Margaret MacDougall

**An overview of**

Preparing medical students for self-directed learning in statistics: What should we expect of tomorrow’s doctors?

Margaret MacDougall
Centre for Population Health Sciences
University of Edinburgh Medical School
margaret.macdougall@ed.ac.uk

**Aim**

This is the second of two papers reporting on plans for implementation of statistical eLearning tools generated through the MSOR Network-funded project ‘Statistics in medicine: a risky business?’ and other funded development work. Here, I aim to provide an overview of the more extensive two-year interdisciplinary project ‘Preparing medical students for self-directed learning in statistics: What should we expect of tomorrow’s doctors?’, which commenced in December 2010. This project is funded for a two-year period by the University of Edinburgh Principal’s Teaching Award Scheme (PTAS), which aims to promote good practice in teaching, learning and assessment at the University of Edinburgh and more widely.

**The project team**

Brief details of the project team members, all of whom belong to the College of Medicine and Veterinary Medicine (CMVM), University of Edinburgh (henceforth, Edinburgh), are provided below.

*Principal Investigator (PA):* Margaret MacDougall (Medical Statistician and Researcher in Education)

*Project Partners:* Helen Cameron (Senior Lecturer and Director of the Centre for Medical Education), Simon Maxwell (Professor of Student Learning and Theme Director for Clinical Pharmacology, undergraduate medical degree (MBChB) programme) and the CMVM Learning Technology Section

**Background and rationale**

Two fundamental pedagogical problems

**The national deficit in learning outcomes in statistics** – Statistical reasoning is fundamental to the development of sound critical thinking within Evidence-Based Medicine (EBM). It ought to be a major concern, therefore, to teachers of medical students that *Tomorrow’s Doctors* [1], the official report of the General Medical Council defining the required “knowledge, skills and behaviours” of UK medical graduates, does not currently provide statistical learning outcomes for medical students. This deficit is likely to have been influenced by the absence of any published literature which defines a statistical curriculum for undergraduate medical students. These observations form the basis for a call for Edinburgh to serve as a pioneer in setting the standards for statistical learning within UK medical schools through the provision of research-informed learning outcomes. From a practical
perspective, the development of these learning outcomes ought to involve an investigation of the needs of our undergraduate medical students throughout their courses and those of practising physicians when engaged in clinical research, problem-solving and decision making.

The potential impact of this collaborative approach in improving the quality of statistical learning within the MBChB curriculum is evident from existing literature. For example, findings dating back to the 1980s report that through the absence of a working knowledge of statistics, practising physicians struggle to interpret or evaluate the presentation of clinical findings in medical literature. [2] This result is particularly troublesome given the recognized demand on practising physicians “to demonstrate that they can reach correct diagnoses using both clinical and statistical data.” [3] Moreover, the plethora of statistical blunders within leading medical journals, [4] including the British Medical Journal and the New England Journal of Medicine, highlights the need for lines to be drawn between statistical practise for professionally trained statisticians and future practising physicians. Through exposure to a prescriptive set of statistical learning outcomes from an early stage, the doctors of tomorrow will be less likely to fall into the same pitfalls as their predecessors when researching clinical findings.

The neglect of prior learning in statistics – A lack of prescriptive learning outcomes for statistics can lead to a shortfall in the development of prior learning in early years. At Edinburgh, this shortfall has been recognized in a curriculum review in response to a recent visit by the GMC. [5] The consequences are most evident, however, in Year 4, where students embark on 14-week research projects, and are required to engage in self-directed learning in statistics to enable them to interpret their research findings. It is typically at this stage that I meet with the students on a one-to-one basis to provide advice on statistical analysis and research design.

In achieving this goal, however, it is important to be aware that on entering medical school, students are rarely intrinsically motivated to learn statistics. The importance of developing a genuinely integrative approach to curriculum design in addressing this concern has a firm grounding in educational theory and practise. For example, even where learners are exposed to multiple perspectives, which can add richness to their insights and impart freedom of choice regarding their own beliefs, it is highly unlikely that the knowledge acquired will be retained unless it is “situated in the learners’ experiences” [7]. It is necessary to lift the “barriers between learning and living.” [6, 8] Further, recent innovations involving a multidisciplinary approach to teaching statistics to undergraduate medical students at Sheffield have been associated with improvements in attitudes towards learning statistics and knowledge of key statistical concepts. [3] Such findings serve to discredit teaching statistics in isolation from, or even in parallel to, clinical topics as teacher-centered approaches which lend little support to the case that statistics is indispensable to clinical practise. [9].

It is has been noted, however, that “Teachers need to understand and become committed to a new design if it is to be effectively implemented.” [10] From this perspective, it makes sense to seek the views of the educators as widely as possible so as to provide a valid evidence

An overview of Preparing medical students for self-directed learning in statistics: What should we expect of tomorrow’s doctors? – Margaret MacDougall
The existing eLearning resources
The eLearning resources of relevance to this project are of two types. Firstly, there are those which I have already designed and implemented in collaboration with the CMVM technology team and which continue to develop in response to ongoing student needs. These resources comprise comprehensive knowledgebases in questionnaire design, research design and statistical analysis together with searchable indexes. At Edinburgh, they are currently used extensively by undergraduate medical students and on request, honours science students. Secondly, there are the new eLearning materials designed through previous educational projects. These include modules on confidence intervals, summary statistics and a wide range of topics relating to the interpretation of patient risk, where in the latter case, the chosen clinical scenarios are of particular relevance to decision making in EBM. The modules include interactive learning objects and clinically contextualized examples and exercises as formative assessment with immediate feedback to students. All modules are subdivided into chapters to support future mapping of content to statistical learning outcomes for each year of the MBChB curriculum. Module content and design have been informed by research into the statistical learning needs of undergraduate medical students, including dyslexic students [11], and needs I have encountered through my teaching.

