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Research-Teaching Linkages: enhancing graduate attributes

Medicine, Dentistry and Veterinary Medicine

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Research-Teaching Linkages: enhancing graduate attributes

Medicine, Dentistry and Veterinary Medicine

Julie Struthers (Project Director)
Dr Anita Laidlaw
Dr James Aiton
Professor Gerry Humphris
Professor Simon Guild
University of St Andrews

Preface

The approach to quality and standards in higher education (HE) in Scotland is enhancement led and learner centred. It was developed through a partnership of the Scottish Funding Council (SFC), Universities Scotland, the National Union of Students in Scotland (NUS Scotland) and the Quality Assurance Agency for Higher Education (QAA) Scotland. The Higher Education Academy has also joined that partnership. The Enhancement Themes are a key element of a five-part framework, which has been designed to provide an integrated approach to quality assurance and enhancement. The Enhancement Themes support learners and staff at all levels in further improving higher education in Scotland; they draw on developing innovative practice within the UK and internationally. The five elements of the framework are:

- a comprehensive programme of subject-level reviews undertaken by higher education institutions (HEIs) themselves; guidance is published by the SFC (www.sfc.ac.uk)
- enhancement-led institutional review (ELIR), run by QAA Scotland (www.qaa.ac.uk/reviews/ELIR)
- improved forms of public information about quality; guidance is provided by the SFC (www.sfc.ac.uk)
- a greater voice for students in institutional quality systems, supported by a national development service - student participation in quality scotland (sparqs) (www.sparqs.org.uk)
- a national programme of Enhancement Themes aimed at developing and sharing good practice to enhance the student learning experience, facilitated by QAA Scotland (www.enhancementthemes.ac.uk).

The topics for the Enhancement Themes are identified through consultation with the sector and implemented by steering committees whose members are drawn from the sector and the student body. The steering committees have the task of establishing a programme of development activities, which draw on national and international good practice. Publications emerging from each Theme are intended to provide important reference points for HEIs in the ongoing strategic enhancement of their teaching and learning provision. Full details of each Theme, its steering committee, the range of research and development activities as well as the outcomes are published on the Enhancement Themes website (www.enhancementthemes.ac.uk).

To further support the implementation and embedding of a quality enhancement culture within the sector - including taking forward the outcomes of the Enhancement Themes - an overarching committee, the Scottish Higher Education Enhancement Committee (SHEEC), chaired by Professor Kenneth Miller, Vice-Principal, University of Strathclyde, has the important dual role of supporting the overall approach of the Enhancement Themes, including the five-year rolling plan, as well as institutional enhancement strategies and management of quality. SHEEC, working with the individual topic-based Enhancement Themes' steering committees, will continue to provide a powerful vehicle for progressing the enhancement-led approach to quality and standards in Scottish higher education.

Norman Sharp
Director, QAA Scotland

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Foreword

This Enhancement Themes project - Research-Teaching Linkages: enhancing graduate attributes - has over the last two years asked institutions, departments, faculties, disciplines, staff and students to reflect on the intended outcomes of HE, and has examined how links between research and teaching can help develop 'research-type' graduate attributes. The 'attributes' in question are the high-level generic attributes that are necessary to allow our graduates to contribute to and thrive in a super-complex and uncertain future where the ability to question, collate, present and make judgements, quite often with limited or unknown information, is increasingly important; key attributes, it is argued, that are necessary for our graduates to contribute effectively to Scotland's civic, cultural and economic future prosperity.

The Enhancement Theme adopted a broad, inclusive definition of research to embrace practice/consultancy-led research; research of local economic significance; contributions to the work of associated research institutes or other universities; and various types of practice-based and applied research including performances, creative works and industrial or professional secondments.

The Enhancement Themes comprise one sector-wide project and nine disciplinary projects: Physical sciences; Information and mathematical sciences; Arts, humanities and social sciences; Health and social care; Business and management; Life sciences; Creative and cultural practice; Medicine, dentistry and veterinary medicine; and Engineering and the built environment. The aim of the projects was to identify, share and build on good and innovative practice in utilising research-teaching linkages to enhance the achievement of graduate attributes at the subject level. The sector-wide project comprised an ongoing discussion within and between Higher Education Institutions, involving staff and students reflecting on and exploring research-teaching linkages, how they can be structured and developed to achieve 'research-type' attributes, and how students are made aware of the nature and purpose of these in order to fully articulate and understand their achievements as graduates.

Research-Teaching Linkages: enhancing graduate attributes has provided the sector with a focus for reflection on the nature and outcomes of HE - along with the opportunity to develop a rich array of resources and supportive networks to add to the student learning experience and enable our graduates to contribute effectively to Scotland's future.

Professor Andrea Nolan
Chair, Research-Teaching Linkages: enhancing graduate attributes
Vice-Principal Learning and Teaching, University of Glasgow

1 Executive summary

1.1 Introduction

This discipline-based project was part of the Enhancement Theme programme on Research-Teaching Linkages: enhancing graduate attributes. The focus of the Enhancement Theme is on sharing and building on current and emerging practice at discipline level.

The project was concerned with the degree to which research skills can be developed in regulated vocational programmes such as those for medicine, dentistry and veterinary medicine. All three disciplines claim that research skills and attributes are necessary to be a good practitioner, as they are specific outcomes for all programmes. So how are these skills achieved? The project aimed to identify research-teaching linkages in the three disciplines and provide examples of good practice, in order to permit an understanding of high-level graduate attributes and how best to support and promote the achievement of such attributes.

Information for this project report was gathered from structured interviews carried out with faculty members from all disciplines, and data collected at a Medicine, Dentistry and Veterinary Medicine Symposium on Research-Teaching Linkages. The report presents a snapshot of current practice and opinion on the degree to which research skills can be developed in regulated vocational programmes such as medicine, dentistry and veterinary medicine. It provides a practical supplement to the current literature on research-teaching linkages.

1.2 Key points

Definitions

Throughout the course of this project work, the terms 'research' and 'teaching' were used in their broadest sense, so that discussions were not constrained.

Core attributes

Representatives of all three disciplines proposed the following seven high-level graduate attributes desirable for both research and professional practice:

- an enquiring mind
- core knowledge
- critical appraisal
- understanding of evidence base for practice
- ability to work in a team
- understanding of ethics and governance
- ability to communicate.

Instilling graduate attributes using research-teaching linkages

Critical thinking and an appreciation of the research ethos were felt to be key ingredients underpinning research and professional practice, such that research attributes are of prime importance in a vocational programme. It was felt that all students should acquire basic core research attributes, although additional values, skills and attributes are necessary for those possibly contemplating a research career. The three disciplines offer different strategies and activities to support students in gaining research-related attributes.

Delivering the core course through a problem-based learning (PBL) approach was believed to be a unique opportunity to deliver core professional knowledge while simultaneously addressing some of the attributes necessary for research. It was felt that critical thinking was embedded in the PBL approach, and that students of PBL would automatically adopt this way of thinking. However, in non-PBL schools, interviewees identified a number of areas where critical thinking was developed in their curricula, such as the analysis of journal articles and student projects.

Role models were felt to be vital to inspire students, encourage and enthuse them, and place skills and attributes in context.

Four main models of how to engage students in a research experience were identified: student-selected components (SSCs), summer projects, integrated honours degrees and science-based first-degree courses with a vocational slant.

Essentially, some kind of independent work - via either a PBL approach or a research project - will provide the opportunity to encourage research attributes.

School-level barriers

Students were not thought to be aware of the relevance of research and research attributes to them and their future professional career. Students focus on areas of the curriculum that are assessed, and efforts to engage them with local research beyond an assessed area of the curriculum can be challenging. Many of the schools interviewed have found interesting ways of overcoming this barrier.

In relation to engaging students in an actual research project, the barriers identified were time for gaining ethical approval, cost of a laboratory-based project and the problem of saturating clinics in community projects with students.

National-level barriers

In medicine, the General Medical Council's *Tomorrow's doctors* (2003) was commended for 'freeing up' 33 per cent of curricular time for SSCs, which allow schools the opportunity to include research or research-related projects in the curriculum. For the other disciplines, those interviewed felt that the General Dental Council and the Royal College of Veterinary Surgeons were more focused towards making sure that the course covered all areas necessary for clinical competence. To them, the opportunities for research appeared to be a luxury, as their graduates would have greater clinical responsibilities immediately after graduation.

Some project participants thought that the governing bodies could and should promote the academic career pathway to a greater extent.

The current Research Assessment Exercise (RAE) was seen as a major barrier from the academic staff viewpoint, as time spent teaching students was time spent away from focusing on their own research output. In addition, it was felt that educational research was not given appropriate value in terms of research recognition or funding opportunities.

Enthusing students

One concern raised in the project was the feeling that students could leave their university without being aware of the key areas of research or the international research 'stars' within their particular school. Some schools have tried to address this issue through researchers giving inspirational talks or by inviting these researchers to guest lecture on their course. Several said that it was embedded in the ethos of the staff that they interact with students at research level; others said that it was up to individual staff to engage with students about their research.

Publication of students' research projects was raised as an important way of encouraging students in research.

1.3 Conclusion

In conclusion, many of the attributes required for research overlap with the attributes required for professional practice. Therefore, it is essential that all graduates acquire a basic level of research attributes.

The project found that deeper levels of research attributes were commonly available in different parts of the curriculum - for example, PBL teaching, SSCs, summer research projects and intercalated/BSc (Hons) courses. Role models were felt to be essential for enthusing students to consider a research career. It was also considered essential to devise novel ways to overcome the many current barriers, such as encouraging the research 'stars' within institutions to sign up to educating the future researchers of their disciplines.

Finally, it was felt that enthusing current students to consider incorporating research into their career plans is vital to the future development of the professions of medicine, dentistry and veterinary medicine.

2 Introduction

This discipline-based project was part of the Enhancement Theme programme on Research-Teaching Linkages: enhancing graduate attributes. The focus of the Enhancement Theme is on sharing and building on current and emerging practice at discipline level. Along with sector-wide projects, the Enhancement Theme's nine discipline-based projects aimed to develop a shared understanding of high-level graduate attributes and how best to support and promote the achievement of such attributes.

2.1 Background

This project focused on medicine, dentistry and veterinary medicine. All are vocational subjects leading to qualifications permitting graduates to practise their profession. The project was concerned with how research skills and attributes such as critical appraisal and critical thinking can be identified and developed in vocational subjects, which are under the control of professional bodies such as the General Medical Council (GMC), General Dental Council (GDC) and Royal College of Veterinary Surgeons (RCVS).

Looking at medicine specifically, *The Medical Act 1983 (Amendment) Order 2002* gave the GMC responsibility for setting and maintaining standards of basic medical education in the UK. The GMC's Education Committee undertakes this role by a variety of means, including publishing recommendations on undergraduate medical education. The most recent publications have been *Tomorrow's doctors* in 1993 and 2003. The GMC's Education Committee also undertakes statutory visits to assess the quality of teaching and inspections of the final qualifying examinations.

The goals of undergraduate medical education set out by the GMC in *Tomorrow's doctors* (2003) are as follows:

- students should acquire a knowledge and understanding of health and its promotion, and of disease, its prevention and management
- students should acquire and become proficient in basic clinical skills
- students should acquire and demonstrate attitudes necessary for the achievement of high standards of medical practice.

Tomorrow's doctors specified that medical curricula must be designed to cover the scientific practice of medicine, where:

> 'Graduates must have a knowledge and understanding of the clinical and basic sciences...and be able to integrate and critically evaluate evidence from all...sources to provide a firm foundation for medical practice.'

In addition, they must 'have an understanding of scientific methods, including both the technical and ethical principles used when designing experiments'.

In Scotland, the GMC guidelines and recommendations published in *Tomorrow's doctors* were refined by the Scottish Deans Medical Education Group into an outcomes-delineated curriculum guide called *The Scottish doctor - learning outcomes for the medical undergraduate in Scotland: a foundation for competent and reflective practitioners*

(Simpson et al, 2002). All five medical schools in Scotland have agreed to shape their curricula to meet common levels of outcomes, and 'the doctor as a researcher' is one outcome expected of the 'doctor as a professional'.

For dentists, *The First Five Years* (GDC, 2002) stipulated under its section on skills that:

> 'The dental graduate must be able to: apply evidence-based treatment and acquire a wide range of skills, including research, investigative, analytical, problem-solving, planning, communication, presentation and team skills.'

Similarly, research was mentioned in several areas of the RCVS 2006 guidelines to veterinary institutions. Two examples were:

> 'Veterinary training institutions are to provide adequate, research-based veterinary training....'

> 'The advancement of knowledge is a task involving all members of the profession. Therefore, interaction between students and clinical researchers working in the clinical field should be arranged in order to stimulate students' interest in research.'

It is evident from the above guidelines that the different governing bodies have identified research skills as a graduate attribute for their discipline. This project set out to discover how the different disciplines and schools have tackled the inherent tensions between providing vocational training and developing research skills and attitudes in their undergraduates. It attempted to find out whether opportunities to develop the appropriate research attributes were embedded within the different curricula and whether they were the same for all students within the three disciplines.

2.2 Brief description of project

The three specific aims of this project were to:

- determine the current level of understanding of research-teaching linkages within schools
- gain opinion on desirable graduate attributes from these three vocational degrees
- collect case studies of good practice from the community.

Information for this report was gathered from structured interviews carried out with faculty members from all three disciplines. In addition, data were collected at a Medicine, Dentistry and Veterinary Medicine Symposium on Research-Teaching Linkages. NVivo7 qualitative data analysis software was used as a tool to facilitate analysing the results from the interviews and symposium.

The interviews (24) were carried out with faculty members from schools in all three disciplines in all Scottish universities and a few English institutions. In all cases, interviews were granted with the Director of Teaching or a suitable member of staff who had knowledge of the curriculum and curriculum development issues. A qualitative survey containing 15 questions was designed to address our aims; these questions were combined into one interview session. They focused the interview and facilitated standardisation of the information gathered.

The questions were grouped to direct the discussion: firstly, on staff's understanding of research-teaching linkages and graduate attributes and, secondly, to move the discussion on to how these are developed at organisational and curriculum level. In addition, questions pursued any practical approaches taken by each school to address the research-teaching linkage.

The second source of information for this report came from a one-day symposium attended by 58 staff and students from the three disciplines; all universities in Scotland were represented. In addition, representatives from medicine, dentistry and veterinary medicine schools in England attended. The aims of the symposium were to:

- develop a better understanding of high-level graduate attributes in medicine, dentistry and veterinary medicine
- illustrate innovative and effective means of integrating research in undergraduate learning
- stimulate debate around best practice in research-teaching linkages
- provide a forum for students' views to influence the integration of research in the undergraduate curriculum.

Following case study presentations, two small-group breakout sessions provided opportunities to focus discussion among delegates on the two main project themes: research-related graduate attributes and linking teaching and research. Specific activities and questions relating to the topics were set during these breakout sessions. Discussion was facilitated and recorded by members of the project team. The results from each group were then collated; they form part of this report[1].

2.3 Outline of report

This project report presents a snapshot of current practice and opinion on the degree to which research skills can be developed in regulated vocational programmes such as those for medicine, dentistry and veterinary medicine. It is a practical supplement to the current literature on research-teaching linkages, an excellent summary of which can be found in Jenkins et al (2007).

The report includes an analysis of the responses from key curriculum developers and practitioners on their understanding of graduate attributes and how they address the requirements of the governing bodies to produce graduates with a wide range of research skills. Selected quotes are given where appropriate within the text to show the variety of faculty responses or to highlight an important point raised. Case study examples are featured in the main body of the report to illustrate how some institutions have incorporated research-teaching linkages into their curriculum. Full details of each case study can be found in the appendix.

[1] Full details of the methods used, along with a list of interviewees, symposium attendees and other project documents can be found at: http://medblogs.st-andrews.ac.uk/ResearchTeachingLinkages/default.aspx

3 Current practice and opinion

This section reports and discusses the responses from the interviews and symposium discussion groups. The questions in the interviews and discussions during the breakout sessions at the symposium targeted different levels of understanding, practice and personal opinion on the issues around research-teaching links and graduate attributes. Hence the responses relating to these issues are presented under the following sections:

- faculty understanding
- organisation level
- curriculum level
- practical approach
- specific graduate attributes
- opinion.

3.1 Faculty understanding

Given the wide range of subjects covered by this Enhancement Theme, it was unlikely that there would be a common understanding of what defines research and, consequently, what establishes the linkage between research and teaching.
The definition proposed by the Enhancement Theme Steering Committee encompasses a range of practices and was an excellent starting point for this project.

The project was asked to embrace:

> 'practice/consultancy-led research, research of local economic significance, contributions to the work of associated research institutions or other universities, and various types of practice-based and applied research, including performance, creative works and industrial or professional secondments.'

To ensure that we understood the standpoint of interviewees within the three disciplines covered by this project, we asked them to consider what their understanding was of research-teaching links. This helped to clarify, in our minds and those of our participants, the scope of the activities that could be considered within the parameters of the project.

We also asked the interviewees and symposium attendees to suggest the research-related attributes they thought a graduate from their own particular degree course should have acquired. This allowed them to focus on the key graduate attributes within the disciplines of dentistry, medicine and veterinary medicine.

The following collates the responses to our questions in these two areas:

- what are research-teaching links?
- what are the key research-related graduate attributes?

What is your view/understanding of these issues?

