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Planning and implementing an undergraduate medical curriculum: the lessons learned

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SUMMARY *In 1995 Dundee medical school introduced an integrated, systems-based spiral curriculum with a number of innovative features. The medical school has now had eight years' experience of the curriculum. This paper describes the changes that have taken place in the curriculum over the eight years. Evidence from internal and external reviews and student examination data are used to identify the lessons learned from implementing the curriculum. The Dundee experience, the approaches to the curriculum described and the conclusions reached are relevant to all with an interest in medical education.*

Introduction

The medical school at the University of Dundee introduced a new curriculum in 1995. The curriculum combined idealism and pragmatism and six aspects were described by Harden *et al.* (1997): the spiral curriculum; a systems-based approach; a core curriculum with options; the educational strategies; the student assessment approach; and organization and management of the curriculum. The medical school has now had eight years' experience of implementing the curriculum in practice. Since 1995 there have been significant changes both in the healthcare delivery system and in medical education. In this paper we look at how the curriculum has withstood the test of time and responded to change; which aspects of the curriculum are still in place; and what new approaches have been added. We reflect on the experience of these eight years and describe the lessons learned about curriculum change in medical education. This analysis is likely to be of interest and potential value to individuals and institutions involved in change in medical education. To allow a comparison with our earlier description of the curriculum (Harden *et al.*, 1997), we have used in this paper a similar organizational framework; the curriculum; teaching and learning, including both student support and educational facilities; assessment; and organization and management, in terms of the committee structures and administrative support.

The Dundee undergraduate medical curriculum

The 1995 curriculum was implemented as the result of proposals by a working group of the Dundee faculty of medicine for curriculum development (Davis, 1993). The focus for implementation was a sophisticated blend of educational strategies, which underpinned the curriculum. These included a spiral curriculum with three interlocking phases; a systems-based approach with themes running through the curriculum that provided a focus for the students' learning; a core curriculum with options; elements of problem-based learning (PBL); community-based learning; student-centred approaches to teaching and learning that encouraged students to take more responsibility for their own learning; and an approach to assessment that emphasized the overall objectives of the course. An organizational and management structure and the allocation of resources were designed to support the educational philosophy.

Since the programme was introduced, not unexpectedly, many details relating to the curriculum have changed. There have also been significant developments. In 1997, an outcome-based approach (Harden *et al.*, 1999a, 1999b) was adopted for all five years of the curriculum, task-based learning (Harden *et al.*, 2000) was introduced as the framework for student learning in phase 3 and the portfolio assessment process (Davis *et al.*, 2001) was introduced as the medical students' final examination.

Evaluation of the curriculum

The curriculum has been evaluated on evidence from a number of sources. These include both internal and external reviews and student examination data. The conclusions reached in this paper are based on this evaluation.

(1) The internal reviews

The internal reviews include:

- the University of Dundee quality assurance processes. These are institutional monitoring processes for university procedures relating to academic standards and quality of awards;
- the academic standards processes of the medical school that include both staff and student evaluations; analysis of student progress; student performance in degree examinations; peer review of teaching; and regular programme review;
- internal evaluation. New developments such as the introduction of portfolio assessment are subject to internal evaluation;
- student diaries. These diaries, collected from students by the curriculum facilitator, were introduced to provide the detailed and continuous monitoring needed in the early stages of the introduction of the new curriculum.

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(2) External reviews, both formal and informal

Formal reviews include:

- a review carried out by the Scottish Higher Education Funding Council (SHEFC, 1996) as part of the teaching appraisal exercise of all Scottish universities;
- a review carried out by the General Medical Council (GMC, 2000) as part of its regular visits to UK medical schools;
- the Quality Assurance Agency (1998) visit to the university. University quality assurance and enhancement processes are subject to regular audit visits by the Quality Assurance Agency for Higher Education in the UK, a national body that oversees all UK university quality assurance processes. The audit process focuses on four main topics: the institution's quality strategy; academic standards; the learning infrastructure; and communications;
- external examiner reports. External examiners contribute to all degree examinations in the medical school and provide reports that are scrutinized through the academic standards procedures of the university.

Informal reviews take place when visitors to the medical school express views regarding the strengths and weaknesses of the curriculum. Although this evidence is subjective, personal and potentially biased and thus less strong than that obtained through the formal reviews, it nevertheless provides potentially interesting qualitative information about the curriculum through the issues identified and the opinions expressed.

(3) Student examination data

Students' performance in examinations and their progress through the curriculum contribute to the evidence about the effectiveness of the programme. There have been several publications relating to student assessment in the Dundee curriculum. Friedman Ben-David *et al.* (2001a) published data on the progress test introduced in 2000 that provide evidence relating to the efficacy of the spiral design. Khogali *et al.* (2002) reported data relating to student competence on the topic of cardiac murmurs in clinical skills examinations. Portfolio assessment data (Davis *et al.*, 2001, Friedman Ben-David *et al.*, 2001b) provide evidence of the efficacy of the curriculum strategies and assessment system in terms of achievement by the students of relevant learning outcomes.

The curriculum

(1) The spiral curriculum

The spiral design (Harden & Stamper, 1999), as illustrated in Figure 1, was a strong feature of the Dundee curriculum. The design has sound theoretical underpinnings (Dowding, 1993) and is based on the constructivist approach to learning (Dewey, 1929).

This has proved to be a robust framework, within which further development of the curriculum could take place. The spiral curriculum has been well received by staff and students and remains in place today. Evidence of the success of the approach has been obtained from a study of the progress test implemented at the medical school (Hunter *et al.*, 2002).

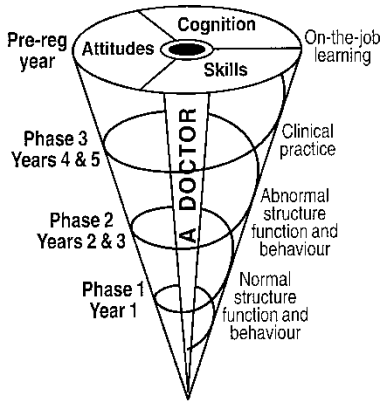

Figure 1. The spiral curriculum model. *Source:* Harden & Stamper (1999).

This demonstrated improvements in student basic science knowledge as the students progressed through the curriculum. In contrast, in a traditional curriculum, student knowledge of the basic sciences usually declines after the early years.

