. 2005)
Thematically organized learning (content, scope, sequence)	The learning objectives are integrated into themes (e.g., "The Chest") which are meaningful for both academic study and clinical practice, and where the scope, level, and sequencing is appropriate to the level of the learner	[17]; [32]; [33] (Bebb & Pittam 2004; Graham & Wealthall 1999; Pirrie et al. 1999)
Knowledge generating	Practitioners as lifelong learners that can adapt to changing contexts and develop the profession will be an outcome of a knowledge-generating curriculum	[34] (Freeman et al. 2000)
Problem- and project-based learning	Beyond thematic integration, students who work on a real-world problem (e.g., preventing the spread of TB) develop not only skills, but "insights"	[35]; [36]; [37]; [38] (Rothenberg 2002; Everingham & Harris 2000; Stark 1998; Klein & Newell 1996)
Work-integrated learning	A variety of curricular practices, such as work-based projects, in-service training, and sandwich courses, facilitate the transition from academic classroom to professional working environment	[39]; [9] (Engel-Hills et al. 2005; Adamson et al. 1997)
Contextual learning	In order to build competent and caring professionals, there is need for contextually based learning, including learning in "high tech" environments and in community-based contexts, such as through service learning	[40]; [41]; [9] (Winberg 2006; Waghid 2002; Adamson et al. 1997)
Team learning	Group-based learning simulates real-world contexts in which there is inter- and intra-professional collaboration	[42]; [43];[44] (Wrightson & Cross 2004; Lavin et al. 2001; Bines 1992)
Sustainable assessment	Assessment practices should not only be aligned with integrated teaching and learning practices, but must support learning beyond the higher education setting	[45] (Boud & Solomon 2000)
Learning support information literacy language support infrastructural support administrative support flexible scheduling	Integrated curricula have many features of resource-based learning programs, thus students need to develop information literacy. In multilingual settings, support is needed for technical communication. Infrastructural and administrative support is needed for new practices, and teaching loads and learning timetables need revisiting	[46]; [47]; [25] (Winberg et al. 2005; Wyrley-Birch 2004; Schön 1983/1991)

7.3 Take Home Message

The traditional curriculum is not likely to prepare students adequately for the demands of the modern medical imaging environment. An integrated approach that encourages self-directed, deep learning (Klein 1997) and knowledge building, develops critical thinking (Perkins 1991), the ability to find information, creative problem-solving (Caine and Caine 1991), reflective practice (Schön 1983/1991, 1986), team work, and life-long learning (Payne and Nixon 2001) responds to the challenges of higher education for health science practitioners of today.

It is suggested that the key to effective learning toward competent practice is the inclusion of a participatory learning environment in a carefully planned integrated curriculum. It is the active engagement in learning activities that enables and encourages students to achieve the predetermined learning outcomes (Biggs 2002) identified to meet the needs of the environment and to respond to development and change. On a continuum of learner participation there should be few offerings where the learners are passively receiving information and many activities that are designed to promote active learning (Figs. 7.1 and 7.2).

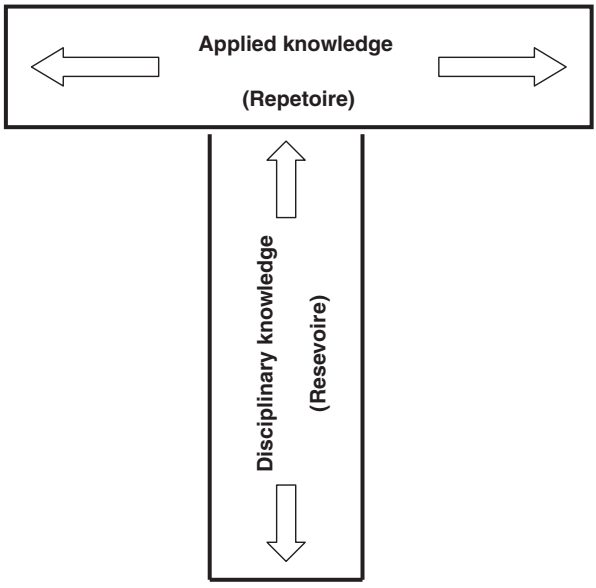

Fig. 7.1 Professional practice represented by the T-Shape (Adapted from Rip, 2004)

Fig. 7.2 Participatory learning increases in an integrated curriculum

In a well-designed integrated curriculum, cognitive knowledge is integrated with forms of practice, application, projects, and problem solving; this does not involve the loss of disciplinary knowledge, or the creation of an "empty curriculum" (Barnett and Coate 2005). An integrated curriculum that is built on an understanding of both disciplinary and professional knowledge can prepare students beyond the present context for the workplace of the future.

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