Three main themes emerged from the interviews. No differences in themes were noted among the three disciplines. The themes identified were as follows:

- **Staff using their research interests, knowledge and experience to inform their teaching and stimulate student interest**

  It was seen as critically important that teaching staff were currently research-active. This ensured that information delivered to students was up to date. The view was expressed that such information would also be more successful in enthusing students to engage with research. A note of caution was expressed, however, that a curriculum led purely by research or the staff's research interests may not be the most appropriate to address all the clinical skills necessary for the three professional disciplines of medicine, dentistry and veterinary medicine.

  'For a vocation such as dentistry that may not be appropriate. What you then get is people teaching their own specific research area viewpoint on an issue and it doesn't necessarily chime with how the rest of the world is. It may be taking that discipline forward, but it doesn't necessarily chime with the day-to-day practice of dentistry in today's world.'

- **Applying educational research to teaching methodology**

  Several faculty members from the different disciplines highlighted research into teaching methods as part of their understanding of research-teaching links. As professional practice was noted to be 'evidence based', then the way in which students were taught should also be evidence based.

  'Integrating the best evidence from research into undergraduate teaching. You integrate not only the research on the clinical and pre-clinical stuff, but also the education research into the way you are doing it.'

Case study: Is medical education research part of the research-teaching nexus?

An active programme of pedagogical research into communication skills teaching forms part of the curriculum. The research can be split into three areas:

- what communicators bring to an interaction - what characteristics of students may impact on their abilities to communicate?
- what we can do - what communication skills teaching methods/innovations are effective?
- looking at the outcome - communication skills assessment, what makes a good communicator?

The teaching methodologies are research based and therefore students experience innovative and exciting teaching techniques refined as work progresses. The teaching environment is research active. As participants in research studies, students gain an understanding of research methods (including ethical issues and study design). Awareness of ongoing research in the school is also raised.

(For full case study, see Appendix, 7.1: Anita Laidlaw, St Andrews University)

- **Involving students in research in a practical way**

  Actively involving students in research was thought to provide a multidimensional approach to research-teaching linkages. Hopefully, involving students in research also enthuses them and raises their awareness of current research findings. It was also seen as a way of helping students to develop an understanding of research methods and therefore of their application to their professional, clinical practice.

  'From the widest possible sense to the narrow sense where students do a research project with a supervisor. Actually go through a research process.'

Can you think of 10 research-related attributes that graduates from your course should have?

Interviewees listed a total of 122 attributes, an average of five per individual. Collation and amalgamation were carried out by two of the authors (Julie Struthers and Anita Laidlaw) to produce a final list of 16 research-related attributes, shown in table 1.

Research-related graduate attributes	
Ability to communicate	Appreciation of the need for continuing professional development (CPD)
Ability to generate research data	Appropriate personal qualities
Ability to search literature	Core knowledge
Ability to work in a team	Critical appraisal
Awareness of an academic career path	Enquiring mind
Understanding of basic research methods	Information technology (IT) skills
Understanding of ethics and governance of research	Practical ability to do research
Understanding of evidence basis for professional practice	Understanding of data analysis

Table 1: the 16 research-related graduate attributes reported by interviewees as important for a graduate of their degree programme

The list reveals various higher and lower-level attributes. There were no obvious differences among the three disciplines regarding which graduate attributes were listed.

These 16 attributes were discussed and probed further during the breakout sessions at the symposium. Participants ranked the attributes from two standpoints: a research career and a professional career. Interestingly, the top seven attributes were the same whether ranked from a research or a professional standpoint, although the rank order differed. Table 2 shows the top seven graduate attributes together with their ranks from a research and a professional career standpoint. Definitions of the ranked attributes were agreed at the symposium; these can be found in table 3.

Attribute	Research ranking	Professional ranking
Enquiring mind/curiosity	1	4
Core knowledge	2	1
Critical appraisal	3	2=
Understanding of the evidence base for practice	4	2=
Ability to work in a team	5	6
Understanding of ethics and governance of research	6	7
Ability to communicate	7	5

Table 2: the top seven graduate attributes desirable for a research career or a professional career, with the rank order reported from the breakout sessions; the lower the number, the more the attribute was thought to be important

The consensus across all groups was that research-related graduate attributes were essential to becoming a good professional as well as a researcher. It was noted that most professionals would at some point have to conduct an audit, and that these skills were vital for doing this even if they were not research-active. From a dentistry perspective, it was noted that patients frequently ask about the evidence basis for particular procedures or materials. Professionals were expected to know this and be able to impart the relevant information in an appropriate, understandable manner as part of professional practice.

There was also the key point that as the evidence base for all disciplines was developing fast, good professionals would keep their knowledge base up to date, for which many of the research-related skills were extremely important.

> 'The practice of medicine or other professions is the distillation of the research.'

However, on a cautionary note it was emphasised that research-related graduate attributes must be 'sold' to students and their value and relevance emphasised. The current Tuning project described at the symposium is in the process of defining Europe-wide graduate attributes and will emphasise the importance of acquiring these[2].

[2] Professor Allan Cumming, Tuning Medicine, available at: http://medblogs.st-andrews.ac.uk/ResearchTeachingLinkages/Project%20Documents/Forms/AllItems.aspx

Attribute	Definition and discussion
Enquiring mind/curiosity	This is a desire to understand and explain. It could be fostered and encouraged during the undergraduate years. There was some discussion in the groups as to whether the current exams system stifles and actively discourages an enquiring mind, instead focusing on the knowledge core. One reason to fight to keep research and research experience as part of the curriculum would be to encourage this attribute.
Core knowledge	There was acknowledgement that core knowledge is continually developing and that graduates should have an understanding of this. But it was also noted that core knowledge enables individuals to ask questions and challenge facts, such that some core knowledge is essential.
Critical appraisal	This is the ability to understand evidence and how it was achieved, and to rate or value it accordingly. It was thought that literature searching would be included here rather than be a separate attribute in its own right.
Understanding of the evidence basis for practice	In all practitioners an awareness of the evidence supporting their practice is vital - why one procedure is favoured over another, or why one material is used in a particular situation. This should also include an appreciation of where the evidence comes from.
Ability to work in a team	'Team' is loosely defined and could include multi-professional teams in a research or clinical setting. It was thought that this attribute should also include an appreciation of different team roles and their importance in ensuring that teams work effectively.
Understanding of ethics and governance	This includes an understanding of ethical and legislative issues, such as ethical committee and Home Office powers.
Ability to communicate	This is a broad attribute covering all aspects of communication, and incorporating a variety of individuals such as patients, co-workers, experts in the field and the general public. It also encompasses communication with various media, one-to-one interactions, public speaking, written notes, leaflets and journal articles. The theoretical as well as the practical elements of communication should be covered.

Table 3: the top seven graduate attributes as defined by the symposium breakout groups

3.2 Organisation level

The previous questions clarified staff's understanding of research-teaching links and identified the research attributes they thought were important for graduates of their programmes. This section reports on current practice: how did different schools incorporate research-teaching linkages in their undergraduate curricula? This question was split into levels, initially focused at organisation level but moving down through curricular level, the practical approaches employed in schools, and finally how specific graduate attributes were tackled.

What are you as an organisation doing to introduce research-teaching linkages into your undergraduate curriculum?

In all three professional disciplines, the research-teaching link was viewed as a way of raising students' awareness of the clinical application of research.

> 'All professional faculties have the ambition to encourage undergraduates to have a grounding in understanding where research fits into clinical practice [as that is what most of them want to do].'

It was clear that some aspects of this linkage were implicit. Interviewees felt that academic staff involved in research would be expected to include some elements of this in their teaching, whether they were basic scientists or academic clinicians.

Honours degree

All three disciplines offer an intercalated degree with an additional year of study in which the student does a major research project, which is written up for an honours degree. This is often done in the middle of their undergraduate professional course. Depending on the school, different percentages of students are given this opportunity. The projects undertaken are related to the research interests of the academic researchers. In one institution, approximately 60 students per year take up this option. Partial funding for this additional year is available from the Scottish Funding Council. Some institutions offer financial assistance to encourage interested students to view it as a viable option. A number of schools allow students the opportunity to take time out for an MSc and, in a few cases, a PhD.

One interviewee noted that the intercalated year was vital for those veterinary students who saw their career path as more research focused than practice focused, saying that:

> '…the single most important thing is the intercalated year; 20 per cent of students do an intercalated year.'

A small number of medical schools offer a BSc (Hons) degree where all students undertake a research project as part of their course. In these courses undergraduates study the scientific aspects of medicine prior to moving on to a clinical school to complete their medical degree.

> 'All of our students must undertake a research project as part of their honours degree before continuing their clinical training.'

Generic skills training

Several interviewees, in all three disciplines, mentioned introducing 'generic skills' taught prior to and in preparation for a research project. In some schools, these were taught as a block, but in others they were integrated throughout the curriculum and viewed as a way of developing the skills needed by students both for evidence-based practice and to carry out a research project:

> '…to emphasise to students that these skills encompass all areas and are relevant to all specialist subjects.'

Case study: Generic scientific skills for medicine - a vertical curricular strand

All medical students at St Andrews complete a research project for their three-year BSc (Hons) Medicine. To prepare students for their research project, generic research skills are introduced from year 1. Students have the opportunity to practise the skills needed for their research programme through a number of elements in the earlier years of the curriculum. The elements covered are categorised as follows:

- the scientific method in medicine
- evidence-based medicine
- writing skills
- presentation skills
- personal development.

(For full case study, see Appendix, 7.2: James Aiton, University of St Andrews)

A similar scientific skills training strand in a dental curriculum was described. This training was designed to prepare students for their research project. The preparation skills matrix spans the three years prior to the project and is a key way of achieving the research-teaching linkages in this school.

> 'Generic research skills are integrated through the BDS programme to aid students in completing tasks such as the Dental Epidemiology project.'

Student-selected components

Medical schools make use of the non-core section of the curriculum - the third of the curriculum given over to student-selected components (SSCs) or special study modules - to offer students the opportunity to be involved in research-related projects. Each school manages the number and duration of these SSCs in a different way, so the depth to which students experience the research environment also varies. Research-related SSCs can be between one week and six months in duration, but often count towards assessment. The extent to which students are involved in the research differs, from gaining experience in practical laboratory skills to literature reviewing. More information on SSCs can be found in section 3.3.

Case study: Student-selected components in the medical curriculum

In the undergraduate programme in medicine at the University of Edinburgh, the SSCs form more than 20 per cent of the timetable and are the main research-teaching linkage. The SSCs are also important in defining this course by providing clear research opportunities to participating students in a research-rich environment. The purpose of the SSC programme is to permit students to progressively develop a broad spectrum of research skills (including understanding evidence-based medicine, informatics, medical statistics and critical appraisal), in conjunction with professional skills (including communication, teamworking and lifelong learning skills), on projects of their choice.

The SSC programme is fully integrated with the core curriculum, both in developing core skills and in its assessment. Students carry out four separate research projects. In year 1, they select (from a wide choice) a hospital-based project and work in small groups supervised by a member of staff. The project usually involves an appraisal of literature and a simple questionnaire to patients. In year 2, students perform two literature-based projects in small groups, facilitated by a member of staff. The first is from a choice of topical medical issues and the second is organised by students themselves; with support, they sign up their own staff facilitator. In year 4, students decide on and self-select a topic or field of study, again with support. They negotiate with and sign up to work with a supervisor for a 14-week research project.

(For full case study, see Appendix, 7.4: Simon Riley, University of Edinburgh)

Plenary lectures

Plenary lectures by researchers, either local or invited, are another way in which the research-teaching link is encouraged at organisation level in medical schools. These lectures were viewed as a way of enthusing students about research.

Case study: Plenary lectures

Plenary lectures were introduced as a means of amplifying and clarifying areas of learning and also as a means of inspiration for students, so that they could appreciate the cutting edge of medical science. The plenary lectures at the University of Glasgow represent an important area where research findings are incorporated into the medical curriculum. Moreover, in some cases they serve a dual purpose of developing research attributes.

(For full case study, see Appendix, 7.5: Sarah Mackay, University of Glasgow)

One interviewee noted that although their institution ran plenary lectures by local academics on research activities, students could not see the relationship between this research and their clinical practice.

Summer vacation projects

Most schools offer students the opportunity to do a summer research project. External funding, in some cases through bequests, allows students to be paid a small salary. Although only a limited number of students (two to three in each school) are able to take part in such projects:

> 'Most end up with their names as co-authors on a paper or have the opportunity to present at an academic meeting.'

One university has established an Undergraduate Research Internship Programme, where students are paid for 10 weeks to do a research project. The aim of this programme is to give undergraduates experience of doing research during the summer vacation. This is a university-wide initiative.

Research days

In one school, students are exposed to research during a 'research emphasis day', when local researchers present some of their current work to students of all years in a conference-style format. In addition, the school invites speakers from a variety of potential research employers to an afternoon called VetChoice, when students from any year are invited to learn about opportunities for veterinary undergraduates and graduates. These include talking about research opportunities within the veterinary school and also external opportunities, as students are able to do their intercalated year elsewhere.

> 'Don't just encourage students to do research...but also advertise opportunities elsewhere.'

As these VetChoice days are run every year, there is the potential for students to hear a huge number of talks during their five years as undergraduates.

Case study: Research core and research track

Research core

The curriculum was reviewed to create space for in-depth study of some topics, making the achievement of generic research-related graduate attributes more likely. Additional components of the research core are specific learning outcomes and activities, which are embedded within a 'vertical thread' running through the curriculum. Students are assessed on these activities.

Further elements are the clinical research project and VetChoice/research emphasis day, now being expanded to a model spread more regularly through the curriculum. The clinical research project is spread over several months. Students investigate a clinical problem, for example, and apply relevant analysis to explore the data. Some of these projects are later published.

Research track

Attracting veterinary graduates into a research career is important for the future of veterinary medicine, as highlighted in the Selbourne report (1997). Evidence in the literature indicates that summer studentships are an important means of attracting students into research. The research track includes developing and expanding opportunities for summer research studentships, encouraging intercalated BScs and MScs and developing an integrated PhD programme.

(For full case study, see Appendix, 7.6: Susan Rhind, University of Edinburgh)

Other schools offer similar inspirational days early in the degree course to raise students' awareness of research and pique their interest.

Probing research interests on admission

One veterinary medicine school reported that potential students were assessed for interest or experience in research prior to admission. The view was expressed that the veterinary degree was seen not just as a way to access the veterinary profession, but also as providing a good grounding for a career in science.

> 'The veterinary degree that is offered is one of the best degrees for training to allow you to enter a scientific career, be it research, veterinary medicine, teaching, whatever.'

This standpoint was not observed in medicine or dentistry, and shows an interesting difference in the focus on producing a vocational 'product'. It may be related to conclusions made by Lord Selbourne in his 1997 report, where he noted that there was a deficit in the numbers of veterinary researchers and that this issue should be addressed.

3.3 Curriculum level

These questions investigated curriculum-level coverage of research-teaching links. They asked how links between research and teaching were built into a professional curriculum, and if anything related to curricular style impacted on this.

How do you fit building research into a curriculum constrained by governing bodies, such as the GMC's *Tomorrow's doctors* and The Scottish Doctor, the GDC's *First Five Years* and the RCVS guidelines? Is this restrictive?

When universities offer degrees aimed at specific professions such as medicine, dentistry and veterinary medicine, in addition to adhering to the university regulations required for the award of a degree, there are external bodies, which oversee and validate the course content. These bodies include the General Medical Council (*Tomorrow's doctors,* 2003), the General Dental Council (*The First Five Years,* 2002) and the Royal College of Veterinary Surgeons (*Criteria and guidance for RCVS approval of veterinary degree courses in the UK and overseas,* 2006). Some veterinary schools are also members of the European Association of Establishments for Veterinary Education (EAEVE) and as such are subject to its evaluation. Such demands are naturally to ensure that graduates from all institutions have the necessary skills for their immediate professional life and, in EAEVE's case, to ensure common standards of veterinary graduates across Europe.

The question obviously arises whether the constraints imposed by these external bodies actually influence the ability to build research thinking into a degree where the prime aim is to learn professional skills.

The majority, indeed universal, view from the medical schools was that these external bodies did not hinder the input of a research ethos into the undergraduate curriculum. Moreover, to some extent *Tomorrow's doctors* has helped to inject a research ethos by stipulating that core teaching should only take up two-thirds of the time and that the other one-third should be taken up by SSCs where research thinking can feature prominently, although not exclusively. One respondent applauded *Tomorrow's doctors* for 'freeing up 30 per cent of student time':

> 'The core curriculum must be supported by a series of student-selected components that allow students to study, in depth, areas of particular interest to them.'

The implication was that only two-thirds of course time was required to cover the core essentials for graduates to begin their professional life and that the remaining one-third should be used to develop other key attributes, including encouraging and developing a research ethos in some students. This was not to say that research would necessarily feature in all students' SSCs, but it could feature prominently in those who choose for it to do so. It is not that SSCs usually involve students doing a research project as such, but rather that they often have to write a report of some kind, which would involve key elements of research such as searching and critically appraising literature. It could also involve working out in some areas:

> '…what the key question is, marshalling the arguments as to why it is a question worth answering and how it might be answered.'

One respondent pointed out that SSCs might alternatively involve doing an audit project, and that audit and research often involved developing similar skills.

The views expressed by the dentists and the veterinary surgeons were somewhat different to those of the medics. For them, the external constraints were much more towards making sure that the course covered all areas necessary for professional and clinical competence. One dental academic said that:

> '…there is a moral imperative really that what this job is about is training dentists. Research is almost a luxury.'

Another said that:

> 'The priority has to be to get GDC approval so that the students who are enrolled on the course will be fully qualified dentists at the end of study.'