One minor change made to the spiral structure was a transfer of pharmacology teaching from phase 2 to phase 1 of the curriculum. This was considered to be more in keeping with the aims of phase 1, which is concerned with normal structure, function and behaviour. Another change was the establishment of an introductory course at the start of each individual phase or loop in the spiral. These induction courses introduced students to the learning outcomes for the phase in relation to the exit learning outcomes for the overall course; bridged the gap at the interface between phases; and introduced students to the approaches to teaching and learning employed in the forthcoming phase.

Lessons learned. The spiral design, with students revisiting topics in each phase, building on what they already know and adding further complexities is a robust and useful model for the undergraduate medical curriculum. One should not underestimate, however, the difficulty students may find in moving from one phase to the next, each with different approaches to teaching and learning. We found that an introduction to the overall curriculum and an interface between the phases was necessary.

(2) Outcome-based education

The curriculum as originally described had general aims for each phase but the overall focus was not made explicit.

The introduction in 1997 of the three-circle model of learning outcomes as a focus for student learning, as illustrated in Figure 2 (Harden *et al.*, 1999a, 1999b), has been one of the most significant developments since the Dundee curriculum was introduced in 1995.

The shift of emphasis from the educational process to the learning outcomes has had an impact on medical education throughout the world (AAMC, 1998; ACGME, 1999; Bloch & Burgi, 2002; GMC, 2002; Schwarz & Wojtczak, 2002; Simpson *et al.*, 2002; Harden, 2002).

The relative emphasis placed on the different learning outcomes has had to be reassessed. Although the outcomes

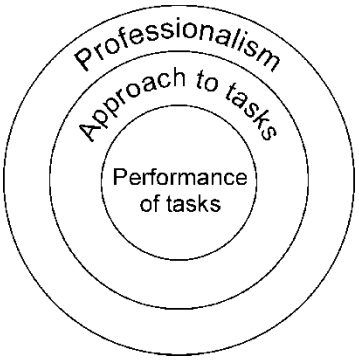

Figure 2. The three-circle model of outcomes. *Source:* Harden *et al.* (1999a, 1999b).

include health promotion and disease prevention and aspects of public health medicine, the GMC (2000) considered that insufficient emphasis was given to public health medicine and encouraged the school to consider ways of enhancing this aspect of the course. Experience has demonstrated that personal attributes may also need increased emphasis similar to the importance given to them by the Association of American Medical Colleges' (AAMC) outcome-based educational model (AAMC, 1998). With regard to probity, Rennie & Crosby (2001) showed that while most Dundee students consider dishonest behaviour to be wrong, some students were unsure what constituted dishonesty.

In the context of the Dundee curriculum, further work is ongoing relating to student progression during the three phases towards the exit learning outcomes. This has proved to be a complex process. A sophisticated curriculum map is needed to enable full benefit to be obtained from the outcome-based education and to allow both staff and students to understand the planned progression and the complex relationship between learning outcomes, learning opportunities, curriculum content and student assessment. That work is under way.

Lessons learned. There is a significant difference between outcome-based education and the production of a list of learning outcomes for an existing curriculum. ''Outcome-based'' suggested Spady (1993), ''does not mean curriculum based with outcomes sprinkled on top. It is a transformational way of doing business in education.'' The implementation in a curriculum of outcome-based education is not easy and requires the use of curriculum mapping. The effort is, however, worthwhile. The outcomes provide a valuable focus for student learning and direct the students' attention towards learning outcomes that are easily ignored in the traditional curriculum. The outcomes also provide a sound basis for the student assessment process.

(3) Core curriculum with options

The move to a core curriculum was one of the most important recommendations made by the GMC (1993) in their recommendations for undergraduate medical education. The options were initially called special study modules (SSMs) but are now referred to as student selected components (SSCs) (Rubin & Franchi-Christopher, 2002).

The core curriculum. There was a general acceptance by the medical school of the concept of core. A significant reduction in curriculum content was achieved in the 1995 revision, with approximately two-thirds of curriculum time devoted to core.

There is an inevitable risk that the time devoted to core will be expanded with time. The school, however, restrained the tendency and core has remained at 69% of curriculum time. Identification of the core proved to be taxing for the medical school and the GMC identified a lack of clarity among the students regarding the core content (GMC, 2000). As student progression towards the learning outcomes becomes better defined through the curriculum mapping exercise, further progress towards clarification of the core is anticipated. This is particularly true of phase 1 (year 1). The GMC was uncertain regarding whether realistic demands were being placed on students in this phase of the course, although the phase 1 students to whom they spoke did not feel overburdened and commented positively on phase 1.

Lessons learned. Identification of the core basic science components of the curriculum is not easy and is best done by basic scientists working in collaboration with clinicians. The specified learning outcomes play a key role in identification of what is core for all students.

The options. The optional part of the 1995 course comprised SSCs and elective studies. These contribute in a number of ways to the learning outcomes. It is through the options, for example, that students have the greatest opportunity to learn to direct their own learning and to assess their own progress. Significant time was allocated for SSCs. In phase 1, students spent half a day per week carrying out a research project where the focus is on acquiring computing skills and expertise with medical databases in a basic science context. In phase 2, students selected 16 weeks of courses from a menu of approximately 90 courses offered by staff. In year 4, students carried out a research project, with a half-day per week available for the work. The focus is on research ability. In year 5, students selected two courses from a menu of 10 offered by staff. The focus here was on vertical integration, with the courses revisiting basic sciences integrated with clinical aspects at a time when the students are in a position to appreciate the relevance of the basic science input.

The SSCs have proved popular with staff and students (SHEFC, 1996) and a significant contribution is made by staff who might otherwise not have contributed to the curriculum. Staff enthusiasm for SSCs, however, has resulted in an increase in the number of SSCs, with the provision of large numbers of small courses, which may run at less than maximum student capacity. Smaller numbers of larger capacity SSCs, while providing less student choice, could prove more efficient in terms of staff time. The SSCs were identified as a particular strength by SHEFC (1996). The combination of enthusiastic staff and interested, motivated students proved to be successful beyond all expectations.

In elective studies, students select what and where they want to study in a seven-week block between years 4 and 5. Most students elect to study overseas to gain experience of a healthcare delivery system different from the National Health Service (NHS). Some students complete electives elsewhere

in the UK. This part of the course seems to be a time of significant personal and professional student development.

Lessons learned. Options have proved popular with both staff and students, but providing large numbers of optional courses each attended by a few students is probably not cost effective. Staff and departments are more likely to accept a reduction of teaching time in the core if they can compensate with time in the optional part of the programme.