The point was made that newly qualified dentists were more on their own in clinical practice than medical graduates were, and this shifted the emphasis towards clinical competences more so for dentists than for medical graduates. However, the GDC guidelines, *The First Five Years* (2002), stated that the dental graduate must be able to:

> '…apply evidence-based treatment [and]…acquire a wide range of skills, including research, investigative, analytical, problem-solving, planning, communication, presentation and team skills.'

The feeling among veterinary schools was more similar to that of dental schools than medical schools. Veterinary schools felt that veterinary students needed to learn too much in order to be clinically competent for them to indulge too much in research. One respondent said that:

> '…reflective aspects get sidelined by students who think that they don't have time to reflect while they have too much to learn.'

The external bodies were felt to criticise more often, with comments like 'you're not doing enough pig medicine', than to be concerned about engendering a research ethos in students. However, the 'Day-One Competences' of the RCVS include knowledge about research and its application to veterinary medicine:

> 'The new veterinary graduate will have acquired a thorough knowledge and understanding of…research methods and the contribution of basic and applied research to all aspects of veterinary science (RCVS, 2006).'

Furthermore, EAEVE-approved veterinary schools must also comply with EAEVE regulations, which state that:

> 'Veterinary education must take place in a research environment, and public funds should be made available to support research infrastructure and to provide seed money for projects, [and] the training in biomedical sciences must enable each student to...gain, analyse and use this knowledge in accordance with the principles of scientific research (EAEVE, 2007).'

Although the governing bodies encourage student exposure to a research environment and to offering the opportunities to gain research attributes, it is clearly difficult for curriculum developers to achieve the appropriate balance. This often places pressure on curricular content from all sides.

In summary, there appeared to be a fairly major divergence between the opinions of medicine on the one hand and dentistry and veterinary medicine on the other. For the former, the GMC's *Tomorrow's doctors* (2003) has helped to free space in the curriculum which can be used to engender a research ethos. This has not occurred in dentistry and veterinary medicine. Here it was felt that there was pressure on time in the curriculum and that the focus of the governing bodies was on clinical attributes and knowledge base, so their curricula were more biased towards teaching required for clinical competences.

This difference may be more perceived than real. One academic commented on how diverse the different curricula are within the constraints of the governing bodies, and was struck by how imaginative people are within these constraints. The common feeling was that the real curricular constraint is the need to cover the range of topics in the undergraduate curriculum to create a competent clinician.

Do any of the medicine, dentistry and veterinary schools use research to inform or shape their teaching? (Is there a difference between PBL and didactics programmes in the use or importance of this approach?)

Traditionally, in all three disciplines the staff involved in teaching have also been involved in research. In the more traditional curriculum, basic scientists are involved in teaching the core sciences and many of them may be cutting-edge researchers who have their own research teams.

Given this framework, the above question was asked in order to explore the relationship between research and teaching at the curriculum level. We sought to probe Jenkins et al's (2007) concern with the relationship between staff's involvement in research in their discipline and their role as teachers of that discipline. Academics interviewed for this project were mainly involved in curriculum development and review in their institutions. Several were actively involved in research on teaching and answered the question in relation to how the curriculum was taught and their own interest in education and educational research. We were also interested in whether there was a difference between PBL schools and those with more traditional didactic programmes. This question was discussed in three different ways:

- some interviewees focused on curricular delivery and their involvement in educational research
- others were more interested in the content of the curriculum and how the latest research evidence was incorporated into teaching
- the third angle taken was that of getting students to learn about research by taking part in a research activity.

This was a similar split to that found for the earlier question probing interviewees' understanding of the issues relating to research-teaching linkages, and probably reflected their interpretation of the subject. The majority view was that curricular design and review took account of 'the educational evidence base', and that individual curricula were constantly evaluated and reviewed in line with new educational research. Medical schools with a PBL approach emphasised the importance of keeping up to date with current teaching practice and using research to inform teaching. Other schools with a more traditional systems-based curriculum also emphasised the importance of medical education research in informing the delivery of the programme.

> 'Research definitely informs teaching - the curriculum is updated constantly and informed by the research findings in *Medical Education.*'

A number of interviewees mentioned the presence of small educational research groups and some staff within their school being actively involved in educational research, and how these groups inevitably fed into delivery of the curriculum.

Regarding curricular content, the feeling was that staff used research to inform their teaching, and that this was something running through the curriculum.

> 'Clinical researchers give lots of lectures putting research in context and highlighting the importance of research.'

Similar feelings were expressed by the dentists:

> 'All clinical academics, when they are lecturing, will try to incorporate their own clinical research, and basic scientists when appropriate will incorporate theirs.'

The veterinarians highlighted the problem with funding for veterinary research, which made it difficult for students to see veterinary research as opposed to basic science research. However, it was felt that:

> '…research doesn't have to be clinically based for students to be interested in it….'

A number of interviewees from the different disciplines expressed the idea of a role model. The feeling was that exposing undergraduates to cutting-edge researchers was a powerful way of interesting them in research. All of those interviewed mentioned the importance of involving students in research projects.

3.4 Practical approach

From the previous responses it is clear that at both institutional and curriculum levels there was acknowledgement that research-teaching links should be incorporated into the curriculum in a planned way, to ensure that students are exposed to these links at an appropriate level for their development. This section describes how this is accomplished in practical terms at delivery level.

How are research processes expressed/conducted within programmes/strategies and operational plans?

From the operational angle, several interviewees mentioned their school research symposia, which are run regularly and to which students are invited. Staff present their most up-to-date research data at these symposia and discuss their research interests. One school mentioned an away day where:

> '…staff are invited to go away and think about research strategy and how this informs practice.'

Reference was made to teaching committees and research committees, and the importance of having a link between the two:

> '…providing a foundation for staff to see that the teaching and research are linked together.'

Students are encouraged to get involved in research projects through personal interest. In one school, a group of students have formed a society to promote and foster research interests in students.

How does your course team go about structuring the programme to best make use of research-teaching linkages?

Two themes emerged from this question:

- teaching students how to do research
- making students research aware.

For medical students, the SSC offers the best opportunity for them to learn research techniques and take part in a research project. Each school organises its SSCs differently, but many of them are 'in areas of medicine where the medical school is research active'. Students have the opportunity to take a number of SSCs through their undergraduate degree; many of the schools use the earlier SSCs to teach literature-searching skills and critical appraisal skills.

> 'SSCs are a good product…they deliver core skills, the learning outcomes complement each other and develop through the curriculum. These are a means of accumulating skills through the years.'

One interesting example of literature reviewing involved a student writing a wiki on a particular topic.

Case study: Use of wikis to present findings from small-group research projects in an undergraduate medical curriculum

For the last two years, we have been using wikis in years 1 and 2 of the SSC programme. Small groups of between six and 10 students (with a staff facilitator) present their findings from a research project as a wiki.

We consider that the introduction of wikis into this part of the undergraduate medical curriculum has been highly successful; overall, feedback from students and staff facilitators has been almost unanimously very positive. It has aided assessment and contributed to student portfolios. We consider that the wiki format enhances group collaboration, leads to better engagement with the learning materials, and improves attainment of the stated learning outcomes surrounding development of research, critical appraisal and personal professional skills.

(For full case study, see Appendix, 7.7: Simon Riley, University of Edinburgh)

Some SSCs also involve developing a research question, planning a project, applying for ethical approval, carrying out the research and writing it up for publication or presentation at international conferences. They are also spread throughout the curriculum, with some being offered from year 1 through to the final year.

> 'We have SSCs in second, third, fourth and fifth year and at least one must be academic. That is to say, have an investigative project type element, in the sense of a doing a research project or an audit in order to learn the skills.'

In addition to SSCs, several medical schools offer students the opportunity to do an elective project. For these, students are required to pose a question, devise a methodology and then write up their findings as a dissertation of between 3,000 and 5,000 words.

Case study: The Study in Depth research within the BM5 curriculum at the University of Southampton

This is a 23-week period of study undertaken during year of the BM5 (Bachelor of Medicine five-year) curriculum, in which students undertake a project in a field of interest. Students also undertake a series of clinical attachments (up to eight weeks) and courses in research methods and clinical ethics and law. Projects are organised into fields of study which broadly map to clinical specialities. Fields are grouped and matched to research divisional structure within the School of Medicine.

(For full case study, see Appendix, 7.8: Susan Wilson, University of Southampton)

The programme for the pre-clinical medical course at the University of St Andrews is structured so that all students do a research project in their final year. In order to prepare students for their project, generic research skills are introduced from year 1.

The dental interviewees mentioned different types of projects with research-related activities. For example, students may do a number of small experiments, which they are expected to write up, or they may be asked to write a research-based essay. Some also have longer-term dissertations (similar to the medical students), which last several months; students are asked a particular question and are expected to go out and find the evidence and report back.

Case study: Using research to motivate students - setting, marking and providing feedback on research-based essays

Students are asked to select an essay topic from two lists provided.

List 1: dental caries, dental erosion, dental plaque/biofilm, gingivitis, mutans streptococci, oral candidiasis, periodontal disease, porphyromonas gingivalis.

List 2: chlorhexidine, disease prediction, fluoride, saliva, triclosan, toothbrushing, xylitol.

They use these topics to search scientific databases for relevant information. Each essay is awarded a grade for each of the published criteria according to clearly stated and published guidelines. For feedback, students are provided with the criteria grades and also receive specific comments written on their essays, which are returned.

(For full case study, see Appendix, 7.9: Stephen Hogg, University of Newcastle)

Case study: Literature research and self-assessment in the virtual learning environment

An assignment is posted on the virtual learning environment (VLE) every two to three weeks. Students are required to research a topic in the library and write an answer. After the submission deadline passes, staff post up a model answer and students must make a written comparison between their own answer and the model. Work is self-assessed with a degree of informal peer assessment as well. No grade is given, and staff do not check the work other than to verify that it has been done.

(For full case study, see Appendix, 7.10: Vincent Bissett, University of Glasgow)

The veterinary interviewees cited summer projects as an option for some undergraduate veterinary students to gain experience of research. These projects can count towards their compulsory extra-mural studies (EMS). They are discussed in more detail on page 28, under 'Does your programme have research projects?'.

Veterinary faculties also pointed out that in terms of ensuring that students were research aware, they had cutting-edge researchers teaching students during the pre-clinical years. One school had a vertical strand called 'Population and veterinary epidemiology' where research was talked about, but not necessarily taught explicitly.

The dentists were very positive that the research-teaching link was present within the professional curriculum from the very start.

> 'Their first lecture was on evidence-based practice and the role of research. They will be reading journal articles right from the start, not just textbooks.'

Furthermore:

> 'In the second year they will be encouraged in critical appraisal and the understanding of population research methods. This is all practically oriented.'

Others thought that they had not deliberately set out to address the link, but that it was there. One school highlighted the role of its curriculum committee, which responds to developments in areas of dental research by bringing in experts for a half-day symposium. It was emphasised that it was part of the ethos for staff to bring research into their tutorials, and this was evident in curriculum documents and positive feedback

from students. Some schools mentioned specialist subject areas where research might be brought into the teaching by individual staff.

Another initiative is the concept of integrated clinically related activities (ICRAs), where students are given the opportunity to replicate experimental work and analyse their own findings. This covers both raising awareness of relevant research and practice in actually doing research.

Case study: Integrated clinically related activities (ICRAs)

The concept of ICRAs is to deliver real clinical activities and stimulate experimental work from a validated research evidence base. Topics studied include: teeth, aesthetics and the smile; bacterial mapping of teeth; plaque disclosing and plaque control; mastication and occlusion.

ICRAs take published research paper(s) on an aspect of clinical dental care and explore the methodology and experimental results behind a particular recommendation. Students replicate the experimental work and analyse their findings.

(For full case study, see Appendix, 7.11: J Newton, University of Dundee)

It is clear from these answers that in all three disciplines there is a difference between providing opportunities for students to become familiar with research and research methods and actually providing them with the opportunity to take part in a research activity. While the curriculum seems structured to give students the opportunity to gain an understanding of research, only a small number of students have the chance to actually take part in a research project. This opportunity is dependent on the school and the discipline.

What part does the undergraduate portfolio play in developing graduate attributes?

There appeared to be large variation in when and how portfolios were used both within and across the three disciplines. Many of the portfolios were at an early stage of development and have not yet been rolled out to all years. Several of the portfolios focus on developing attributes such as understanding of professionalism, appreciation of the need for CPD, awareness of strengths and weaknesses, teamworking and reflection. Using the portfolio to record evidence of reflection was common. Students are asked to reflect on specific learning experiences and aspects of the curriculum, teamworking being a common one. Some of the different ways of using the portfolio were as follows:

- the portfolio may be fairly heavily integrated into the curriculum, including assessment. For one school, the final exam was a portfolio exam, giving students a chance to present a whole range of experiences to their examiners
- students used a portfolio to log evidence of competence in clinical skills and clinical case studies. An example of this was the Embedded E-Learning Solutions (EELS) project under development at the University of Bristol Veterinary School (Bailey et al, 2008)
- the portfolio was used as a summative assessment in personal and professional development modules
- students were required to complete reflective tasks in their portfolio; these may or may not be assessed. During their honours degree dissertation, students at one

institution complete a reflective piece, which is logged in their portfolio along with previous reflections. This final reflection can be awarded up to five per cent of the total marks available for the dissertation project.

Case study: Portfolio-reflective task as part of the honours degree dissertation project

Students are required to summarise the aim of their project and then reflect on their experiences in doing the project. Questions for reflection are:

- what have you learnt about yourself during this project?
- how do you feel you dealt with any problems that arose?
- how could you improve in the future?
- how did you feel this experience would be useful to you in your future career?

The reflections are marked by the tutor and are worth five per cent of the total dissertation mark.

(For full case study, see Appendix, 7.12: Julie Struthers, University of St Andrews)

Does your programme have research projects? If so, what kind are they and when do they occur? (How does your programme ensure that all, or selected, students have an opportunity for an extended research experience?)

Opportunities for students to do a research project within the normal curriculum were discussed at all interviews. We found that the range of research projects offered to individual students across and within the three disciplines was wide.

> 'We need to be clear what we call a research project in these situations and how much research we expect students to do, given that there are sometimes constraints around getting ethical approval.'

One interviewee said that projects ranged from reading-type projects through to actual lab-based projects.

Case study: Exploring dental epidemiology

In a Dental Public Health and Epidemiology module, students are given data from two dental health surveys carried out nationally. One of these involves staff from the School of Dentistry in collaboration with colleagues from other institutions. The students use new data every year to improve their understanding of dental health across the UK and how this varies among key population groups.

Students select, analyse and choose appropriate methods of presenting sections of the data to demonstrate differences and similarities between different parts of the country. They then discuss these variances, relating them to other teaching about socioeconomic factors, fluoride and dental services. The emphasis is on examining and explaining the data.

(For full case study, see Appendix, 7.3: Deborah White, University of Birmingham)

Honours degree project

The intercalated degree forms the main vehicle for providing opportunities for research projects within the three disciplines. Although it requires students to add an additional year of study to their course, this is the place in the curriculum where students have the opportunity to do a piece of original research and write a research dissertation. Students are selected on academic grounds and in some schools as many as a quarter to one-third of the class take up the opportunity. The intercalation takes place between years 2 and 3 in some schools and between years 3 and 4 in others.

Uniquely in Scotland, the University of St Andrews Medical School offers a three-year pre-clinical BSc (Hons) Medicine. As part of this programme all students do a 15-week research project introducing them to scientific research principles, the research ethos and the practicalities of doing research. Similar courses to this exist in other areas of the UK.

Summer research projects

Summer projects or vacation research scholarships are available in all three disciplines, but they feature strongly within veterinary medicine. These projects are partially funded by the schools and other bodies such as the Wellcome Trust, and can be laboratory or clinically based. In the lab, they are related to gaining practical skills and in the clinic to collecting data. The projects are competitive and small in number; however, the time spent on them counts towards veterinary students' compulsory extra-mural studies. Similar opportunities for summer projects exist for medical and dental students. One school offers them to approximately five per cent of its students, although demand is higher. Funding can come from the university, school or individual academic researcher. A common feature of the summer projects in all three disciplines is that:

> 'Students are encouraged to write up and publish the work that is the outcome of these projects, or take it to a research conference.'

Case study: Summer projects for veterinary students

The University of Glasgow Veterinary School summer research programme primarily targets students at the end of their third year of the veterinary undergraduate degree. It comprises six to eight-week projects encompassing a diverse range of topics. Most are research lab based, but clinical and pathological projects are offered as well as projects with a focus on data analysis or development of novel teaching resources.

(For full case study, see Appendix, 7.13: Thomas Anderson, University of Glasgow)

Student-selected components (SSCs)

Specifically in medicine, SSCs provide the space and opportunity within curricular time for medical students to be involved in research or a research-related activity. One of the objectives of an SSC in one school is 'to develop familiarity with the scientific method'. Different schools have different numbers of these options for students to take during their course. One school has seven SSCs, each lasting five weeks, while another has at least one lasting as long as 14 weeks. The variability of length obviously determines how much can be achieved in the period of time available.

Most schools encourage students to have a range of different activities for their SSCs, at least one of which should be a research-related activity (such as a literature search or an audit). Clearly, not all students have the opportunity to take part in an extended

research project. However, in one school all students must do an eight-week elective project. This is arranged by students themselves and can be carried out anywhere in the world. A common form of research-related activity, mentioned by several interviewees, was the audit.

> 'Audits are a classic…doing a good audit is not difficult but something that all students do. Audit will always have relevance to clinical practice.'

Final-year projects

One veterinary school has a final-year project based on clinical research. The titles of the projects are given out at the beginning of year 4; students have the rest of the year to collect data. Researchers offer projects students sign up to, or they can develop their own. This can involve revisiting earlier summer projects with extensions. Some of these projects can go on to be published. The same school is proposing to bring in-group research projects for second-year students as a compulsory element of the curriculum.

Electives

Electives form part of the curriculum for several dental schools. They usually occur at the end of year 4, where students have four weeks to carry out a project. A team of clinical and academic staff run these electives, which students can do in some area of dentistry or in an area not within the school or dentistry. Whatever students do in this project, certain outcomes must be met.

> 'There are outcomes related to self-directed learning, they need to have accessed literature and appraised it.'

Reports are prepared on the elective and a presentation may be involved. If the project is lab-based or scientific, it should be presented in an appropriate manner. Some students may go abroad, where they might observe dentistry being carried out in different settings. These would be more qualitative studies, but the methodology should still be rigorous.

All of those interviewed mentioned the importance of maximising students' research-project experience by encouraging publications.

> 'Students are substantially more mature in their fourth year and they see those a year ahead applying for jobs. This helps them appreciate the importance of publications and so they are more focused on seizing opportunities than they were earlier in the course.'

There seemed to be no actual figures for the number of students who write up and publish their work or take it to a research conference. However, an estimate was given of two to three per year from each school. One interviewee remarked that:

> 'Publication or not probably depends on the mindset of supervisors.'

3.5 Specific graduate attributes

The following questions probed how individual schools encouraged the development of specific attributes such as critical thinking, lifelong learning, professionalism and ethics, research ethos and awareness of local research.

How is critical thinking developed in your programme?

Critical thinking, or critical appraisal, was viewed as an important research-related attribute that graduates of all disciplines should have. There were no major differences among the three disciplines in how this was developed in undergraduates.
One interviewee noted that critical thinking is a research-related attribute, but is also of vital importance to a professional:

> '**Critical thinking** could also be called **clinical thinking** and you can't do any of the three subjects medicine, dentistry or veterinary medicine without **clinical thinking.**'

Interviewees gave different examples of where critical thinking was developed within their programmes. It might be covered during a specific session, often focused on the critical analysis of a journal article. The focus of the critique could be related to either the study methods employed or how the results from the paper related to clinical practice. This type of specific session tended to take place during the first or second year of study.

Case study: Critical reading - the journal referee

To foster the skills of critical reading, we have developed an exercise entitled 'The Academic Journal Referee' as part of the SSC Pathology for Junior Doctors. The exercise is primarily a formative assessment tool, although it also contributes to the overall summative assessment of this SSC.

The student is asked to act as a referee for an academic journal. They are given a paper submitted to the journal (actually an already published paper) and asked to write a report to the editor commenting on the strengths and weaknesses of the paper. Time is specifically set aside for the exercise, usually two half-days. Suggested reading is Studying a Study and Testing a Test (Riegelman, 2000).

As preparation for the exercise, a seminar on critical scientific reading is delivered. Several points are highlighted, particularly the need to read the paper in a systematic, analytical way, and that this is a different way of reading.

(For full case study, see Appendix, 7.14: Stewart Fleming, University of Dundee)

Case study: Introducing graduate students to critical thinking and appraisal

Within a new master's programme, the MRes Molecular Medicine, a three-session module was designed to introduce graduate students to critical thinking and appraisal. It was intended to prepare students for critically evaluating scientific research articles. Sessions were held at weekly intervals.

(For full case study, see Appendix, 7.15: Susan Jamieson, University of Glasgow)

One interviewee pointed to guidelines evident in clinical practice:

> 'SIGN (Scottish Intercollegiate Guidelines Network) has a load of checklists when you're evaluating evidence, for example how to review randomised controlled trials or a paper about diagnostic accuracy of a new test. They [students] should be pointed to this at an early stage in their training, but I don't think they are. Students I see, seem to be surprised that something like that exists.'

This area could also be implicitly covered in the approach to teaching. Schools advocating PBL noted that critical thinking was embedded in this approach and students would automatically adopt this way of thinking.

> 'However, the main focus for developing critical thinking is the PBL approach, which fosters critical thinking.'

In all three disciplines, a popular way to develop critical thinking is through project work. Students often develop critical thinking implicitly as part of the process of completing the project. In schools where students complete an earlier component of the curriculum in which this skill is explicitly taught, it was seen as a way of ensuring that the skill is practised. One interviewee suggested, however, that perhaps more practice should be given to students in this skill as it could take some time for critical thinking to develop fully, and undergraduate projects were often of short duration.

One symposium speaker, Susan Jamieson, described a project that was looking for evidence of critical thinking by students undertaking a PBL-based curriculum[3]. In a description of the project, she said that:

> '…various stakeholders in medical education expect that their graduates will acquire/develop critical thinking skills as an underpinning to developing clinical reasoning and judgement.'

Although this project was at an early stage, she called for educators:

> '…not only to design teaching that will help students acquire and develop graduate research attributes, but to look for evidence that this teaching has been successful in its aims.'

The speaker emphasised that it is not so much about ways of teaching or facilitating the development of graduate attributes, but about looking for evidence that students are displaying the skills in question. The results of this study will be reported in *Medical Education*.

How are students trained to be lifelong learners? Do research-teaching linkages play a part in this training?

All three disciplines agreed that CPD and the concept of lifelong learning lie at the heart of the professions of medicine, dentistry and veterinary medicine. Students who graduate from such degrees are morally bound to continue learning and to keep up to date with the latest advances in their profession.

There was a sense that students need to be aware that lifelong learning is part of being a professional, no matter what the discipline.

> 'It is made clear that medicine is continually evolving, it is the nature of medicine that they need to keep up to date, almost implicitly reinforced from all angles, all of the time.'

[3] Dr Susan Jamieson, Critical thinking by Students Undertaking a PBL-based Medical Curriculum: What is the Evidence? Available at: http://medblogs.st-andrews.ac.uk/ResearchTeachingLinkages/Project%20Documents/Forms/AllItems.aspx

Another interviewee commented that:

> 'A true professional will have the patient's benefit at the heart of anything and everything they do. If that's the case, they will naturally be lifelong learners and they will naturally want to explore the evidence base because they will always want to know they are doing the very best for the patient and therefore they will have to know what is going on.'

Reinforcing this theme was the following comment from a veterinary surgeon:

> 'There is a moral obligation for veterinary surgeons to take part in CPD once they graduate. At the moment I don't think all students are engaged in this to the extent they should be.'

There was a split between those institutions using a PBL-based approach and those that did not. Institutions where the curriculum was based on PBL felt that the development of the ethos of lifelong learning and the skills required for lifelong learning was an inherent part of the learning approach. Some institutions explicitly introduced these skills at the start of the first year and thereafter students continually practised them as they progressed through the cases.

In non-PBL institutions it was not entirely clear how the necessity for lifelong learning was instilled in students, although role models formed a large component. Clinical role models questioned and explained to students the evidence base of their practice, while in the basic science arena, students were made aware that science is continually progressing by lecturers, and therefore they must keep up to date with current advances in knowledge.

In one school, the development of clinical audit skills was used to encourage CPD. In the words of one interviewee:

> '…they are able to analyse their technique. This particularly develops in the fifth year and they have a logbook and a clinical portfolio to lead them into CPD, where everything they do is self-validated, they set their own goals and action plans.'

Student projects and SSCs were seen as a key way of developing the skills of independent lifelong learning in non-PBL courses.

One school has allocated six hours per week to guided study elements that are integral components of the curriculum; these are learning tasks that students are expected to complete independently. Learning objectives linked to the guided study elements may be assessed, but work is not usually monitored formally. The tasks vary and include reading assignments, customised tutorials that extend curricular content, clinical vignettes that require application of students' current understanding to novel situations, and problems that illustrate integrative topics within the spiral curriculum.

> 'The skills associated with independent learning are fundamentally important to the process of lifelong learning and continuing professional development. The aims of the "guided-study" components within the curriculum are to impress on students the expectation that they should assume increasing responsibility for their own learning, to value the importance of self-assessment and to encourage effective time-management.'

Many schools (both PBL and non-PBL curricula) also used a portfolio or personal development plan to help students to develop the skills of lifelong learning. Students were

encouraged to use portfolios to reflect on their progress or learning and highlight areas where they required further training or knowledge.

> 'This is preparing undergraduates for things they will be expected to do once they graduate anyway. Reflect on their own practice and identify opportunities for further training. It's all tied in with "fitness to practice" and professional conduct with the moral obligation to do these things.'

How are professionalism and ethics covered in your programme?

A variety of methods were described where curricula instilled professionalism and educated undergraduates in ethical issues.

Professionalism is a growing area of the curriculum and is frequently instilled through role modelling of professionals who teach undergraduates, especially in clinical years. Some schools run specific learning events on professionalism, and all schools have a regulatory framework on professionalism managed by fitness-to-practice committees. Students are made aware of these committees at the start of their undergraduate years.

Portfolios were often used for students to develop professional skills. In dentistry, these or similar devices were often used to record the assessors' comments from a day's clinics. Dental students treat patients from an earlier stage than medical students and are usually assessed on a daily basis in clinical practice. Part of this assessment is professionalism, and this area can be separated from others such as practical ability for focus by tutors.

> 'In the clinical years, they [students] are assessed on a daily basis by staff, and one of the areas of assessment is professionalism. This is an area that is isolated so that if there are problems in the area of professionalism, these can be highlighted separately from, for example, clinical skills.'

Innovative practice in the area of developing professionalism included symposia and open debates (in some cases online) on areas relating to professionalism where students could discuss issues with other students and professionals. A couple of schools used a 'yellow-and-red-card' system, whereby students acting in an unprofessional manner are issued with a yellow card. Continued unprofessional behaviour results in red cards and ultimately in denied permission to proceed.

Reflection is increasingly becoming a means of instilling professionalism in students. Students are given opportunities within the curriculum to write a short reflective piece on situations they have encountered.

Ethical issues are often tackled in a more explicit way, with most schools in all disciplines having either a stand-alone module in the early years of study or a vertical strand running throughout the course. Once students are more exposed to clinical situations, ethical issues of cases are discussed. Schools with a PBL approach noted that most cases used for learning contained professional or ethical issues raised and discussed by students. One school has developed a partnership with the law department at the university; joint sessions are taught in students' final years, where role-playing exercises based on ethical cases are run.

> 'About confidentiality, record keeping…in the last year there is a law and ethics course in partnership with the law department, where we do cases brought to the GDC. Role-playing with law students being judge, defence and prosecution,

> dental students being expert witnesses and me playing the part of the defendant. Students loved it.'

Another school used case histories, TV dramas and plays to illustrate ethical points, encouraging students to identify ethical issues and critically appraise the behaviour of others, using popular and interesting media.

Case study: The use of humanities resources in teaching the practice of medicine - critical thinking and reflection in medicine

For the purposes of teaching medical ethics, professionalism, the patient-physician relationship and the like. Under the inclusive title Practice of Medicine in the curriculum, the tutor has used various plays, short stories and docudramas to highlight the principles, issues and ethical dilemmas that require critical thinking and decision-making and that are inevitably encountered in the care of patients and the practice of day-to-day healthcare. The focus is on the issues that will potentially be encountered in the early years of clinical medicine as well as those, which a more senior doctor confronts.

Students quickly become aware that much of what they see and read in these humanities resources requires, firstly, interpretation (what is happening here?) and, secondly, reflection (how do I feel about this?).

(For full case study, see Appendix, 7.16: Peter Nelson, University of St Andrews)

Most schools assessed professionalism and ethics in some way. This was done through written exams, objective structured clinical examinations (OSCEs) or portfolio content.

> 'Each case the students work on has a strand of ethics/professionalism through it. This also means it is assessed via the portfolios. This is summative assessment.'

Do you have a research ethos in your programme? If so, how and when does it appear or is encouraged?

This question was asked to create discussion around whether the curricula created a research environment for students and, if so, how this was achieved. There was little difference in opinion among the three disciplines. People tended to fall into two camps: those who thought their institution did have a strong research ethos and those who thought it was not a research ethos as such but more an evidence-based ethos.

Those schools where the ethos was evidence-based relied on role modelling and questioning during clinical practice or clinical situations to embed this evidence-based ethos in their students.

> 'Certainly it's an evidence-based ethos. Information should be sought to support what you are doing. In the clinical context an evidence basis is better than a pure research base.'

Some felt that a research ethos was encouraged from day one and appeared in day one of the curriculum.

> 'We want our students to be aware of things like NICE [National Institute for Clinical Excellence] and Cochrane reviews.'

Institutions with a research ethos noted that as their staff were usually engaged in research themselves, this enthusiasm would automatically transmit to the students. In schools where students were required to do an honours dissertation, it was felt that:

> 'The research ethos is fundamental as the students must undertake an honours project and the curriculum is designed to develop research skills.'

Some interviewees expressed doubt that the research ethos of the school or the individual staff member was apparent to students. It was suggested that one way of instilling a research ethos in students might be to encourage them to do an undergraduate honours degree before applying to the professional course.

> '…the BSc in Veterinary Science has been used as a stepping stone to the BVetMed by the majority of applicants.'

Case study: Instilling a research ethos into an undergraduate science programme

The Royal Veterinary College, University of London, added a non-clinical three-year BSc in Veterinary Science to its portfolio of degree programmes in 2002. Although designed to be completely independent of the Bachelor of Veterinary Medicine (BVetMed), the majority of applicants have used the BSc as a stepping stone to the BVetMed. A study was carried out to determine whether the career aspirations of any students with deeply held ambitions to become veterinary surgeons could be changed as a result of their experience of the strong research-science focus of the BSc.

(For full case study, see Appendix, 7.17: Vicki Dale, Royal Veterinary College)

The issue of conflict of duties arose in some of the heavily research-active institutions for those staff members who taught and carried out research, especially if they were also engaged in clinical duties. The conflict was on how to divide their time and energies among their three activities, often leading to less emphasis on teaching.

> 'Researchers are being driven out of education because their bosses and their contracts are making it much more difficult for them to engage in teaching, and people who are not returnable in the Research Assessment Exercise (RAE) are being forced to reconfigure, take on new titles and job descriptions so that they are not paid to do research but are paid to do education, teaching, appraisal and assessment….'

One interviewee noted that some clinicians who might have a heavy teaching load were being told that:

> 'We can't afford to have you doing teaching, it doesn't bring any money in and it distracts you from clinical work and research.'

Finally, some interviewees felt that having faculty taking part in educational research was believed to create a research ethos among both staff and students. Participation in studies, especially those where an information sheet had to be read and consent given, was seen as improving student awareness of research processes, and staff involved in educational research were continually involved in professional development. Some institutions were very active in their support of this type of research.

Does your curriculum highlight local cutting-edge research?

Whether students are aware of the current research and research interests of their own school was open to question in all three disciplines. Some schools stated that they brought local research to students' attention, while others did not believe that this was covered sufficiently.

Case study: Research in action - integrating science with clinical practice

This is a fourth-year special study unit (SSU) where students 'piggy back' an active research group and experience the process of research. They have the opportunity to try out the techniques, analyse data and pose questions. Staff are given some guidance and examples on what is appropriate to give students to do. This involves three one-week blocks across the fourth year. Students are able to choose the type of research group they join; there are often three or four students with each research group.

(For full case study, see Appendix, 7.18: Karen Mattick, Peninsula Medical School)

The schools stating that they highlighted local cutting-edge research achieved this in different ways. Many noted that it was down to individual staff members to highlight their own research (and that of others) while interacting with students. They might do this explicitly within lectures, but also implicitly in how they spoke to students. One interviewee said that:

> 'It is embedded within the ethos of the staff that they interact with students at a research level.'

Another said that:

> 'All clinical academics, when they are lecturing, will try to incorporate their own clinical research and basic scientists, when appropriate, will incorporate theirs. So students are aware that it is going on and it's not something that just happens outside the building.'

Another method was to hold a series of seminars or plenaries specifically aimed at highlighting advances made locally. Several interviewees noted that students often failed to see the relevance of these seminars to them and their practice, as usually the content was often related to basic science research rather than clinical practice. Two reported that they had changed the emphasis of these lectures with the aim of making them more inspirational or relevant in the eyes of students. Projects and SSCs were another popular way of building on prior awareness of local research and extending it to specific research groups within the schools.

Among those schools where interviewees stated that they did not believe this area was covered sufficiently, there was a level of concern that students were missing out on an important area of knowledge. There was a level of appreciation that this was an area that needed to be emphasised.

> 'Yes, but not enough. I am concerned that students can leave university without being aware of the key areas of research in their medical school and of the international research stars that are part of their school.'

3.6 Opinion

These next questions probed the opinions of symposium delegates and interviewees on best practice. The questions asked about the scope for, and barriers to, best practice as well as respondents' views on the career potential for those graduates who wish to include research in their careers.

How can we best use research-teaching linkages to inform the development of learning?

Five complementary approaches were felt to be important.

More educational research into educational methods

The answers to this question mainly focused on educational research and how it links to the curriculum.

> 'I would like to see a lot more educational evidence put into the styles we teach.'

How research informs curriculum development, curriculum delivery and assessment was felt to be an important issue. This view was supported by a number of interviewees who expressed the view that there was an urgent need for more educational research.

> '…should be using much more educational research to inform how to deliver the curriculum.'

> 'Education research is sadly lacking, particularly in dentistry.'

However, the current low level of educational research was equated to a lack of money being available for such research.

> 'National funding of education research would be really helpful. Money in it is so small, not enough to employ anyone.'

> '…educational research is a sideline for enthusiasts because there is insufficient money to do this properly.'

More involvement of research-active staff in teaching

A second approach put forward was to ensure that research-active staff were involved in teaching.

> '…academic training should have links to the research-active staff in the university.'