(4) The adaptive curriculum

An adaptive curriculum model, as illustrated in Figure 3, was adopted in phases 2 and 3 of the curriculum.

As in mastery learning (Bloom, 1968), the aim was to ensure that students reached the required high standard in the core. Multiple attempts at examinations were provided for students to ensure that they reached this standard, with planned supplemental instruction provided for those who failed to reach the core standard at the first attempt at the examinations. The supplemental instruction took place during some of the time when their peers were studying SSCs. The importance of SSCs, however, was recognized and all students were required to study SSCs for at least 50% of the time allocated for the options. The support provided by the medical school to help students reach the appropriate standard was acknowledged and praised by external examiners.

The adaptive curriculum model continues in use. Staff found, however, that they were, at times, running examinations for one candidate. While this is less of a problem in computer-based tests of knowledge, it is a major challenge in examinations such as the OSCE that require considerable staff resource to set up and run. Studies within the medical school showed that the optimal number of attempts at an examination was two (Davis, 2003). Students who did not reach the core standard at the second attempt at the examination were found to fail for other reasons, some because they had insufficient SSC passes in that part of the course and others because they failed the core in subsequent years. The adaptive curriculum approach caused controversy with the GMC (2000) and SHEFC (1996), both of whom were critical of the reduction of time for SSCs for those students undertaking supplemental instruction. ''Protection of student time for SSCs'', suggested SHEFC (1996), ''was an area where improvements could be made by identifying alternative ways of providing additional support in the core curriculum for weaker students''. The GMC (2000) invited

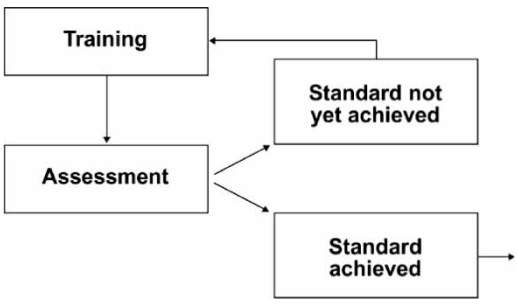

Figure 3. The adaptive curriculum model.

''the school to consider ways of ensuring that students who fail to perform well on the core elements of the course have the same opportunities to undertake SSMs as their more successful peers''. Staff were supportive of the approach, however, and students appreciated it. It achieved a balance between supporting students through the core and achieving the required number of SSC passes. Students who were slower learners were not subjected to the additional stress of 'carrying' courses or working in vacation time. The priority was to enable as many students as possible to achieve the core standard while still benefiting from SSC studies. Both staff and students elected to retain the adaptive curriculum approach in a questionnaire survey carried out after the GMC's 2000 report (Davis, 2003). External examiners also commented favourably on the provision of supplemental instruction.

Lessons learned. We learned that the adaptive curriculum approach could be employed in an undergraduate medical programme. Logistical difficulties were encountered with the implementation of the adaptive curriculum that led to changes in the number of attempts at an examination without, however, compromising the basic principles. What has been more challenging, however, is the creation of a new mindset which recognizes that curriculum time is finite and that how students may best use this time may vary from student to student.

(5) An integrated, systems-based approach

The integrated, system-based approach to teaching and learning was included in plans for the new curriculum. The approach has been accepted as the focus for teaching and learning in phases 1 and 2 of the curriculum.

In practice, the level of integration as set out on the integration ladder (Harden, 2000) varied from system to system. Organization of the system-based teaching also varied from system to system, with working groups meeting regularly in some systems and individuals taking responsibility for the integration in others. Individual responsibility for a system is demanding for the individuals involved and strengthening of the team approach is necessary. Minor changes have occurred to the sequence of the systems in phase 2; for example, moving a system from one month to another to avoid the system's teaching taking place during national/international meetings relating to the system or discipline was a timetabling imperative. A practice of medicine working group was set up to support integration of clinical teaching in hospitals, the clinical skills centre and general practice. The GMC (2000) identified the range of clinical and community settings provided for teaching and learning as an area of good practice.

The principal of integration, however, with an emphasis in years 1 to 3 on system-based teaching, has not been in doubt in the medical school. Externally, SHEFC (1996) considered integration as a particular strength of the curriculum. The GMC (2000) also commented on the high degree of horizontal integration in phases 1 and 2 but had concerns regarding vertical integration and considered that there was a need to integrate phase 1 more closely with the rest of the curriculum. More clinical involvement is likely needed in phase 1 to achieve this.

Lessons learned. System-based teaching is a key strategy in the early years of an undergraduate medical programme and is popular with both staff and students. Implementation may vary according to the preferred approach of individual teachers. Significant input from clinicians throughout the curriculum is needed to achieve both horizontal and vertical integration.

(6) Multiprofessional learning

There was a commitment by the medical school to multiprofessional learning boosted by the addition of a school of nursing to the faculty in the early years of the new curriculum.

A working group met regularly in the evenings under the chairmanship of the vice-principal for health and produced ideas for multiprofessional courses at various points on the multiprofessional ladder (Harden, 1998). Some successful courses were introduced (Mires *et al.*, 1999) but, in spite of individual successes, most multiprofessional courses have not been maintained. Nursing staff, however, continue to play a part in medical student teaching, in particular through the clinical skills centre. One successful course involves medical and nursing students providing care for simulated patients in a simulated ward setting in the clinical skills centre. Lack of facilitators and incentives and logistical problems relating to timetabling led to the withdrawal of the other multiprofessional courses. When the vice-principal for health retired, the responsibility for developing multiprofessional initiatives was not reassigned. The early promise of multiprofessional learning has not been fulfilled. The reasons are complex but logistics and lack of multiprofessional leadership and a strong advocate certainly played a part.

Lessons learned. Multiprofessional education offers advantages and has attractions as a tool for enabling students to understand and respect the role of other healthcare professions. The true role of multiprofessional teaching and learning in medical education, however, is not clear. Unless there is a strong proponent or standard-bearer for the approach, significant change is unlikely. Multiprofessional education has to be institutionalized if it is to survive and contribute to the curriculum.

(7) Problem-based learning

While there are some elements of problem-based learning (PBL) in the undergraduate programme, it was not a strong feature of the 1995 curriculum. There was never a major commitment among faculty to a traditional PBL approach and there remains among staff the feeling that what have been claimed as the benefits of the PBL approach can be gained in other ways. The PBL was focused on phases 1 and 2 of the curriculum, with some—but not many—of the phase 2 system-based courses adopting patient scenarios as the basis for learning. The point on the PBL continuum (Harden & Davis, 1998) adopted by individual systems varied. Some systems used problem-focused learning, some problem-initiated learning and some problem-centred discovery learning. Several points on the continuum can be identified in the Dundee curriculum but not the traditional PBL approach.