> 'By the way we do it in…ensure that teaching is delivered by people active in research and teaching in their own areas. This is effortless, it is a natural process talking about your own research.'

It was felt to be important that students were taught by experts who were active in research and who emphasised the relevance of research to their everyday clinical practice. The ever-changing development of research and the need to keep up to date with current clinical practice should be highlighted.

> 'Medicine is an ever-changing profession; having the adaptability to change and move forward in the profession is a good paradigm in which to deliver this.'

Progressive development of research skills

Another suggestion was a vertical strand cutting across all years ('a roadmap for research-teaching linkages…') where research-related skills could be developed. This was a reference to research studies and how they inform students' learning around particular subject areas.

> 'Highlighting that research isn't something weird and wonderful, it's commonplace and it incorporates a number of skills together to answer questions and inform future research.'

Encouraging an inquiry-based approach to learning

Others highlighted the importance of forming a partnership in learning, with the teacher and students working together to develop an enquiry-based approach to students' learning.

> '…getting students to identify their own learning needs and how to address them….'

This could be developed through the research-teaching nexus, encouraging learners to move from:

> '…learning and knowing facts to developing the skills of an adult independent learner, that is, one able to analyse and interpret information.'

> '…an increased research-teaching nexus would promote this move up to the higher level to ensure that students are competent and able to practise.'

Highlight academic career opportunities

Finally, one interviewee also noted that external bodies need to highlight to students that academic career opportunities exist as well as the professional pathway. It was felt that undergraduates were not always alerted to this opportunity, but schools should appreciate the importance of it and incorporate information into their curriculum guidelines.

What scope and opportunity are there for linking research and teaching?

This question was posed at the symposium as the interviews had suggested that the scope for linking research and teaching was felt to be constricted by the guidelines issued by the governing bodies. This was mainly the case for dental and veterinary schools.

Generally, it was felt that there was currently plenty of opportunity within the curriculum to implement research-teaching links. Several groups highlighted that a drip-feed approach was useful, with opportunities scattered throughout the course. This had to be planned at the curriculum level to ensure coverage. The opportunities themselves need not be labelled as research skills to students; indeed, many such skills are equally as applicable to clinical practice as to research. It was also noted that although the provision of such skills should be overseen at the curriculum level, there needs to be a respect for the professionalism of the deliverer.

Many participants were in favour of all students having an opportunity to consolidate these research skills in a specific research project towards the end of their undergraduate years. Some dissented, however, as they felt that some students would never be involved in research once they graduated, even if the individual skills may be useful in their professional practice. There was some discussion of what constitutes research experience.

Some faculty took a very broad view of research experience, with literature reviewing and audit being included.

It was generally accepted that students should be encouraged to be involved in scholarship and that they should understand the principles of research. It was felt that students who had actual experience of the hurdles of research would have a deeper understanding of these difficulties and a greater appreciation of the pitfalls and shortcomings of the research they read about. As many clinicians are asked to review literature when writing clinical guidelines, these skills would be useful even to those who would never actively participate in research themselves.

What are the barriers to implementation of linking research and teaching?

This question complemented the previous questions to symposium delegates. We hoped it would explore why the full scope of possibilities for linking research and teaching may not be realised by all schools. Barriers to implementing further research-teaching links were noted by individuals from all three disciplines.

Finding time in a crowded curriculum was highlighted by many present. This was especially difficult for those in the disciplines of veterinary medicine and dentistry, as the focus of their degree programmes is on preparing students for independent practice immediately after graduation. In addition, undergraduates on these courses may perform irreversible procedures on live patients as part of their training, so the training requirements and proficiency of students in these professional skills are necessarily higher. This results in less time that can be devoted to raising the profile of research.

Staff numbers were another reason why projects and research experience could not be provided for all students. This was particularly noted by those in the discipline of dentistry, and was also thought to impact on the research ethos visible to dentistry students.

There were several other barriers to providing the opportunity for all students to engage in a research project, including the cost of laboratory materials and equipment and the time required to obtain ethical approval.

Another factor was that research staff were often viewed by students as being remote and difficult to approach, as they were unused to talking to students at a level they could understand. It was a recurring theme that students needed to be enthused by research and researchers and made aware of the opportunities that research could provide.

What are the potential benefits of including research as a component of your career?

What new opportunities could research provide? There was discussion at the symposium that the career structures of the three disciplines pushed research experience to the margins, resulting in its not being regarded as a benefit to students. It was felt that experience in research did not contribute sufficiently to the chances of being successful in job applications, and there was a strong feeling that it could be detrimental. This concern was voiced in a poster by some young doctors who were involved in the new system for applying for and gaining a training position in their career - Modernising Medical Careers (MMC).

The surgical trainees' views:

> 'The advantages of having done a research post are not clear to potential applicants in the MMC process.'
>
> 'There is little information pertaining to the weighting of research posts in the MMC shortlisting process.'
>
> 'In the past, research experience was an advantage for those applying at registrar level, but it is now going to be a disadvantage.'
>
> 'I am questioning whether undertaking research is worth the sacrifice of time and money.'

Views on Academic Clinical Fellowships (ACFs)[4]:

> 'Are they supposed to be only for the academic clinicians of the future?'
>
> 'I could not find a standardised method of ranking candidates on academic competency.'

The academic's view:

> 'Having taken time out to complete a research post, the junior consultant may be disadvantaged in terms of competition ratios for consultant jobs.'

The foundation doctor's view:

> 'MMC is not a theoretical barrier to research but it may affect the doctor's motivation to apply for such posts. Personally, I believe experience in research will remain an important discriminatory factor when applying for jobs at a consultant level.'

The conclusion was that there is a global appreciation that research experience forms an important component of a well rounded doctor's training and therefore research experience should add value to any job application. This is as important in dentistry and veterinary medicine as it is in medicine.

It was not just within the professional career structure that there were thought to be barriers. Participants referred to similar difficulties within the academic career in all three disciplines, but in relation to teaching and research. The differing value that universities placed on teachers in comparison to researchers was thought to be compounding difficulties. As the RAE has placed a huge emphasis on the value of research output, teaching was viewed in some faculties as taking time away from research. Such academics could not afford to take time away to teach. The situation was similar for clinical academics where teaching time was not valued. This was felt across all three disciplines.

The view was that policy-makers needed to act to ensure that an academic career involving research and/or teaching does not appear unattractive compared to a career involving only clinical practice.

[4] The ACF was created in 2007 to provide a programme for clinicians with an interest in research.

4 Discussion

This project set out to gain opinion on desirable research-related graduate attributes in the disciplines of medicine, dentistry and veterinary medicine, and to identify current and emerging practice on how these attributes are developed through research-teaching linkages in the undergraduate curriculum. The project succeeded in its aims through collecting the wealth of varied material described above.

In a project like this, it was important to define what we meant by 'research' and by 'teaching'. In both cases, a broad definition was felt desirable. Indeed, the Enhancement Theme Steering Committee asked us to adopt a broad definition of research:

> '…practice/consultancy-led research, research of local economic significance, contributions to the work of associated research institutions or other universities and various types of practice-based and applied research, including performance, creative works and industrial or professional secondments.'

The discussions with interviewees and symposium participants confirmed that the term 'research' was subject to a variety of interpretations by different individuals. The concept of 'research' and the acquisition of research skills and attributes were described in three main ways. These ranged from a basic level of understanding of research and research techniques, through to the acquisition of the attributes needed to conduct a research project, and up to the highest level of being able to conduct an original research project. Therefore the term 'research' in the context of this report is used in its broadest sense.

The definition of teaching (within the concept of 'research-teaching linkage') was broad as well because teaching is also subject to a variety of interpretations. At its most basic level, this was described as being teaching delivered by research-active staff. Alternatively, research methodology might inform teaching methods and/or students' learning. At its broadest level, the explicit use of an evidence-based approach to teaching may be used to emphasise the strong and ongoing inter-relationships between research and teaching. Again, we allowed participants to use whatever definition they wished in order not to constrain discussion.

4.1 Core attributes

In identifying and defining 'high-level' graduate-type attributes, there were no obvious differences among the three disciplines. Seven attributes common to graduates interested in professional and research careers were identified:

- enquiring mind
- core knowledge
- critical appraisal
- understanding of evidence base for practice
- ability to work in a team
- understanding of ethics and governance
- ability to communicate.

These attributes might all be described as high level, suggesting that they are equally critical for those whose main focus is a professional career and for those who wish to pursue a research career. The importance of context in the teaching of such graduate attributes is unclear. It may be that the context within which the attributes are developed is key, irrespective of the final career path followed by graduates.

It is noteworthy that creative thinking in itself was not within this list of top attributes. In saying this, we are making a distinction between creative thinking (as the process whereby individuals develop their own research ideas) and critical appraisal/thinking (where individuals interpret research ideas emanating from others). It is recognised that teaching students to be creative is beyond even the most skilled teacher; however, it is important to reinforce a sense of curiosity and encourage the trait of creativity.

4.2 Instilling graduate attributes using research-teaching linkages

The project identified that a number of different strategies and activities are being used by the three disciplines to support the students in gaining these research attributes.

One common theme was the problem of how best to include all the core content required to produce a competent clinical professional while at the same time devoting enough time in the course to develop research attributes. It was thought by some that problem-based learning might 'kill these two birds with one stone'. Delivering the core course through a PBL approach was believed to be a unique opportunity to instil core professional knowledge and simultaneously introduce students to some of the attributes necessary for research (for example, posing key questions, searching the literature and using websites and online databases to source knowledge). This seemed to be a reasonable hypothesis, and indeed, there is limited evidence for it, at least for self-reported skills (Schmidt et al, 2006). However, more data are required.

It was also felt that critical thinking was embedded in the PBL approach and that students of PBL would automatically adopt this way of thinking. However, in non-PBL schools interviewees identified a number of areas where critical thinking was developed in their curricula, such as the analysis of journal articles and student projects.

A second common theme among the three disciplines was that the two domains of core professional skills/knowledge and research attributes were felt to overlap substantially. Critical thinking and an appreciation of the research ethos were felt to be key ingredients underpinning both research and professional practice, such that research attributes were of prime importance in a vocational programme.

It was felt that all students should acquire basic core research attributes, although additional values/skills and attributes were necessary for those possibly contemplating a research career. Carrying out a full-blown research project was obviously necessary for those students who were keen to pursue a research career, but there was less agreement on how far down the path of performing a research project it was necessary to go for students with no thought of entering a research career.

It was generally agreed that it was valuable for all students to undertake a literature survey and an audit project, and that in doing so every student would go a long way towards acquiring basic, core research skills/attributes important to a practising professional. For example, a practising professional who never did research might still be asked to assess research papers to help to decide what clinical guidelines were

appropriate. Basic research attributes were felt necessary in this case. Therefore, space should be available for some core skills/attributes training within all professional curricula, but further opportunity for training should be available for those students who are keen to take the extra step towards entering a research career.

A third common theme was that role models were felt to be essential to an undergraduate professional course, and that several role models would be best. Each student would ideally be able to identify at least one role model for good clinical professional practice and a separate role model as a good researcher. Whether students engage with a role model is currently haphazard, and a formalised system of linking students with tutors or role models may be a goal to aim for. Role models were felt to be vital to inspire students, encourage them, enthuse them, and place skills and attributes in context.

4.3 Models for engaging students in research

There were considered to be four main models of how to engage students in research (in addition to the concept of using PBL to deliver the core curriculum, as described above). The first of these was student-selected components, which were mainly noted in the medical schools and which the GMC has stipulated should constitute one-third of the total course in medicine. SSCs varied greatly in their content, but 'research' in its widest form was a common constituent of many of them. The SSC could be a literature survey, an audit or even a research project if a longer period of time were available. SSCs are a compulsory feature of the medical school curriculum, with most schools insisting that students do at least one 'research'-related project.

The second method was student summer projects. These featured prominently in veterinary medicine, but were available in all three disciplines. However, in all disciplines they were only available to a small minority of students, usually those already identified as being keen on a research career. Summer projects usually involved doing a defined research project with a local research group. Funding was usually available from internal sources or from external funding that the supervisor applied for. These projects tended to be advertised and competitive.

The third method was an intercalated honours degree, which was offered in all three disciplines. This involved students completing a research project of some kind, but was only offered to less than 40 per cent of students in any one year. However, in at least one medical school (for example Imperial College London) it is mandatory for all medical students. A variation is the BSc (Hons) offered by some universities, where undergraduates must complete a research project in their final year to graduate with a BSc (Hons). These students move onto another university to complete their clinical training.

The fourth method consisted of certain research/science-based first-degree courses with a vocational slant such that they prepared students to become graduate-entry students into vocational courses. For example, the University of Edinburgh has a BVet Science (Hons) degree after which 40 per cent of students choose to enter a veterinary medicine degree. The University of Aberdeen has a BSc (Hons) in medical science, which can equip students well for entry into a medical graduate programme. The Royal Veterinary College (RVC) has a Vet Science degree, although interestingly the percentage of graduates from this course going on to study for BVetMed has decreased since the first

graduation in 2005. Other schools offer places to graduate entries, which means that students on their course have all completed honours dissertations and therefore have already acquired the research attributes prior to entry.

4.4 Current barriers to research-teaching linkages

A key requirement of this project was to identify barriers to the research-teaching linkage. From the student viewpoint, a barrier might be that students tend to focus mainly on what is examined and what determines whether they pass or fail. This raised the issue of how schools assess the achievement of attributes. Although it is easier to examine factual knowledge, it is possible in some courses to overcome this barrier by attributing marks to reports written by students after they have surveyed the literature, completed an audit or performed a research project. In some cases, portfolios are used to keep a record of work done and copies of reports, so examining portfolios could be part of overcoming this barrier.

Another barrier, from the postgraduate medical student viewpoint, was Modernising Medical Careers (MMC). This has led to the culture of young professionals hesitating to divert from the clinical training treadmill, especially since 'research' currently seems to attract very few extra points in the shortlisting process for jobs through MMC. This point was reinforced during the symposium in a talk describing an initiative to set up clinical PhD programmes designed to address such key problems of recruitment into clinical academia[5]. But however attributes are assessed, students need to be made aware that research informs all practice and that research skills are needed for them to become lifelong learners and proficient practitioners.

From the staff viewpoint, a major barrier was felt to be the RAE, which has encouraged academics to focus on their own research output. This was seen as especially important in two areas:

- clinicians were especially pressurised to decrease teaching, as it was seen as 'too expensive' to have high-earning clinicians spending valuable time teaching undergraduates
- educational research was not given appropriate value in terms of research recognition or opportunities to apply for funding.

These and other problems with the RAE have been much discussed in the literature, with no clear solution as to how best to re-emphasise teaching. At the time of writing, it was unclear whether the new system would adjust contingencies to encourage researchers to develop research-teaching linkages.

Another barrier identified was that researchers were reluctant to let inexperienced students use their expensive laboratory equipment in case they might break it. They were also reluctant to allocate hard-earned research money to undergraduate projects, which would be less likely to generate publishable results. In addition, supervision of students in clinical situations where research data may be collected introduced the necessity of ethical approval. The limits to designing new projects with the consequent ethics application were a substantial barrier for many supervisors. These latter problems obviously do not apply so much to projects that do not involve

[5] Sara Marshall, A Brighter Future for Academic Medicine, available at: http://medblogs.st-andrews.ac.uk/ResearchTeachingLinkages/Project%20Documents/Forms/AllItems.aspx

collecting data, but other issues might arise, such as the problem of saturating clinics in community projects with students.

4.5 Governing bodies

The regulatory bodies of all three disciplines state that research skills and attributes are necessary for a competent and proficient practitioner. So how are these skills developed/achieved?

The role played by the three governing bodies in encouraging research was described by interviewees as somewhat different across the three disciplines. In medicine, the GMC's *Tomorrow's doctors* (2003) was commended for 'freeing up' 33 per cent of curricular time for SSCs, which has allowed schools to include research or research-related projects in the curriculum.

For the other disciplines, those interviewed felt that the guidelines of the GDC (2002) and the RCVS (2006) were more focused on making sure that the course covered all areas necessary for clinical competence, despite statements that they valued knowledge of research and acquisition of research skills. For these interviewees, the opportunities for research were seen as a luxury as there are no pre-registration years. This means that their graduates would have greater clinical responsibilities immediately after graduation.

Some participants felt that the governing bodies could and should promote the academic career pathway to a greater extent. Clearly, across all three disciplines there was implicit and explicit awareness of the tensions between training and education.

4.6 Enthusing students

One concern raised in the project was the feeling that students could leave their university without being aware of the key areas of research within their school and the international research 'stars' who were part of their school. Some schools have tried to address this concern through inspirational talks by researchers or by inviting these researchers to guest lecture on their course. In many cases, these were felt to be unsatisfactory as the lectures were often not at a level students were able to engage with. Several said that it was embedded in the ethos of staff to interact with students at research level, and others that it was up to individual staff to engage with students about their research. There was a level of concern that students were missing out on the knowledge of local research and the opportunity to become involved.

Publication of students' research projects was raised as an important way of encouraging students in research. This could be linked to future job applications where applicants need to find ways to stand out. It was unclear whether publication was initiated by students or by the supervisor. It was not possible to get actual figures on the number of projects published, but the estimate was about two to three per year from each school. It was certainly felt that if this were possible, publication would be of advantage to the individual student's career and as a way of encouraging future students to engage in research. However, it was felt to be unrealistic to expect publication of all student research projects.

5 Recommendations

In making recommendations, the project team is aware of the demands on all curricula to produce graduates ready for independent practice immediately after graduation. This is especially true for dentistry and veterinary medicine, as neither discipline has the equivalent of foundation training as in medicine, meaning that they have sole responsibility for clinical treatment from day one. In addition, we are aware that there was a general feeling from all participants in the project that research - in the broadest sense - should be an integral part of the teaching curriculum. The degree and manner to which this is achieved are dependent on both the discipline and the school.

Also, when considering recommendations, it is recognised that the governing bodies strongly influence the curricula of all three disciplines. Nevertheless, the guidance given by these professional bodies already recommends the development of research skills.

5.1 School policy level

In the view of the project participants, the opportunity to take part in some form of research project at undergraduate level is the best way to develop research attributes. This was the main observation from project participants, and therefore the main recommendation of this report is that:

All students should have the opportunity, within the curriculum, to engage in research in the broadest sense.

The medical curricula have demonstrated that SSCs are a valuable way to provide students with research opportunities. Perhaps the dental and veterinary governing bodies could consider freeing up part of their curricula to allow opportunities for all students to take part in small research projects. Another way to improve research opportunities would be for schools to consider how best to increase the number of students taking intercalated degrees and/or summer research projects. This might entail earmarking funds for student research bursaries.

Other recommendations focus on raising awareness of research and enthusing students about it. Universities should encourage their successful researchers to describe their research to students at a level they will understand and in a manner that will enthuse them. A further suggestion is therefore to encourage a more formal way of linking students to research-active role models within the school. We recommend this as we feel it would be the best way of enthusing at least some students about research, which is essential if we are to continue to generate research-active academics in the future.

5.2 National policy level

The messages from the project participants to national policy-makers covered three areas: fund research into teaching methods, increase the value of teaching, and remove barriers to improving research-teaching links.

There was a strong voice for more external funding opportunities to be made available for educational research, as the current level of funding is limited. One area where more educational research would appear to be required is to see whether or not there are benefits from a PBL approach over a more traditional approach; many participants hypothesised that a PBL approach better provides graduates with the correct research attributes.

With regard to valuing teaching more highly, it was felt that the RAE'S replacement, the new Research Excellence Framework, should positively value the time spent by senior academics in engaging students in research. It was also felt within all three disciplines that effort should be made to improve the attractiveness of a research career. This would require students to have clear evidence of the benefits of conducting research, which may require research experience to be given added weight in job applications. An additional recommendation for improving the attractiveness of including research within a career would be to provide more opportunities to dip in and out of research during professional training.

The above recommendations all came from the one-to-one interviews conducted as part of this project and the discussions at our one-day symposium. Naturally, some of these recommendations would be more easily implemented than others. Those designated as 'school policy' would probably be easier to implement as they require concentrated effort within each university. Those designated as 'national policy' would require more concerted effort at government level, cascading down to each university.

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7 Appendix: Case studies

7.1 Is medical education research part of the research-teaching nexus?

Authors and affiliations

Anita Laidlaw and Gerry Humphris, Bute Medical School, University of St Andrews.

Description of initiative

One component of the research-teaching nexus is education research, but in what ways could it benefit students? The GMC's *Tomorrow's doctors* guidelines on medical education (2003) suggested that communication skills teaching should be a core component of every undergraduate medical course to improve skills among future doctors (Rider and Keefer, 2006; Maguire, 1999). We have an active programme of pedagogical research into communication skills teaching which can be split into three areas: 1) what communicators bring to an interaction, 2) what we can do, 3) looking at the outcome. Below is a brief description of current and past projects and how medical students benefit from this work.

What communicators bring to an interaction

- Perception of facial micro-expressions - does a person's ability to perceive facial micro-expressions impact on their ability to communicate, and can we improve the skills of students who have difficulties in this area? Medical students taking part in this study gain an insight into how research is carried out (as participants), but also receive feedback and training in facial micro-expressions perception.
- Social anxiety and communication skills - for an honours dissertation project, medical students showed that female peers who experienced high levels of social anxiety had a more negative attitude towards communication skills teaching. Current medical students carrying out their projects are extending this to include self-reported communication skills and practical exam performance. Students learn about research by carrying out a dissertation project, but also benefit from the results collected during the project (Laidlaw, under review).
- Self-efficacy - medical students will participate in a study investigating the relationship between self-efficacy and communication skills. They will learn about the process of research, but will also receive feedback on performance.

What we can do

- Reflection-on-action method - medical students participated in a research study investigating this method of teaching. They learned about the research process, were asked for informed consent, and students also benefited as the results meant that improvements in teaching were made (Laidlaw and Humphris, 2006).
- Dissertation projects in communication behavioural analysis - students will carry out a dissertation project where they will analyse their own communication behaviour. Students will therefore gain an introduction to research, but it should also impact on their communicative behaviour; this will be evaluated.

Looking at the outcome

- Amsterdam Communication Test - a pilot study of this software, which can be used to test various aspects of communication (such as ability to critically analyse observed behaviour and cognitive approach to communicating), has shown that students can use it and appreciate its application. Medical students learned about the research process as participants and received feedback on their performance.
- OSCE communication behavioural analysis - this project will investigate patterns in student communication behaviour during a practical exam. It will examine differences in patterns between students who score highly and those who experience difficulty. Medical students will experience being part of a research study and future students will benefit by receiving focused feedback.

This wide variety of work should be considered as part of the research-teaching nexus, and it benefits students in a variety of ways. It means that teaching methodologies are research based and therefore students experience innovative and exciting teaching techniques, which are refined as work progresses. The teaching environment in which students are immersed is research active. As participants in research studies, some understanding of research methods, including ethical issues and study design, is learned. Awareness of ongoing research in the school is also raised. Participation in such research often results in students gaining feedback on performance; this feedback can be very specific.

Students gain research experience by carrying out research projects. All students studying BSc Medical Sciences at the Bute Medical School complete a project. The project investigating social anxiety involved students collecting and analysing survey data, then presenting the data in the form of a dissertation. The students involved gained valuable research skills. Students take part in research related to their teaching as researchers themselves. This gives them the opportunity to see how directly relevant research is to their everyday lives. The research they carry out could be directly acted on for future teaching.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All students in all three years of BSc Medical Science.

Which graduate attributes are enhanced by this initiative?

Critical thinking; literature searching; understanding research methods; statistical analysis; understanding of ethical issues; communication skills; reflective practice.

What resources were required and what difficulties were encountered/overcome?

Several grants, both internal and external to the University of St Andrews, have funded this work. Ethical application has been given for all studies.

7.2 Generic scientific skills for medicine - a vertical curricular strand

Authors and affiliations

James Aiton, Bute Medical School, University of St Andrews.

Description of initiative

Medical students from St Andrews graduate after three years of study with a BSc (Hons) in Medicine before completing their clinical training at the University of Manchester or a partner medical school in Scotland. The curriculum is an integrated systems-based course, which provides a firm scientific basis to the practice of medicine and consists of a pre-honours year followed by two further years of honours study. In the final semester of the honours programme, every student completes a research dissertation which may be laboratory based, involve survey data collection or require an extensive literature review.

To lay the groundwork for the honours dissertation, we have devised a generic research skills strand running through all three years of the curriculum. This provides students with the opportunity to acquire and develop the appropriate skill set needed for their dissertation. The research skills are mapped to a matrix which covers all three years of the curriculum. This is to ensure that the appropriate skills are covered at appropriate points in the curriculum and integrated with other professional skills such as ethics, clinical skills and portfolio work.

Initially, entrant students are introduced to the concept of the scientific method and the importance of embedding the practice of medicine within a firm evidence base of high-quality research. Students are required to read a scientific paper and analyse its structure and the methods used to present data, and learn the importance of scientific referencing. They gain practical experience of using the NHS Scotland e-library to search the literature for key publications and full-text articles, and compare the effectiveness of other search tools such as PubMed and Google Scholar.

In the second semester of their pre-honours year, students apply the research skills acquired in the first semester to write a scientific report on a topic of their choice in the style of a *British Medical Journal (BMJ)* editorial. They are required to find and use the *BMJ's* instructions for authors, which gives them experience of writing in a style appropriate for publication.

The role that evidence-based medicine plays in determining practice is considered in more detail in the two-year honours programme, with particular focus on research study design, basic statistical concepts, literature searching and the use of an online citation management system (RefWorks). Students are required to be more critical of the published literature and use their own data from an exercise laboratory experiment as the framework for writing a scientific paper. A selection of published articles on related experimental findings (body mass index and fitness measurement) are used to prompt students through a series of questions on study design, selection of control and experimental groups and the extrapolation of research study findings to population epidemiology.

In the final honours year, and as preparation for the research dissertation, the research skills matrix centres on the analysis and interpretation of published data. This workbook-

based exercise provides students with the edited introduction and methods a paper. The research data are presented in the paper as figures (with legends) or tables.

Students are guided through the analysis of the data and the interpretation of the experimental findings. To complete the task, students write an abstract they can then compare with that published in the original report.

In the final semester of their honours programme, all students submit an honours dissertation representing the major SSC of their pre-clinical programme. Although most students write a critical review answering a particular research question, some have the opportunity to conduct a laboratory-based research programme or a community-based survey.

The learning objectives for the dissertation embody the culmination of the research skills matrix outcomes. On completion of their dissertation, we anticipate that our students will have:

- developed an understanding of the scientific method
- used research and scientific methodologies to interpret published data
- demonstrated the ability of critical thinking and analysis
- displayed competence in accessing online information sources
- presented the research findings as a conference-style oral presentation
- formulated a work plan to complete a task in a defined time frame
- reflected on a significant learning event.

These learning outcomes are a challenge for students at this stage of their career. However, by developing generic research skills early and mapping them to a matrix to ensure appropriate opportunities for acquisition and consolidation, students have the chance to realise these objectives. Our pre-clinical curricular content means that these research skills are not fully developed on graduation to clinical training, but the skills of self-directed learning and critical appraisal will equip students well in their future clinical careers.

The process of mapping the research skills throughout the curriculum was key to identifying skills gaps and implementing a programme that prepared students for their dissertation. The research dissertation, as the culmination of this process, has provided students with a real insight into the process of research, critical analysis and the role that research plays in modern medical practice.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All students in all years.

Which graduate attributes are enhanced by this initiative?

Critical thinking; communication and presentation skills; information retrieval and literature review; appreciation of evidence-based medicine; data interpretation; understanding of scientific method(s); practical ability to design and implement a research programme; self-directed and self-motivated learning.

What resources were required and what difficulties were encountered/overcome?

Access to online sources and staff time to develop meaningful and appropriate research-related tasks for inclusion in the training programme.

Impact of the initiative (if assessed) and/or student feedback

Very positive feedback from students completing their research dissertations.

7.3 Exploring dental epidemiology

Authors and affiliations

Deborah White, School of Dentistry, University of Birmingham.

Description of initiative

In a Dental Public Health and Epidemiology (PH&E) module, students are given data from two dental health surveys that are carried out nationally. One of these involves staff from the School of Dentistry in collaboration with colleagues from other institutions. The students use new data every year to improve their understanding of dental health across the UK and how this varies among key population groups. The students select and analyse appropriate methods of presenting sections of the data to demonstrate differences and similarities in different parts of the country. They then discuss these variances, relating them to other teaching about socioeconomic factors, fluoride and dental services. The emphasis is on examining and explaining the data.

Generic research skills are interwoven throughout the BDS course to aid students in completing tasks such as the dental epidemiology project and elective projects which are undertaken at the end of the fourth year. Generic skills are integrated in the teaching of each speciality rather than taught in a block. This emphasises that these skills underpin all areas and are relevant to all specialist subjects.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All second-year students undertake the Dental Public Health and Epidemiology module.

Which graduate attributes are enhanced by this initiative?

It supports development of an enquiring mind and research ethos, promotes awareness of and engagement with ongoing research and develops understanding of data analysis.

What resources were required and what difficulties were encountered/overcome?

To support students in undertaking this task, a preliminary lecture was introduced to explain the task and outline the data. It became obvious that students needed further support and that they needed to ask further questions once they had started to undertake the work. To address this, an optional drop-in session was timetabled to clarify and explain misunderstandings and answer questions. In addition, students use an electronic discussion board to promote further dialogue. This has proved very successful, particularly in terms of making effective use of staff time.

Impact of the initiative (if assessed) and/or student feedback

Students have shown a marked improvement in their understanding of the relevance of dental epidemiological tools and techniques. They are able to synthesise information and relate research in this field to real-life dental problems. Students have generally performed well in the work, achieving high marks and demonstrating a good grasp of the subject.

Student feedback has been mixed, with some positive comments such as 'coursework was fun' and 'coursework and responses on the discussion board were good'. However, students have also found it difficult: 'PH&E was very long and very hard'.

7.4 Student-selected components (SSCs) in the medical curriculum

Authors and affiliations

Simon Riley, Obstetrics and Gynaecology, University of Edinburgh.

Description of initiative

Student-selected components (SSCs) are a result of the guidance from the GMC (2003) to restructure medical curricula to reduce content overload and at the same time provide students with opportunities for choice and depth of study. In the undergraduate programme in medicine at the University of Edinburgh, SSCs form more than 20 per cent of the timetable and are the main research-teaching linkage. The SSCs are also important in defining this course by providing clear research opportunities to participating students in a research-rich environment. Furthermore, 40 per cent of our medical students also take the opportunity to do an intercalated honours degree (between the second and third years), which incorporates a significant research-project component.

The purpose of the SSC programme is to permit students to progressively develop a broad spectrum of research skills (including understanding evidence-based medicine, informatics, medical statistics, and critical appraisal) in conjunction with professional skills (including communication, teamworking, and lifelong learning skills) through projects of the students' own choice. The SSC programme is fully integrated with the core curriculum, both in delivering core skills and in its assessment. Students carry out four separate research projects.

In year 1, students select a hospital-based project from a wide choice, and work in small groups supervised by a member of staff. The project usually involves an appraisal of literature and a simple questionnaire to patients. In year 2, students perform two literature-based projects in small groups, facilitated by a member of staff. The first is from a choice of topical medical issues and the second is organised by students themselves, who (with support) sign up their own staff facilitator. In year 4, students decide on a topic or field of study and self-select, again with support. They negotiate with and sign up to work with a supervisor for a 14-week research project.

The year 4 project in particular is highly regarded by both students and staff as an excellent opportunity to perform some useful 'real' research. The project may take the form of an audit which can influence local care provision, a component of an ongoing larger research project, a small stand-alone complete study, a preliminary or pilot study, or a systematic review across the whole spectrum of medical specialties.

Several factors seem to make this project work successfully:

- by this stage, students have already developed a useful range of research skills, which they bring to a project
- by getting students to self-select and sign up their own supervisors, they develop a real commitment and ownership of their project and a partnership with their supervisor
- students view it as a real opportunity for several reasons. These include being able to view a speciality they may be considering as a potential career, to gain a range of useful skills and some independence, to enhance their CV in a range of ways, and even to 'do something useful'
- similarly, supervisory staff view the project as an opportunity to get a motivated student to perform some useful research, and to encourage students interested in their own field of research and speciality
- students and supervisors are well supported (including medical statistics, library and ethical support), and the administrative and assessment burden is minimised.

The SSCs provide an opportunity in medical curricula for students to perform a wide range of research projects and progressively develop their research and professional skills, which are essential for their future success in careers across medicine.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All students on the MBChB undergraduate programme.

Which graduate attributes are enhanced by this initiative?

Full range of research skills, together with allied professional personal skills.

Impact of the initiative (if assessed) and/or student feedback

Overall, very good feedback across the whole SSC programme.

7.5 Plenary lectures

Authors and affiliations

Sarah Mackay, University of Glasgow.

Description of initiative

Since 1996, the University of Glasgow has had a medical curriculum using a student-centred/problem-based learning approach. Small groups of about eight students meet twice weekly for two hours. They respond to scenarios by setting learning objectives for themselves, undertake self-directed learning and then feed back to the rest of the group. Typically, the first hour of each session is spent feeding back information about the previous scenario and the second hour is spent brainstorming and setting objectives for the next scenario. Students are supported by fixed-resource sessions of two to three hours, twice a week. These are generally laboratory sessions where material supporting their PBL work is presented.

Plenary lectures are also given. These were introduced not as a primary means of communicating new information but rather as a way to amplify and clarify areas of learning and also for inspiring students, so that they could appreciate the cutting edge of medical science. The plenary lectures at the University of Glasgow therefore represent an important area where research findings are incorporated into the medical curriculum. Moreover, in some cases they serve a dual purpose of developing research attributes, as illustrated by the following examples.

MB1 block 1: Hierarchy of Systems, Regeneration, Repair and Defence

'Cutaneous wound healing' - this plenary by Mike Edward, Reader in Dermatology at the University of Glasgow, is primarily a brief overview of the mechanisms involved in cutaneous wound healing, followed by recent developments in the enhancement of wound healing, including grafting.

MB1 blocks 3 and 4: Determinants of Health; Disease Patterns; Nutrition, Metabolism, Growth and Development

One recently introduced venture is a closing plenary, dealing with cancer and translational research. Some students found this a bit daunting but others were clearly stimulated by the cutting-edge nature of the material - a result we feel is very positive.

MB2, block 7: Conception, Growth and Development

Coursework for this block involved the critical appraisal of a research article: Coovadia, H, Rollins, N, Bland, R, Little, K, Coutsoudis, A, Bennish, M, and Newell, M-L (2007) Mother-to-child transmission of HIV-1 infection during exclusive breastfeeding in the first six months of life: an intervention cohort study, *The Lancet,* 369, 9567, pp 1107-1116.