Staff development sessions relating to PBL were well attended at the planning stage of the new curriculum. There were, however, significant problems in enlisting sufficient staff trained as facilitators to meet the needs of phase 2 students. The time commitment needed from facilitators was undoubtedly one reason for this difficulty but it may also reflect the lack of priority faculty gave to PBL as an educational strategy. Collaborative learning groups supported by study guides and 'floating' facilitators, who facilitated several groups at the same time, were introduced to overcome the lack of trained facilitators. The early difficulty relating to lack of tutors for the PBL sessions might have been overcome by employing lay facilitators, individuals hired and trained specifically as PBL tutors, but the lack of faculty commitment to the approach made this solution unrealistic.

The medical school sought the benefits of the PBL approach in another way, through the introduction in 1997 of task-based learning (Harden *et al.*, 1996a, 1996b), a clinical form of problem-based learning where the tasks undertaken by a healthcare professional are the basis for the 'problem' presented to the student.

Staff, students and those evaluating the curriculum have considered that the task-based learning strategy is successful. The assessment of Race (2000) was that task-based learning is ''a very useful approach to integration of the medical curriculum and, not least, a time-efficient and cost-effective approach to developing highly relevant skills, attitudes and competence for the profession.'' Visitors to the medical school frequently cite task-based learning as a reason for coming to Dundee. The tasks or core clinical problems have provided an acceptable structure for integrating student learning in phase 3 (Harden *et al.*, 2000). Additionally, some of the core clinical problems are used as scenarios for focusing student learning in individual weeks in the phase 2 core curriculum and also for introducing relevance to phase 1 learning. The core clinical problems provide a further integrating structure for the curriculum, along with the systems and outcomes.

While there have been minor adjustments in the list of approximately 100 tasks identified, there have been no major changes to the task-based learning approach. This has, however, been refined. The initial strategy of allowing students all two years of the phase to 'cover' all of the tasks proved too open, with some students reaching the end of the course without studying some of the core clinical problems. Appropriate tasks are now identified for each block of year 4 teaching to ensure all students have the opportunity to learn through the complete range of core clinical problems. The allocation of tasks to specified clinical attachments has led at times to tensions between the centrally planned, systematic curriculum and the freedom of individual teachers to teach opportunistically on patients presenting during the block attachments.

Lessons learned. Implementation of an educational approach such as PBL may run into difficulties unless it is enthusiastically endorsed by the medical school. Task-based learning provides an option to PBL that is, in many ways, more attractive to staff, particularly in the clinical years. Task-based learning has been one of the curriculum's successes. It is a valuable strategy for introducing an integrated and

problem-based approach in the clinical years of an undergraduate medical curriculum. The tasks, matched with the appropriate learning outcomes, provide a framework or grid for identification of the core curriculum.

Teaching and learning: student support

The approach taken to learning throughout the Dundee curriculum emphasized students taking increasingly more responsibility for their own learning in the core programme. In addition, students chose their own courses for approximately one-third of the curriculum time. It was recognised at the planning stage that both of these moves required increased student support and various support structures were put in place. These included study guides and a student-support scheme. Later developments included curriculum mapping and peer-to-peer (P-2-P) learning.

(1) Study guides

Study guides that describe what students should learn in a course and relate this to the learning opportunities available (Harden *et al*., 1999c) were introduced for all courses as part of the 1995 curriculum revision. The study guides have proved to be an important part of the Dundee curriculum. Indeed, it is now difficult to envisage the curriculum without them. They were identified as a particular strength of the educational programme by SHEFC (1996) and are a valuable resource not only for students but also for staff. Students equipped with study guides have at times informed staff of what was expected of individual teaching sessions.

A major development has been incorporation of the learning outcomes into the study guides, with explanations of how individual educational opportunities enable students to meet the learning outcomes. This work in identifying the content for the study guides and outcomes of individual courses and educational opportunities has focused both staff and student attention on the curriculum aims and outcomes. Different approaches to the design of study guides have been studied (Khogali *et al*., 2001) and have informed the future development of the guides. Given the scale of the exercise, with each three- to five-week module having its own study guide, there were issues related to the costs of print-based study guide reproduction. Initially, students were charged for print-based study guides but this was vetoed by the university centrally. Electronic delivery of the guides was introduced but students complained about the printing costs from the electronic version. These issues have now been resolved by the provision of guides both electronically and in print with printing costs met by the medical school.

Lessons learned. The introduction of study guides clarifies what has to be taught and learned and has proved to be one of the most important innovations of the new curriculum. The costs of study guide production are substantial and need to be addressed. Both electronic and printed study guides have a role to play.

(2) Student-support scheme

Before the implementation of the 1995 curriculum, the medical school had an existing personal tutor scheme for students. Additionally, members of staff were identified as student advisers for each year of the course. The students normally approached the advisers only when they had failed an examination. The 1995 curriculum recognized the need to boost student support to provide continuity and more individual advice. A member of staff was identified to implement the student support scheme and provide leadership for it. Different approaches to implementation of the scheme were trialled. In year 1, the existing system was retained with academic tutors also acting as personal tutors for students in their tutorial group. In years 2–5, secretarial staff in the medical school office allocated groups of students to individual staff members who volunteered to participate in the support scheme. Some staff members took responsibility for a group of students following them throughout all four years while other staff members were responsible for several groups within a year, passing them over to another tutor the next year. An individual staff member was allocated responsibility for students from the International Medical University in Kuala Lumpur, who joined year 4 of the course.

While there were complaints from some students that they had never seen their tutors and from some members of staff that students did not turn up for pre-arranged meetings, at least every student had a named member of staff to approach should the need arise. Notwithstanding these occasional complaints, the student support arrangements were identified by the GMC (2000) as an area of good practice. All the students they spoke to confirmed that the school had created a very caring and supportive environment in which to study medicine. The phase 1 personal tutor scheme was singled out as an excellent system, which provided students with the necessary academic and pastoral support.

Subsequently, however, the member of staff providing leadership for the scheme gave up this responsibility in 2000 and no new leader was appointed. Since then no reports about the scheme have been presented at the undergraduate medical education committee.

Lessons learned. Student support is a taxing process that needs, to ensure its ongoing success, personal commitment from a large number of staff, secretarial resource to administer the system and a dedicated member of staff to provide the required leadership.

(3) Curriculum mapping

After the introduction of the 1995 curriculum and the later introduction of outcome-based education and task-based learning, it became apparent that the sophistication of the curriculum led to a complex situation. The interrelated components included learning outcomes, systems, core clinical problems or tasks, disciplines, educational opportunities and assessment. A mapping exercise began and it was swiftly realized that electronic mapping (Harden, 2001) was required to enable staff and students to identify the links between components. The electronic mapping process began in 1999 and continues today. New approaches to the creation of an electronic managed learning environment have facilitated this work. Through the use of electronic mapping different lenses can be applied to the curriculum. It can be inspected from the point of view of the core clinical problems

or tasks that are the basis of learning and teaching in phase 3. Staff and students can identify through the map the prerequisites for understanding each core clinical problem provided through the system-based courses in phases 1 and 2. The development of the system-based learning can be traced throughout all three phases of the curriculum. Students can identify their progression towards the learning outcomes through various educational opportunities and this progression can be fine-tuned by staff as necessary. The student assessment system and how the assessment relates to the outcomes of the curriculum, individual courses and the educational opportunities provided can be viewed as an aid to staff involved in the assessment system.

Lessons learned. Planned learning throughout a curriculum needs to be made explicit to both staff and students. Curriculum mapping aids this process. The complexities require an electronic learning environment.

(4) P-2-P learning

Students supporting each other informally has always been a feature of the education process. The benefits to students of advice from more senior students have not been quantified but are likely to be substantial. The first cohort of students entering a new curriculum lack these benefits and can regard themselves as either guinea pigs or pioneers. There was no formal P-2-P learning at the start of the 1995 curriculum but the potential of the approach was recognized. A more recent development has been formally arranged P-2-P learning (Crosby & Ball, 2001). Senior students in year 4 of the course were encouraged to volunteer to tutor junior students in years 2 and 3 and were given training to do this in terms of group facilitation skills and instruction in tutoring. The P-2-P learning was highly rated by both junior and senior students, with both groups indicating that it improved their learning.

Lessons learned. P-2-P learning has an important part to play in supporting students.

Teaching and learning: educational facilities

A range of educational opportunities was provided to support the integrated curriculum and the different student learning styles. As part of this strategy new educational facilities were introduced with the 1995 curriculum including a computer learning suite; an educational resource area; an integrated learning area; and a clinical skills centre.

(1) Computer learning suite

The approach taken to helping students develop information technology (IT) skills was to integrate this with the teaching and learning programme. Phase 1 students used computing facilities at the main university campus where they are based for most of their studies. A computer learning suite in the main teaching hospital was expanded to provide facilities for phase 2 and 3 students.

In phase 1 of the curriculum the focus of the SSC was developing IT skills in a basic science context. Both off-the-shelf and 'home-made' computing programmes were employed in the system-based courses in phase 2 and students were timetabled to spend a minimum of two hours per week in the computing suite using computer-based learning. Students were expected to word process the report for their year 4 research project and to build their portfolios for their final examination using word-processed material. There were inevitable student complaints, on occasion, about lack of computer access, system breakdown and loss of material. But by and large the computing suite has been one of the successes of the curriculum. It was extended on several occasions and much curriculum information is now provided on line.

(2) Educational resource area

At the start of the 1995 curriculum the existing educational resource area was redeveloped to provide phase 2 students, with a particular interest in specific areas, access to additional material beyond the core, supplied by the system working groups. Not all phase 2 system courses made use of the area and it was insufficiently used and resourced. In particular it was not timetabled into the curriculum. There was a trend to replace the video, tape-slide and print-based educational resources that were used in the resource area with computer-based resources. Pressure on space in the computing suite and the need for more computer terminals led to the expansion of the computing suite into the educational resource area and it eventually became an extension of the computing suite.

(3) Integrated learning area

This area was established for the 1995 curriculum in recognition of the importance of integration in the curriculum. After experience with a coordinated, systematic course in the previous curriculum, it was recognized at the planning stage for the 1995 curriculum that integration would not succeed if multiple teachers had to be present at individual teaching sessions as this approach would be neither cost effective nor efficient. The integrated learning area was established to facilitate integration in the minds of students and additionally to promote collaborative learning between small groups of two to three students. Individual teachers and disciplines provided material in the form of interactive poster displays that the small groups of students studied in timetabled sessions during phase 2. The poster displays were usually focused on the key patient/core clinical problem for each week of the teaching and on the topic for the week and the displays were changed weekly.

Initial development of the material was time consuming but a departmental technician was redeployed to support this area and make the posters for the teachers. Updating of material was not taxing and the posters provided reusable learning resources that continue to be used each year. The posters provided self-assessment questions that students could tackle in small groups. Some systems provided a facilitator for the sessions. Other systems timetabled whole-group sessions at the end of each week that provided opportunities for teachers to give answers to the self-assessment questions and deal with student queries.

There were initial problems relating to student non-attendance at the integrated learning area sessions and some students had to be discouraged from copying the poster

material into their notes. Some facilitators had to be dissuaded from providing mini-lectures in the area. Once both the students and the teachers realized the purpose of the area and the benefits in terms of integration, its use became institutionalized. Work is ongoing to explore provision of sessions for phase 1 students in the area.

(4) Clinical skills centre

A clinical skills centre was established for the 1995 curriculum. Its purpose was to introduce students to clinical skills in a protected environment and facilitate early clinical contact, one of the vertical integration strategies. The centre was equipped with a range of simulations or plastic models that medical students could use, in a protected and safe environment, in preparation for carrying out intimate or potentially painful procedures such as rectal or vaginal examinations. Multiple versions of each model are provided to enable four groups of students to practise the same skill at one time. Clinical skills sessions are timetabled into the weekly timetable for all core curriculum teaching in years 2 and 3. An advert was placed in the local press for lay volunteers to help with medical student training and 150 members of the local community turned up for an arranged meeting, of whom approximately 100 subsequently became simulated patients. These people are unpaid and receive only travel costs for their significant contribution to medical student teaching and learning. Where acting skills are needed, such as in bereavement or dealing with violent patient scenarios, paid 'actors/volunteers' are employed. Dedicated staff were appointed to the clinical skills centre. The staffing includes a director and a deputy director whose main task is clinical teaching and they contribute to the system-based teaching with members of the system teaching teams. Some systems choose not to use the clinical skills centre staff, electing to have consultants in the speciality carry out the teaching. A simulated patient coordinator, an administrator and technical support are needed for the centre. The resuscitation officer for the local NHS trust is located in the centre to facilitate CPR training for both under- and postgraduates.