Two plenary lectures were associated with this piece of coursework. One of the authors, Ruth Bland, delivered a supporting plenary. The students received a highly relevant and interesting presentation explaining the objectives and significance of the research study. In a subsequent videolink, after Ruth Bland had returned to Africa, the students had an opportunity to ask questions. Ruth Bland commented:

> 'I am writing to say how much I enjoyed the video-audio link with the second years at lunch time. I thought that they were enthusiastic and very interested. I was surprised not only at the number of questions but the calibre of the questions. It was clear that the students (at least those who had asked questions) had read the paper very carefully and the questions they asked were astute, and some of them better than questions we have been asked at international conferences! The paper is not an easy one, statistically, so it would have been easy for the students to be put off. But they didn't seem to be.

A second supporting plenary - 'To discuss approaches for critically appraising a research study' - was delivered by Phil Cotton two weeks before students completed the coursework. This second plenary served to develop the particular critical skills necessary to evaluate research papers.

MB2 block 8: Musculoskeletal and Neurological Systems

'Back pain' - this plenary represents a review of the current state of knowledge of illness behaviour in patients with back pain. Details of important growth areas in the topic are reviewed from the standpoint of an international expert, orthopaedic surgeon Tony Reece.

'The pathology of head injury' - consultant neuropathologist Willie Stewart says of his plenary lecture:

> 'For many reasons, we are perhaps more inclined to consider head injury as an acute, short-term management issue. However, as successful interventions in treatment reduce mortality in the acute phase, the long-term consequences are beginning to be recognised. During this lecture we will discuss the pathology of head injury and the contribution Glasgow has made to the field.'

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All students.

Which graduate attributes are enhanced by this initiative?

Understanding of basic research methods; awareness of local cutting-edge research expertise.

Impact of the initiative (if assessed) and/or student feedback

The plenary lectures are evaluated each session by means of a questionnaire on the course webpage. Each lecture is listed by title with the lecturer's name, and students can select 'not applicable' (if they missed the lecture), 'poor', 'fair', 'good' or 'excellent'. There are also boxes for free comments under the headings 'What did you find useful/interesting?' and 'What could have been improved?'.

Feedback obtained from annual questionnaires for each block of teaching over 10 years suggests that students appreciate the integration of research in plenary lectures, providing that:

- its relevance to PBL is obvious
- the plenary is delivered with enthusiasm and humour
- PowerPoint presentations are available afterwards on the Medical School's intranet.

Occasional comments show that some students in the class consider some plenaries to be:

- more research based than necessary
- pitched at too high a level
- a waste of time if the content is not examinable.

The anonymity of student feedback means that it is hard to correlate appreciation of plenaries with exam performance. So it is difficult to discover whether those students who most appreciate plenaries including research are the most academically able. In recent years, there has been a tendency to introduce plenaries clarifying areas of learning, in response to student pressure. It is important to also retain and develop inspirational plenaries to spark the interest of the top end of the class, who are more likely to carry out research in hospital-based specialities in their future careers.

7.6 Research core and research track

Authors and affiliations

Susan Rhind, University of Edinburgh Veterinary School.

Description of initiative

Research core

Understanding research methods, the application of research to all aspects of veterinary science and evaluating evidence are requirements in the 'Day-One Competences' as defined by the RCVS (2006). With space in an undergraduate programme being limited, the curriculum was reviewed to create room for in-depth study of some topics, making achievement of the generic research-related graduate attributes more likely regardless of which topic is chosen. Further components of the research core include specific learning outcomes and activities such as critical review of scientific papers, which are embedded within a 'vertical thread' running through the curriculum. Students are assessed on these activities.

Additional elements of the research core are the clinical research project and VetChoice research emphasis day, which is being expanded to a model spread more regularly through the curriculum. The clinical research project is spread over several months, with students investigating a clinical problem, for example, and applying relevant data analysis/statistics to explore the data. Some of these projects are later published.

Research track

In addition, attracting veterinary graduates into a research career is important for the future of veterinary medicine, as highlighted in the Selbourne report (1997). Evidence in the literature indicates that summer studentships are an important means of attracting students into research. We have initiated the R(D)SVS research track (RRT), which includes developing and expanding opportunities for summer research studentships, encouraging intercalated BScs and MScs, and the development of an integrated PhD programme.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

Research core - all students.

Research track - variable depending on which options chosen, but less than 5 per cent.

Which graduate attributes are enhanced by this initiative?

Understanding the application of research to all aspects of veterinary science.
Evaluating evidence/evidence-based medicine.

What resources were required and what difficulties were encountered/overcome?

In an already overloaded curriculum, the best time to consider enhancing and developing research-teaching linkages is during an outcomes-based curriculum review.

Impact of the initiative (if assessed) and/or student feedback

The effect of the core curriculum change is not at a stage to be evaluated yet.

Following the activities of the RRT group, 20 students have been recruited onto the summer studentship programme for 2008-09.

7.7 Use of wikis to present findings from small-group research projects in an undergraduate medical curriculum

Authors and affiliations

Simon Riley, Queen's Medical Research Institute, University of Edinburgh

Simon Edgar, St John's Hospital, Livingston, University of Edinburgh

Dermot McKeown, Royal Infirmary, University of Edinburgh

Description of initiative

Wikis are a group collaborative website tool that have become increasingly widely used across the internet community in recent years. The most obvious use of this technology is Wikipedia, the free online encyclopaedia where anyone can contribute content, which is 'peer-reviewed' and regulated by the community itself.

In the undergraduate medical curriculum at the University of Edinburgh, the SSC programme forms 21 per cent of the time commitment across the five years of the course. The overall learning outcomes for the SSCs are to progressively develop research and critical appraisal skills, together with a wide range of professional skills, including communication, teamworking, personal management and self-directed learning.

For the last two years, we have been using wikis in years 1 and 2 of the SSC programme. Small groups of six to 10 students (with a staff facilitator) have the opportunity to perform a small research project.

Rationale for using wikis in this part of the curriculum

Between 2002 and 2005, students presented their findings for SSC2s using a standard html-type website. The course leaders perceived from formal and informal feedback that:

- this format was often not a result of a full collaborative effort, as students tended to rely on one or two group members with pre-existing skills who took a greater share of the development and writing content, despite provision of training to all students
- assessment was also potentially biased to the most impressive-looking websites developed by a cohort of skilful students, potentially at the expense of the quality of the content.

To counter these problems, provide equality across all student groups and facilitate real engagement in collaborative group work, since 2006 we have required students to present for SSC1 their group diary, and for SSC2s their research findings, as a wiki.

Advantages of using wikis:

- readily permits engagement in collaborative group interactions - format gives 'ownership'
- individual skills required to permit contribution are simple, allowing the whole group to contribute content rapidly and edit equally (we only need to provide an online tutorial because of its simplicity - even the facilitators can work it out - and because students already have some skills)
- content 'evolves' - this adds an extra dimension permitting all in the group to engage and participate deeply in learning material as a group
- facilitator's job is simpler because wiki content can be readily reviewed from early developmental to final draft stages, then it can be appraised and formative feedback can be provided
- better equality when making assessment of quality of site content - not reliant on a group member with specific website design skills
- permits simple checking for plagiarism (using Turnitin)
- can make sites available outside course as a window into the course, if considered appropriate and after content has been checked
- ease of integration with peer and facilitator assessments into the student's e-portfolio through the Edinburgh Electronic Medical Curriculum (EEMeC) platform.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

Across our whole cohort (approximately 220 students), in years 1 and 2 of the SSC programme. All students select membership of small groups (six to 10) with a staff facilitator.

- SSC1 (year 1), the Clinical Options project, takes place in the second semester over 10 weeks. Students select a topic from a wide choice, although the topic is hospital-based across a wide range of departments and is usually a blend of researching the existing literature and a simple audit of patients in a waiting room.
- For SSC2a in the first semester of year 2, students select a topic from a wide and eclectic choice, whereas for SSC2b in the second semester they have to decide on their own topic of interest and find their own group and, with some assistance, a facilitator.

Which graduate attributes are enhanced by this initiative?

The overall learning outcomes for the SSCs are to progressively develop research and critical appraisal skills together with a wide range of professional skills, including communication, teamworking, personal management, and self-directed learning. These SSCs in years 1 and 2 are the first two years of a five-year integrated programme.

What resources were required and what difficulties were encountered/overcome?

- Requires platform that supports wikis (through EEMeC we support a basic toolkit of writing and formatting functions).
- Good IT support, both computer facilities and staffing for support and development.

Impact of the initiative (if assessed) and/or student feedback

We consider that introducing wikis into this part of the undergraduate medical curriculum has been highly successful. Overall, feedback from students and staff facilitators has been almost unanimously very positive. The introduction of wikis has aided assessment and contributed to student portfolios. We consider that the wiki format enhances group collaboration, gives better engagement with the learning materials, and improves attainment of the stated learning outcomes surrounding the development of research, critical appraisal and personal professional skills.

7.8 The Study in Depth - research within the BM5 curriculum at the University of Southampton

Authors and affiliations

Susan Wilson, University of Southampton.

Description of initiative

This is a 23-week period of study undertaken during year 4 of the BM5 (Bachelor of Medicine five-year) curriculum, in which students undertake a project in a field of interest. Students also undertake a series of clinical attachments (approximately eight weeks) and courses in research methods and clinical ethics and law.

Aims:

- experience and gain an understanding of the methods involved in research
- encourage an enquiring and critical approach
- appreciate that the undergraduate curriculum is part of a large continuously expanding field of medical knowledge
- gain experience in oral and written presentation skills.

Types of projects undertaken

A broad range of projects offered across a diverse range of fields - clinical, lab-based or a mixture - and classified as research, audit or service evaluation:

- research - motivated to generate new knowledge, may be quantitative or qualitative
- audit - motivated to provide best care; does this service reach a predetermined standard?
- service evaluation - motivated to define current care; what standard does this service achieve?

Organisation of the Study in Depth

Projects are organised into fields of study broadly mapping to clinical specialities. The fields are grouped and matched to research divisional structure within the School of Medicine. Each field has a leader and each division has a divisional coordinator. Divisional coordinators sit on the Study in Depth Working Committee, which manages the Study in Depth.

Project selection

Students choose the subject/field in which they would like to undertake their Study in Depth during their third year. Information about subject areas is given in the field guide to the Study in Depth. Each field describes the type of research being undertaken, lists the supervisors within the field, and has links to previous projects undertaken in that field. The field guide is linked to the School of Medicine's research pages. Students submit a ranked list of choices and are then matched to a field and subsequently a project.

Preparation for the Study in Depth

During their third year, students undertake a week of study to prepare them for their Study in Depth. Topics covered include principles of research, research governance and ethics. Students are encouraged to start ethics applications if appropriate at this point.

Research methods and statistics

Topics covered include:

- management of bibliographies
- use of SPSS and Excel
- statistical issues related to project design, including questionnaire design and number of subjects required
- statistical issues relating to data analysis
- statistical issues relating to data presentation
- general IT issues and support.

Assessment of the Study in Depth

- ongoing evaluation of student progress
- three reports during the year, after progress review meeting between student and supervisor
- end-of-year conference - each student gives an oral presentation of their project
- project report - students prepare an in-depth 5,000-word report on their study.

Which graduate attributes are enhanced by this initiative?

Knowledge of:

- the principles of scientific investigation, including formulating and testing a hypothesis; addressing a research question; exploring a research field
- the legal and ethical principles underlying research and audit
- the subject area studied.

Skills:

- critical evaluation
- study design
- oral and written presentation skills
- organising and planning own programme of work.

What resources were required and what difficulties were encountered/overcome?

Support for project supervisors:

- Study in Depth Coordinator
- divisional coordinators
- heads of fields
- workshops
- supervisor handbook.

Impact of the initiative (if assessed) and/or student feedback. Student/graduate perception of the Study in Depth:

Positive:

- being able to choose a field of study, which may persist through their medical career
- confidence in critical thinking and research skills improves during Study in Depth
- developing a range of skills which are of benefit to medical practice, though this may not be apparent at the time of study
- quality of supervision.

Negative:

- time away from clinical practice
- difficult to set own goals and timetable
- variation in workload and degree of independence required among projects.

7.9 Using research to motivate students - setting, marking and providing feedback on research-based essays

Authors and affiliations

Stephen Hogg, School of Dental Sciences, Newcastle University.

Description of initiative

Students are asked to select one item from each of the two lists below to determine their essay topic. They then use these to search scientific databases for relevant information.

List 1: dental caries, dental erosion, dental plaque/biofilm, gingivitis, mutans streptococci, oral candidiasis, periodontal disease, porphyromonas gingivalis.
List 2: chlorhexidine, disease prediction, fluoride, saliva, triclosan, toothbrushing, xylitol.

Students find this essay very challenging, mainly because:

- they have yet to receive any formal teaching in the general area (preventive dentistry)
- searching scientific databases is novel to most of them
- few have been exposed to the philosophy of science underpinning the language of the articles they discover
- they are required to invent their own title for the essay
- there is a large element of choice.

This creates a degree of anxiety which is addressed through a high level of support:

- instruction on searching databases (for example PubMed), with practical sessions run by library staff
- early drop-in session with staff to get over the initial discovery phase
- daily surgeries to talk through problems
- blackboard discussion forum
- transparent assessment criteria.

All written work is assessed using a four-point grading scheme:

- **M**erit
- **S**atisfactory
- **B**orderline
- **U**nsatisfactory

It is marked by a pre-selected team of eight to 10 staff, normally within two days after submission. Each essay is awarded a grade for each of the published criteria according to clearly stated guidelines. The final grade is calculated according to a matrix weighted in favour of the content criteria.

Content criteria:

1 incorporation of factually correct material relevant to topic

2 discovery, use and integration of source material

3 critical, balanced and ratiocinative approach and interpretation of data.

Presentation:

- organisation and layout
- use of English
- diagrams, tables and figures
- correct citation of source material.

For feedback, students are provided with the criteria grades and also receive specific comments written on their essays, which are returned.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

The entire cohort of stage 2 (second-year) students: 80-100 students each year.

Which graduate attributes are enhanced by this initiative?

Critical thinking; database and literature-searching skills; written communication skills; data interpretation; academic referencing; fostering the enquiring mind; appreciation of complexity, incongruities, contradiction and uncertainties in the literature.

What resources were required and what difficulties were encountered/overcome?

Staff time is needed for daily surgeries, individual tutorials and essay marking. Staff support is essential to alleviate anxiety and maintain students in the 'zone of curiosity' (Day, 1982).

Impact of the initiative (if assessed) and/or student feedback

Students appreciate having a choice of topics and enjoy the discovery involved. They also become comfortable raising questions with staff. The essay has been consistently well received by students:

> 'The in-course essay added interesting research insight.'
>
> 'The essay made me think.'
>
> 'I hated doing it, but after I realised how much I had learned.'
>
> 'Thought the essay was brilliant great support learned loads.'

7.10 Literature research and self-assessment in the virtual learning environment

Authors and affiliations

Vincent Bissell, School of Dentistry, University of Glasgow.

Description of initiative

An assignment is posted on the VLE every two to three weeks, requiring students to research a topic in the library and write an answer. After the submission deadline passes, staff post up a model answer and students must make a written comparison between their own answer and the model. Work is self-assessed with a degree of informal peer assessment as well. No grade is given, and staff do not check the work other than to verify that it has been done.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

The entire cohort.

Which graduate attributes are enhanced by this initiative?

Critical thinking, literature searching, reflection, self-directed learning.

What resources were required and what difficulties were encountered/overcome?

This initiative requires little resource other than a virtual learning environment and appropriate access to library and computer facilities. At first, students find it very strange to complete an assessment on which they will not be graded, so this needs to be explained in the context of lifelong learning and responsibility for one's own development.

7.11 Integrated clinically-related activities (ICRAs)

Authors and affiliations

Jim Newton, John Radford and Andrew Mason, School of Dentistry, University of Dundee.

Description of initiative

The concept of ICRAs is to deliver real clinical activities and stimulate experimental work from a validated research evidence base. Topics studied include: teeth, aesthetics and the smile; bacterial mapping of teeth; plaque disclosing and plaque control; mastication and occlusion.

ICRAs take published research paper(s) on an aspect of clinical dental care and explore the methodology and experimental results behind a particular recommendation. Students replicate the experimental work and analyse their findings.

Doing the work themselves and being participants in the studies enables students to appreciate the broader context of their recommendations to patients, including patient-related factors such as the likelihood of compliance and reasons for poor compliance.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

The entire cohort, beginning in the first year.

Which graduate attributes are enhanced by this initiative?

Critical thinking; appreciation of the need for evidence-based healthcare; appreciation of inconsistencies in evidence base; practical ability to do research; supports a research ethos.

What resources were required and what difficulties were encountered/overcome?

Clinical and laboratory facilities, including dental materials and microbiology laboratory. Staff time for supervision.

Impact of the initiative (if assessed) and/or student feedback

ICRAs give the first real opportunity to 'practise dentistry' and provide students with some key learning elements for their future care of patients; 72 per cent of students regard ICRAs as one of the three best aspects in first year BDS. Many perceive them as one of the most relevant aspects of being a practising dentist:

'...reminded me that I was not just doing a science degree.'

'…made my week. It has got me hooked on dentistry.'

'I look forward to a Friday afternoon'.

7.12 Portfolio reflective task as part of the honours dissertation project

Authors and affiliations

James Aiton and Julie Struthers, Bute Medical School, University of St Andrews.

Description of initiative

Students have to complete this reflection as part of their honours dissertation. They are required to summarise the aim of their project and then reflect on their experiences in doing the project. This is worth five per cent of the total dissertation mark.

Honours dissertation - portfolio entry		
Title: The title of the project		
Project aim: The aim of this project is… (maximum 100 words)		
Reflective task Aim: to write a short reflective piece on the experiences you had during your honours project and while writing up your thesis		
Questions for reflection		**Word count**
What have you learnt about yourself during this project?		200-300
How do you feel you dealt with any problems that arose?		200-300
How could you improve in the future?		200-300
How did you feel this experience would be useful to you in your future career?		200-300

Marking scheme	
Five per cent is available for the portfolio entries. The following marking advice should be given to staff and students.	
Mark	**Performance**
0	Written nothing
1%	Written very little or what they have written is not relevant
2%	Gave factual account with no reflection
3%	Showed reflection in response to one of the questions
4%	Showed reflection in response to most of the questions
5%	Showed reflection in response to all questions

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All final-year students.

Which graduate attributes are enhanced by this initiative?

Ability to reflect.

What resources were required and what difficulties were encountered/overcome?

Marked by tutors who supported the students during their dissertation. Staff feel that it was important it was marked by the tutors, as they witnessed the students' journey through the project.

Impact of the initiative (if assessed) and/or student feedback

Students have found this to be a useful exercise. Staff have been impressed with the standard of reflection reached by the majority of students.

7.13 Summer projects for veterinary students

Authors and affiliations

Thomas Anderson and Lesley Nicolson, University of Glasgow Veterinary School.

Description of initiative

The University of Glasgow Veterinary School summer research programme primarily targets students at the end of the third year of their Veterinary undergraduate degree. It comprises projects of six to eight weeks encompassing a diverse range of topics. Most are research-lab based, but clinical and pathological projects are offered, as well as projects with a focus on data analysis or the development of novel teaching resources. All projects offer experience of generic skills (see Graduate attributes section on page 13) irrespective of their individual focus.

Participation in the programme is voluntary and project selection is student driven. Students who undertake a project can gain extra-mural studies credits (up to eight

weeks out of a total requirement of 26 weeks), thus diversifying their EMS experience. Students are required to present their results, orally and as a written report, at the end of their summer project. Some may opt to present to their peers in an annual competition open to all participating students undertaking projects at the University of Glasgow and further afield. Past projects have resulted in publications, generation of educational CDs, and data presentation at national and international conferences.

Projects are advertised to students in an oral presentation, by leaflet distribution and on the VLE - Moodle - via a dedicated vacation research page. A member of staff is tasked with collating and advertising the project list and providing support to students and staff regarding project allocation and funding. The faculty provides funding of student stipends where applications for external funding have been unsuccessful.

Project options in 2008 included:

- how to measure and predict racehorse performance
- investigating cardiac function using state-of-the-art ventricular pressure catheters
- how African trypanosomes evade host immunity
- immunoepidemiology of a nematode infection
- molecular mechanisms of disease resistance in ruminants
- pathogenesis of equine sarcoid tumours
- calf eating and drinking behaviour
- updating and running a veterinary clinical skills lab
- gross and histopathological findings in feline arthritis.

Although the opportunity exists for University of Glasgow veterinary students to undertake intercalated science degrees with a research project component, few students do so. Our summer project initiative is therefore a means by which veterinary students' exposure to the research environment can be maximised in a degree programme in which exposure to the laboratory environment and uptake of an intercalated degree option are minimal. While 25-30 students (one in four of the third-year cohort) undertake summer projects each year, up to two opt for intercalated degrees.

A study by Murray et al (2005) reported that 'Summer studentships…were shown to be strongly associated with a career involving research', and our summer research programme directly responds to the recommendation of the Selbourne report (1997) that 'veterinary schools should increase the exposure of undergraduate students to research'.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

Self-selected students between their second and fourth year.

Which graduate attributes are enhanced by this initiative?

Ability to design experiments, generate data, present results, analyse data, work in a team. Placements provide an insight into ongoing veterinary research, primarily within the faculty.

What resources were required and what difficulties were encountered/overcome?

Resources: research-active supervisors willing to supervise student(s) and financially support the research; funding from the school for student stipends; external funding.

Difficulties: increasing numbers of interested students not matched by increasing availability of external funds for stipends. To date, the school has financially supported all student stipends for which external funding is unsuccessful.

Impact of the initiative (if assessed) and/or student feedback

Students and supervisors are each asked to complete a feedback form rating 'attitude, communication skills, problem-solving abilities and research skills' (supervisor form) and 'exposure to research environment, opportunities for practical experience, experience of task design and data analysis, and appreciation of new areas of veterinary science' (student form) as 'excellent', 'good', 'satisfactory', 'less than satisfactory', or 'poor'. Space for comments is also provided. Student and supervisor feedback is, with few exceptions, extremely positive, with scores rarely falling outside the excellent and good categories. Student comments include:

> 'Well worth the experience!'
>
> 'Good insight into veterinary research career.'
>
> 'The experience has given me an insight into the rewards and challenges of a research career, and has stood me in good stead for my intercalated degree.'
>
> '...provided me with the chance to think independently about various aspects of the project.'
>
> '...now realise the importance of accurate and well-managed recording systems.'

7.14 Critical reading - the journal referee

Authors and affiliations

Stewart Fleming, Pathology and Neuroscience, University of Dundee.

Description of initiative

Critical reading of the literature and assessment of the significance of a piece of research are important skills for all doctors and an essential component of the academic, as opposed to the professional, training of medical students. To foster the skills of critical reading we have developed an exercise entitled 'The Academic Journal Referee', which is part of the SSC Pathology for Junior Doctors. The exercise is primarily a formative assessment tool, though it also contributes to the overall summative assessment of this SSC.

Students are asked to act as a referee for an academic journal. They are given a paper submitted to the journal (actually an already published paper) and asked to write a report to the editor commenting on its strengths and weaknesses. Time, usually two half-days, is specifically set aside for the exercise. Suggested reading is *Studying a Study and Testing a Test* by Riegelman (2004).

As preparation for the exercise, a seminar on critical scientific reading is delivered. Several points are highlighted, particularly the need to read the paper in a systematic, analytical way, and that this is a different way of reading.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

Self-selected students.

Which graduate attributes are enhanced by this initiative?

Critical reading, analytical skills.

What resources were required and what difficulties were encountered/overcome?

Preparatory seminar.

Impact of the initiative (if assessed) and/or student feedback

In general, students prove to be excellent critical readers with the guidance given. They report significant improvement in their critical analytical skills. Although we have no hard evidence, students also claim that they find that other pieces of work, such as project or audit studies, benefit from having completed this SSC.

7.15 Introducing graduate students to critical thinking and appraisal

Authors and affiliations

Susan Jamieson, Faculty of Medicine, University of Glasgow.

Description of initiative

Within a new master's programme, the MRes Molecular Medicine, a three-session module was designed to introduce postgraduates to critical thinking and appraisal. This module was intended to prepare students for critically evaluating scientific research articles. The sessions were held at weekly intervals and comprised the following:

Critical thinking

A two-hour interactive workshop designed to introduce the concept of critical thinking in a non-threatening environment, promote discussion of the concept and encourage students to practise thinking critically about writing in excerpts from popular books, websites and news articles. Students took part in four activities, the last of which ('Would you credit it?') was intended to encourage them to devise and apply a framework for thinking critically about any topic presented orally or in writing.

Critical appraisal of written text

This two-hour session aimed to provide a bridge between the relatively light-hearted workshop on critical thinking and the final session on critical appraisal of scientific research articles (critical appraisal was defined as critical thinking about and evaluation of written text). Students read a passage about metaphors used by modern biologists to discuss human development (Coen, 1999), then thought critically about the passage, applying a framework from the first session. Following a brief interactive presentation

about some of the reasons why people believe information (faith, evidence, etc), students were presented with a template for critical appraisal of research articles (adapted from Meltzhoff, 1998).

Critical appraisal of a research article

This two-hour session aimed to give students practice in applying a template for critical appraisal to a scientific research article. Following a brief didactic presentation on the key topic in the paper, students undertook individual critical appraisal of a research article distributed a week in advance, applying the critical appraisal template. There followed a group discussion of the article and appraisals.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

Postgraduates undertaking a hybrid taught/research master's programme.

Which graduate attributes are enhanced by this initiative?

Critical thinking and critical appraisal.

What resources were required and what difficulties were encountered/overcome?

- staff time for identifying resources and planning and facilitating sessions
- flip charts and pens
- research article for session 3
- photocopies of template for critical appraisal
- specific texts (others could suffice): Coen, E (1999), Cottrell, S (2005), Meltzoff, J (1998).

Impact of the initiative (if assessed) and/or student feedback

All sessions were evaluated using an electronic questionnaire delivered via Moodle, the VLE used by students undertaking the module (n=5). Students rated all sessions highly. Their text comments were also illuminating and almost exclusively positive. For example:

Critical thinking:

'…showed [us] not to take everything we read at face value.'

'…it was a funny way to deliver a little bit boring topic.'

'It made me THINK during the tutorial AND also after it [student's emphasis].'

Critical appraisal of written text:

'The template is absolute GOLD. A lot of the time we critically appraise ideas unsystematically…The guidelines help organise our thoughts. They force us to think about 'what' is discussed in the article, 'if' we agree with it, and 'why'….'

'…I thought a lot about the 'painting metaphor' even afterward.'

Critical appraisal of a research article:

> '…I really liked the fact that we judged the article thoroughly….'
>
> '… the session was fairly challenging but extremely useful.'
>
> '…it was a good idea to criticise some published work, that activity was quite new to me.'

To conclude, this three-session module was an effective means of introducing postgraduate students to critical thinking and critical appraisal, maintaining their interest while allowing them to practise applying the skills in a manner relevant to their research orientation.

7.16 The use of humanities resources in teaching The Practice of Medicine: critical thinking and reflection in medicine

Authors and affiliations

Peter Nelson, Bute Medical School, University of St Andrews.

Description of initiative

For the purposes of teaching medical ethics, professionalism, patient-physician relationship. Under the inclusive title 'Practice of Medicine' in the curriculum, the tutor has used various plays, short stories and docudramas to highlight the principles, issues and ethical dilemmas that require critical thinking and decision-making and that are inevitably encountered in the care of patients and the practice of day-to-day healthcare. The focus is on the issues that will potentially be encountered in the early years of clinical medicine as well as those that a more senior doctor confronts.

Students quickly become aware that much of what they see and read in these humanities resources requires interpretation (what is happening here?) followed by reflection (how do I feel about this?). The manner in which this all takes place is outlined below.

The humanities resources are made available to students electronically. If they are written resources such as a short play, a fictionalised short story or a narrative form of a doctor's experience they form supporting material for class meetings or guided study (as a separate element for which students are equally responsible) and are provided as PDF files. The other mechanism is to place video segments and/or entire videos within an electronically accessible Medical School video library firewalled within the University. Once again, these can be supporting materials or guided study assignments.

All these resources have learning objectives attached to them within the element accessed by students. Students understand from the outset that these resources are central to the interactive teaching taking place in class. Hence, class discussion and understanding will lose their meaningfulness if they do not read or view the resources previously.

This type of teaching is more commonly carried out in smaller groups. Typically, the tutor introduces a theme(s) covered by the resource and then gets the students to view the resource again during class. Multiple segments of a large resource can be covered during class, and class discussion under the direction of the tutor commences following each segment. Written resources can be used interchangeably with video resources. The learning objectives are addressed through the appropriate themes.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

When this method is used in year 2 of the curriculum, group size is about 35 students. All our students are pre-clinical and the teaching alternates with their clinical and community practice visits.

Which graduate attributes are enhanced by this initiative?

Students learn early in their professional lives the necessity for critical thinking and decision-making skills. They are also meant to realise that the practice of medicine involves interpretation and uncertainty.

What resources were required and what difficulties were encountered/overcome?

As indicated above.

Impact of the initiative (if assessed) and/or student feedback

Students find this a meaningful and memorable way of learning - a relief from the factual information they are expected to absorb in much of the rest of the curriculum.

7.17 Instilling a research ethos into an undergraduate science programme

Authors and affiliations

Vicki Dale, Donald Palmer and Stephen May, Royal Veterinary College, University of London.

Description of initiative

The Royal Veterinary College, University of London, added a non-clinical three-year BSc in Veterinary Science to its portfolio of degree programmes in 2002. Although designed to be completely independent of the Bachelor of Veterinary Medicine (BVetMed), the majority of applicants have used the BSc as a stepping stone to the BVetMed.
The purpose of this study was to determine whether the career aspirations of any students with deeply held ambitions to become veterinary surgeons could be changed as a result of their experience of the strong research science focus of the BSc.

Methods

A questionnaire was distributed to 101 graduates from 2005 to 2007. They were asked to state their original motivation for enrolling, as well as their current or future role, and to elaborate on whether this was their ideal choice.

Results

In all, 56 forms were returned (55.4 per cent). The majority of applicants had enrolled on the course in order to become veterinary surgeons (91.1 per cent). However, only 60.7 per cent of graduates subsequently entered the BVetMed; 26.8 per cent went on to postgraduate science or laboratory science work and of these, 66.7 per cent stated science to be their ideal choice. This means that 25 per cent of the respondents with

deeply held ambitions to become veterinary surgeons decided instead to become scientists. The proportion of graduates who have become scientists has increased over the last three years.

Another outcome of the study was that while those who went on to become veterinary surgeons were split between preferring the second or third years of the course, those who went on to become scientists exclusively favoured the third year.

Discussion/conclusions

It is unusual to have an opportunity to assess the ability of a teaching programme to change students' motivation and ambitions. This BSc has demonstrated that an inspiring programme can change career ambitions, which in some cases have been passionately pursued since infancy. The reasons for this, to be clarified using structured interviews, are likely to include the option for students to pursue their own interests in the third year, which one student clearly recognised as 'life-changing'. This is made possible through the selection of specialist modules offered by the RVC, and also by King's College London, and students undertaking a substantial research project of their own choice.

The second year of the BSc deals with pathology and pharmacology, content which potential veterinary surgeons in particular may find of relevance, whereas the third year has a structure more likely to be stimulating to those entering the programme with a science focus or those whose ambitions have changed.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All graduates were invited to participate in the questionnaire study of learning styles and career aspirations in July 2007. Follow-up structured telephone interviews are planned with a sample of the 56 respondents who:

- originally wanted to do veterinary medicine and subsequently enrolled on the BVetMed
- originally wanted to do veterinary medicine but were inspired to follow a career in science.

The questions explore the relationship between student and mentor and look at the impact of role models - academics actively involved in cutting-edge research. Interviews will also be conducted with staff to gain insight into their views on self-directed learning and the research-teaching nexus.

Which graduate attributes are enhanced by this initiative?

A strong component of the BSc in Veterinary Science is professional skills training. Topics include effective communication, interviews and appraisals, teamwork, leadership and management, and entrepreneurship. This is combined with a thorough grounding in scientific methods, statistics and epidemiology. The substantial third-year dissertation and other projects encourage students' ownership of their work and consequently skills for self-directed learning. The inclusion of PBL approaches encourages higher-level cognitive processing. Students are taken through the entire research process from writing grant applications to project management and the dissemination of results. This includes frequent oral presentations of the results of group work.

Impact of the initiative (if assessed) and/or student feedback

The course has been successful in encouraging students to pursue research careers in veterinary and medical laboratory science. This is a necessity given the national shortage of animal scientists and those engaged in veterinary research, and the fact that the number of students admitted annually to the BVetMed has reached full capacity.

The BSc serves as a useful template for other UK veterinary schools wishing to diversify the range of undergraduate programmes offered. In addition, because of its emphasis on professional skills and veterinary research, aspects of the BSc have been incorporated into the new BVetMed curriculum at the RVC to foster the development of independent, lifelong learning skills in veterinary surgeons.

It is too early to assess the long-term impacts of the BSc. Surveys of graduates will need to be repeated at five to 10-year intervals to assess graduate migration to different careers over time. Employer satisfaction surveys will also need to be conducted.

7.18 Research in action - integrating science with clinical practice

Authors and affiliations

Karen Mattick, Peninsula Medical School (PMS).

Description of initiative

In this fourth-year special study unit (SSU), students 'piggy back' an active research group and experience the process of research. They have the opportunity to try out techniques, analyse data and pose questions. Staff are given some guidance and examples of what is appropriate to give students to do. The SSU involves three one-week blocks across the fourth year. Students are able to choose the type of research group they join, and often there are three or four students with each research group.

After the first contact session, students are asked to produce an overview of the research topic in the form of a BMJ critical review. This review is formatively marked, and is set in order to ensure that students have a good understanding of the field. In the second contact week, students are expected to analyse data generated by the research team and use it to produce a research poster. The poster is summatively marked and contributes one-third of the overall mark. Students present their posters at an internal PMS research-in-action poster day, but this is not part of the summative assessment.

At the end of the third week, students are expected to produce a future work proposal, which should build on the data presented in the poster and state where they would take the project in the next 12 months. The future work proposal is summatively marked and provides the remaining two-thirds of the overall mark. The mark contributes to the overall assessment of the SSU modules, of which this is one of three in the fourth year. Students must pass the SSU module, but can compensate marks over the three SSUs.

Which students are involved? (for example percentage of cohort, stage of training, means of selection)

All fourth-year students.

Which graduate attributes are enhanced by this initiative?

Ability to work in a team; awareness of an academic career path; understanding of basic research methods; understanding of ethics and governance of research; enquiring mind; presentation skills; practical ability to do research; and understanding of data analysis.

What resources were required and what difficulties were encountered/overcome?

Training for supervisory staff.

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Julie Struthers (Project Director)
Anita Laidlaw
James Aiton
Gerry Humphris
Simon Guild

QAA Scotland
183 St Vincent Street
Glasgow
G2 5QD

Tel 0141 572 3420
Fax 0141 572 3421
Email comms@qaa.ac.uk
Web www.qaa.ac.uk

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