Initially the centre was housed in temporary accommodation. A year after the start of the 1995 curriculum, a state-of-the-art, new-build clinical skills centre was opened, with 11 small-group clinical teaching rooms, video feedback facilities and a seminar room for groups of up to 40 students. It was designed round a circular corridor so that it can also be used as an objective structured clinical examination (OSCE) venue. More recently Harvey, the cardiology simulator, was acquired by the medical school and based in the clinical skills centre. The centre is used extensively by other schools in the faculty (nursing and dentistry) and for postgraduate teaching. It has been extended several times, the latest additions being a simulated ward where medical and nursing students encounter simulated patients in realistic conditions; video conferencing facilities; and additional small-group rooms where student performance can be videotaped.

There have been ongoing issues related to clinicians not turning up for teaching sessions in the centre or last-minute replacements arriving to teach the medical students without adequate briefing for the teaching session.

Notwithstanding these issues, the clinical skills centre has been one of the success stories of the curriculum, identified as an area of good practice by the GMC (2000) and as a particular strength in the SHEFC teaching appraisal exercise (1996).

Lessons learned. The computer learning suite, the clinical skills centre and the integrated learning area are essential resources in a medical school. They support an integrated student-centred curriculum and help students to achieve the learning outcomes. Institutionalization of the educational facilities is essential for their successful and continued use. The clinical skills centre provides an important focus for clinical teaching, particularly in the early years of the curriculum. Unpaid volunteers have successfully provided a bank of simulated patients who are able to meet most needs of undergraduate medical student teaching in the centre. In the UK context, payment of simulated patients is not necessary and may make the extensive use of simulated patients unaffordable.

Assessment

(1) Twenty principles of assessment

The key principles relating to assessment in the context of the Dundee curriculum were identified for the 1995 curriculum. These remain essentially unchanged. Identification of a customized set of principles of assessment has proved helpful in the difficult and complex decision-making processes associated with an integrated assessment system.

Lessons learned. Principles of assessment are a useful tool to guide the development of an integrated assessment system. The principles need to be customized for the individual medical school context and kept up to date.

(2) Self-assessment

From the start of the 1995 curriculum, self-assessment questions have been provided in study guides and in the integrated learning area. Answers to the questions have also been provided. This is a formative process providing feedback to enable students to assess their progress and its value is generally accepted.

A study of self-marking of summative assessments was carried out (Mires & Friedman Ben-David, 2001) to improve feedback to students. Some students found the procedure stressful. In addition some students expressed concerns that faculty were avoiding their responsibility for marking the examination papers. This approach was not continued in the light of the staff organization required and the student misunderstandings regarding the nature of the exercise.

Lessons learned. One of the first principles of assessment is that the purpose of the assessment should be clear. Confusion between self-marking of summative assessment and self-assessment for formative reasons caused anxiety in some students. While self-marking of examination papers has potential for provision of rapid feedback to students,

the purpose of the self-marking has to be clearly communicated to the students. The introduction of the process has to be carefully managed.

(3) Assessment to a standard

The assessment-to-a-standard approach, which was introduced in the 1995 curriculum, continues to be applied in the educational programme. The basis of the approach is that there is a standard with regard to core that all students must achieve before progressing to the next part of the course. Supplemental instruction is provided within the timetabled curriculum for students who do not meet the core standard, with additional opportunities provided through the assessment procedures to demonstrate their mastery of the core.

In the initial years of the 1995 curriculum, phase 2 students were assessed at end of semester assessments. Semesterization within the university did not take place as initially intended, however, and after two years a three-term year was reinstated. The relationship between core and supplemental instruction was retained, however, with students who had mastered the core progressing to the next part of the course. Those students who did not demonstrate core mastery at the first attempt were still provided with supplemental core instruction.

Lessons learned. The assessment-to-a-standard approach has been successful in supporting slower learners through the provision of supplemental instruction.

(4) Integrated assessment

An integrated assessment system was a key feature of the 1995 core curriculum. The range of assessment instruments employed in the summative examinations included multiple-choice questions (MCQs), extended matching item (EMI) questions, constructed-response questions and OSCEs. All the disciplines contributing to the integrated, system-based courses in phases 1 and 2 contributed questions and stations to these examinations. In phase 3 the clinical departments involved in the teaching contributed to the end of year 4 examinations. The integrated assessment system remains in place today.

One minor change was the replacement of MCQs by EMIs in phase 2 to enable assessment of higher order thinking. At times it has been difficult to obtain staff involvement in the integrated examinations and it has been necessary to link academic staff appointments with responsibility for running individual examinations in order to implement the examinations.

Lessons learned. Integration of assessment is important to support curriculum integration. Integrated assessment may result in an academic staff 'stand off' from the assessment process related to lack of ownership.

(5) External examiners

External examiners are an important component of the assessment procedures in terms of quality control and standards across medical schools in the UK. The participation of external examiners in the summative assessment process has occurred throughout all years of the 1995 educational programme for both the core curriculum and SSCs. Adjustments are made to the examinations in response to their reports. There have been no major changes to the external examiner process since the introduction of the 1995 curriculum.

Lessons learned. External examiners have an important contribution to make in ensuring that standards are set and maintained at an appropriate level.

(6) SSC assessment

Student assessment in the SSCs continues with the rigour anticipated when the 1995 curriculum was introduced.

We found that there are challenges relating to student assessment in SSCs. There are inevitable variations in the effort students are expected to make across a large number of SSCs that create difficulties in comparison. Standardization of student assessment across the SSCs is under way with progress being made using the outcomes as a framework for student assessment. Avoidance of soft and hard options remains a challenge but the introduction of a credit accumulation transfer (CAT) system, based on hours of student effort, should facilitate a more equitable distribution of student effort in the SSCs.

Lessons learned. Relating SSC assessment to the learning outcomes facilitates standardization across SSCs. Standardizing student effort and marking criteria across disparate SSCs is challenging but achievable.

(7) Formative assessment

There were plans for formative assessment at the end of each course in the 1995 curriculum. While formative assessment at the end of each phase 1 course proceeded as planned and is now provided on line, plans for formative assessment at the end of each phase 2 system-based course and phase 3 clinical attachment proved difficult to implement. It was felt that a written examination on its own would not have adequately reflected the outcomes of the phase 2 and 3 courses. The logistics of organizing a clinical assessment at the end of each course and clinical attachment in the form, for example, of an OSCE proved too difficult and the concept was abandoned. SHEFC (1996) indicated that "more use could have been made of the opportunity to provide formative feedback both to individual students and to the class as a whole".

Lessons learned. The logistical implications of integrated assessment are considerable and had a deleterious effect on the provision of formative assessment opportunities for students.

(8) Progress test

A significant development in the assessment system for the 1995 curriculum was the introduction of a progress test (Friedman Ben-David *et al.*, 2001a). All students in all years of the course sat the test. The progress test superseded the use of long-loop assessment, where questions from examinations in previous years were included in the summative

assessments to promote retention of the core. Unlike the original description of the progress test as implemented at Maastricht (Van der Vleuten *et al.*, 1996), constructed-response questions were used. The test was marked by lay markers and academic staff under the supervision of a member of faculty. This was a major expenditure in terms of staff resource.

Since the introduction of the progress test, computer marking of the examination has been introduced. Further development work on the progress test is ongoing.

Lessons learned. A progress test can provide useful feedback to staff and students. Student assessment needs to be adequately resourced in terms of academic staff, professional assessment advice, time and money.

(9) Portfolio assessment

The major change to the assessment system was the introduction in 1997 of portfolio assessment for phase 3 students. The move to outcome-based education highlighted the need to assess professionalism and attitudes, outcomes that are difficult to assess using traditional assessment instruments. There was also a need to assess not only what students do under the strictly controlled and highly standardized conditions of an examination such as the OSCE, but also how the students habitually behave with patients in the wards, outpatient clinics and general practice surgeries. Portfolio assessment was introduced as the medical students' final examination (Davis *et al.*, 2001, Friedman Ben-David *et al.*, 2001b) to meet these needs. At the end of year 4 students sat part 1 of their finals, an integrated assessment comprising an EMI question paper, a constructed-response question paper and an OSCE. The portfolio process extended throughout years 4 and 5 with students submitting their portfolios to the examiners towards the end of year 5: part 2 of finals. Staff development sessions and examiner briefings were carried out and students were given guidance about the portfolio process in an induction period, handbook and other written instructions.

The portfolio process was fine-tuned each year in response to staff and student feedback. Reflection, an essential attribute for portfolio building, proved difficult for some individuals and coaching was needed at times to help individual students understand what was required. Student induction for the portfolio approach was greatly enhanced by the contributions of students who had already participated in the portfolio assessment process.

Lessons learned. Portfolio assessment provided a framework within which student performance across a range of outcomes could be assessed. The portfolios identified student problems that the medical school did not have the processes to deal with; for example, a fitness to practice committee had to be set up for the undergraduates. The portfolio process is a major logistical exercise for the medical school, but it is considered to be worth the effort.

Organization and management: committee structures

Committee structures have undergone substantial change since the start of the 1995 curriculum. The committees/working groups responsible for the organization and implementation of the 1995 curriculum have been described (Harden *et al.*, 1997) and included: the undergraduate medical education committee (UMEC) and its working group; the three phase sub-committees of UMEC; a theme committee; a SSC committee; the faculty assessment committee; the faculty academic standards committee; and the computer committee.

(1) UMEC

A United Nations approach to curriculum planning (Harden 1986) was adopted for the initial implementation stage of the 1995 curriculum, and UMEC had over 50 members.

This membership was considered too unwieldy for the maintenance phase. UMEC was reconstituted and slimmed down in 1999 after all years of the new curriculum had been implemented. It was chaired by the teaching dean and membership was confined to the dean; the three phase convenors; the chairpersons of other curriculum committees; the director of the clinical skills centre; the convenor of community-based teaching; a representative of the NHS trust staff; lecturers in medical education; student representatives; and support staff. Its role changed from that of a forum for consideration of detailed as well as general issues relating to the curriculum and discussion of educational issues to review of reports and recommendations from other curriculum committees.

(2) UMEC working group

Weekly meetings of the UMEC working group, chaired by the teaching dean, have continued. They now provide a forum for discussion of day-to-day curriculum implementation issues.

(3) The three phase sub-committees of UMEC and the SSC committee

These committees continue to meet regularly to take decisions regarding the organization and delivery of the phase/SSCs.

(4) The theme committee

With the introduction of outcome-based education the curriculum themes became redundant and the theme committee stopped meeting. Many of the themes were represented as outcomes, and outcome advocates/conveners were appointed but an outcomes committee was not formed. Oversight of student progression towards the outcomes became the responsibility of one of the lecturers in medical education. This individual has now left Dundee. Currently there is not an identified individual with responsibility for overseeing the development and progression of the outcomes.

(5) The faculty assessment committee

At the development stage of the 1995 curriculum heads of departments were surveyed to identify what involvement they wanted in planning the new curriculum (Davis, 1995). While most heads of departments were satisfied to be kept

informed of developments in planning the teaching and learning, 72% said they wished to retain responsibility for planning the assessment processes. The faculty assessment committee was set up to give heads of departments input into the integrated assessment process and to tap into their assessment expertise. It was chaired by the dean.

The committee has, however, met infrequently and for the most part heads of departments have not played an active role in planning the assessment procedures. There are assessment committees/examination boards for each year of the course that implement the assessment in individual years of the curriculum. Medical education staff supported the assessment committees but as these staff moved on and have not been replaced, development of the assessment has inevitably become piecemeal. The current structure does not favour overall management or supervision of the assessment system throughout the curriculum.

(6) The academic standards committee

The activities of the academic standards committee were taken over by UMEC. The academic standards process actively continues under strong leadership but underwent a significant change in emphasis with a move from policing and monitoring to quality enhancement.

(7) The computer committee

The activities of this committee continue with many successful initiatives such as expansion of the computing suite; establishment of Dundee online, a developing virtual learning environment; curriculum mapping activities; and a pilot study of the use of wireless laptops by students. IT initiatives need substantial funding to keep pace with curriculum developments.

Lessons learned. The education committee structure and membership should reflect the needs of the curriculum. As a curriculum becomes established there is a tendency for the committee structure and membership to change, reflecting a more administrative and maintenance role rather than a forward-planning education role.

Organization and management: administrative support

With the introduction of the 1995 integrated curriculum, administration of the curriculum was moved out of departments. Giving departments responsibility for delivering integrated courses was perceived to create more problems than solutions and moving departmental secretaries to a centralized administrative structure was politically unacceptable. Secretarial and administrative support for phases 2 and 3 of the curriculum is provided by the medical school office and faculty office administered by the faculty secretary. Secretarial staff from the medical school office take minutes of curriculum committee meetings; produce student study guides; and deal with the day-to-day running of the curriculum. Phase 1 (year 1) teaching is largely delivered by basic scientists, many of whom are academic staff in another faculty. Phase 1 organization and management is carried out outwith the medical school but good liaison is provided by the phase 1 convener and the phase 1 SSC convener who are active participants at curriculum committee meetings. The shift to central administration of the curriculum was not easy. It resulted in the loss of a pool of administrative expertise that resided in the departmental secretaries and took time to develop in the central administration. There were some compensations with regard to flexibility, however, in having a central group of secretarial staff available to support the curriculum. Changes to the administrative support structure have evolved since 1995, with the formation of two new administrative offices: a curriculum development office and an assessment office.

The curriculum development office was staffed by four lecturers in medical education with secretarial support. The lecturers provided educational support for the curriculum committees and administrative support for the curriculum. They carried out research in medical education and were responsible for many of the publications on the Dundee curriculum in academic journals. They also made presentations on the curriculum at medical education conferences. The office provided a focus for interactions between the student body and the curriculum.

An assessment office was established to administer the student examinations. It is staffed by an administrator and secretarial staff and provides support for the assessment committees for years 2–5.

Lessons learned. Administrative expertise residing at departmental level can be lost with the move to centralized administration of the curriculum. High-quality/senior administrative support is necessary for a successful shift to a centrally administered integrated curriculum. Separation of educational and administrative functions is needed as medical education staff can easily be regarded as administrators if academic staff are not aware of their areas of expertise. The assessment expertise residing within departments can be lost with the move to a centrally administered assessment system.

Conclusions

The curriculum introduced at Dundee medical school in 1995 proved to be robust and was supported by both external and internal reviews. It has stood the test of time and its major features remain unchanged. The curriculum has gained international recognition and, just as significantly, the endorsement of graduates. Goldacre *et al.* (2003), in their survey of UK preregistration house officers, found large differences between medical schools in how well their graduates felt prepared for their house jobs. Of the 23 UK medical schools surveyed, Dundee had the highest percentage of graduates who thought that their school had prepared them well for their house jobs (Goldacre, personal communication).

There is, however, a potential danger when a curriculum is successful. There is less incentive to change and there may be resistance to revising the curriculum. A curriculum is, however, a dynamic process that needs to respond to circumstances: the changes in society, medical practice and educational thinking. Indeed what is of interest is that there have been very significant changes within the framework of the 1995 curriculum. Innovations such as outcome-based education, task-based learning and portfolio assessment have

been of great importance. These changes should not be regarded as failure in the original curriculum planning but as a reflection of the medical school's responsiveness to the changing needs of society, government, students and teachers and of the supportive and caring educational environment identified by students and by external evaluation.

A number of lessons have been learned from the implementation and follow up of the 1995 curriculum about what is important in planning and implementing a medical curriculum.

(1) The importance of initial planning

The 1995 curriculum was introduced as a result of a significant curriculum review. The review group was headed by the Dean and comprised 10 individuals with key roles in the curriculum and two students. They met regularly in the evenings for two to three hours at two weekly intervals over a six-month period. Attendance at the meetings was almost 100%. A careful analysis of the problems of the existing curriculum was carried out. Future needs were also considered. A key feature of the review was the wide consultation with a range of stakeholders, including recent graduates, general practitioners, current teachers and students. These stakeholders were invited to attend a meeting of, and discuss their views with, the review group. Other medical schools were surveyed for information regarding how they addressed a range of educational issues. The group issued a draft report for consultation and following this the final recommendations were produced and approved by UMEC and the faculty board. Communication of the finalized curriculum revision plans took place at a well-attended staff meeting and through circulation of the working group report.

(2) The need for a big picture

An overall structure and clearly enunciated educational principles provided a framework to inform ongoing discussions regarding curriculum implementation and guide change. The identification of the core clinical problems as the basis of task-based learning, integrated systems-based teaching and learning, outcome-based education with identification of 12 exit learning outcomes, the spiral curriculum, the core and options model and the 20 principles of assessment provided this structure and guidance.

(3) Facilitation of student learning

A range of approaches is needed to support student learning. Student study guides, introductory courses, educational facilities such as a clinical skills centre, computing suite and integrated learning area, P-2-P or collaborative learning, curriculum mapping, the student assessment system and a student support scheme are all important in facilitation of student learning.

(4) The student assessment system

The student assessment system needs to be integrated with the teaching and learning and be capable of supporting student learning. This is part of the paradigm shift from testing to assessment. If the curriculum is integrated in terms of disciplines and specialities, then the assessment system must also be integrated or the curriculum integration will be lost. The assessment-to-a-standard approach recognized the needs of different students and supported slower learners through the curriculum, even though the underlying concepts and shift in thinking involved in the approach had difficulty gaining general acceptance.

(5) Committee and administrative structure

The committee and administrative structure needs to support the curriculum. Changes in this structure may be necessary for different stages in the life of the curriculum: planning, implementation and maintenance. Implementation of an integrated curriculum where the responsibilities lie centrally in a school and where staff are located within departments does cause difficulties that need to be addressed. A matrix management system within a medical school may resolve the tensions between departmental and central control of the curriculum.

(6) Professionalism in medical education

There is a need for the commitment of all staff to the curriculum process. Different levels of educational expertise, however, are required. A critical mass of staff need to have an understanding of the underpinning educational principles and concepts and the educational vocabulary to discuss educational developments and to take part in the decision-making processes. Medical staff with educational expertise are needed for educational facilities such as the clinical skills centre. Professionalism in medical education is needed to support the curriculum, the assessment and the staff in their teaching activities. Research into medical education is necessary and professional medical educators can provide a focus for research activities. They can also engage students in the teaching and learning process and involve them in educational research.

(7) Leadership

Leadership is intimately associated with change and its sustainability. Leadership by the dean and other senior staff was needed for the curriculum revision and for the institutionalization of change. It is needed for the endorsement of change by curriculum committees. When leadership for the multiprofessional initiatives was lost, most failed.

(8) Flexibility

Built-in flexibility is important for sustainability. A curriculum is a living entity where ongoing change is almost certainly needed. When major changes such as outcome-based education, task-based learning and portfolio learning and assessment were introduced, the curriculum could adapt and cope.

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