Aims and Objectives
The main aims of this project are
1. to define a statistics curriculum for medical students which is informed by:
   • the experiences of practising physicians from a wide range of specialties and
   • the learning needs of undergraduate medical students at Edinburgh throughout their curriculum and in so doing,
2. to empower undergraduate medical students to be effective self-directed learners in statistics.

With a view to achieving these aims, the project team will seek to:

i) obtain a comprehensive evidence base defining which statistical methods are useful to physicians within the workplace;

ii) engage undergraduate medical students at Edinburgh in curriculum design within a multidisciplinary research team;

iii) identify a list of learning outcomes in statistics for use by students and their educators within all years of the Edinburgh MBChB curriculum and

iv) use the concept of stages of self-directed learning in statistics to develop students’ capacities to think statistically.

Methodology and assessment of impact
Phase 1 (20 December 2010 – 19 December 2011)
The evidence base referred to under i) will rely on an online survey targeting over 200 practising physicians who teach undergraduate medical students at Edinburgh. Survey questions will include a list of statistical topics which are already covered by the existing eLearning resources, inviting respondents to indicate a) the value of these topics to their own clinical practise and b) the importance of these topics for the clinical areas they teach within the MBChB curriculum. Respondents will also be encouraged to add to this list and to provide case scenarios for the types of clinical problems where they recognize a need for statistics within their specialties.

In an earlier paper, I presented the case for integrating online discussion forums with statistical eLearning activities during clinical problem solving and decision making. [12] The survey will invite clinicians to comment on specific learning contexts within the MBChB curriculum where they would consider this approach to learning to be particularly effective. Correspondingly, they will be asked to indicate what contributions they would be willing to make by way of sharing my role as e-moderator in strictly scheduled online discussions with medical students. This will be with a view to avoiding Bland’s experience, as outlined earlier, being replicated in relation to statistics teaching at Edinburgh.

Respondents will also be invited to comment on the potential utility of introducing PBL in Year 3 as a basis for integrating learning in statistics and EBM while allowing students to take a more self-directed approach to statistical learning than in Years 1 and 2. PBL typically involves students working in small teams to identify what extra information is required for responding appropriately to a simulated patient presentation. Through delegating responsibilities among team members, they seek out this new information in order to arrive at suitable recommendations for addressing the “problems and issues raised” by the clinical scenario. [9] As such, this approach to learning can be managed to ensure appropriate guidance is provided to the team relative to their level of training. There is therefore scope for re-designing PBL...
sessions in consecutive years of the curriculum to include statistical content in a manner consistent with Grow’s SSDL model and to reinforce this learning through tutor-moderated online discussion within PBL teams.

In keeping with ii) and by way of complementing the above survey work, students will evaluate existing statistical eLearning resources in terms of relevance to clinical learning and future clinical practise and in terms of clarity. This will involve focus groups comprising MBChB students from Years 1 to 5 and monitored by two project team members other than myself. Focus group members will be purposively sampled to assess inclusiveness of the resources to a variety of learning approaches, including those of dyslexic students. A convenient design feature already within the eLearning modules will also allow students to respond to feedback questions while viewing module content.

Phase 2 (20 December 2011 – 19 December 2012)

Findings from the staff and student feedback will determine the learning outcomes under iii) and inform any decisions to revise or expand the existing eLearning resources. In keeping with iv), the content of the learning outcomes will be carefully constructed so as to ensure that self-directedness in statistical learning is highlighted as a quality to be developed and appropriate progressive levels of self-directness are defined for different stages of the curriculum. Furthermore, to ensure that participating in dialogue through discussion forums and vicarious learning through observation of stored dialogue from previous students are viewed by learners as worthwhile, it is intended that course-specific learning outcomes will specify what is expected through engagement with such dialogue, thus “turning discussion into learning tasks”[13].

It is also intended that the learning outcomes forthcoming from this project will reflect Biggs’s theory of constructive alignment, according to which “the intended verb in the outcome statement is present in the teaching/learning activity.”[14] This ought to include not only what students are to learn but the clinically related activities of critical importance to the workplace through which statistical learning is to be accomplished and assessed.

As further input under ii), undergraduate students will design a website with searchable indexes to facilitate the construction of figures analogous to concept maps to a) align the new learning outcomes in statistics with those stages of the curriculum where they apply and b) in turn allow students to navigate to the statistics resources which are most useful in achieving them. This will be managed through the use of the in-house web-based application COM:MAND (Curriculum Outcome Mapping: Management and Delivery), which a staff member from the CMVM Learning Technology team is currently developing. Based on previous work in Veterinary Medicine, [15] it is expected that the concept maps will prove to be an efficient means of identifying overlapping statistical learning needs within the MBChB curriculum. This should offer the advantages of allowing the project team to identify stages where prior learning can be cultivated and of enabling students to develop a deeper approach to learning through recognizing the connectedness of their learning activities.[16]

“Through involvement in this project, students will be welcomed as new researchers into a community of practise where their prior knowledge can be validated and used for the benefit of future students.”

The student evaluation methods from Phase 1 of the project will be repeated with the revised version of the eLearning resources. Where possible, this will involve the same students as in Phase 1. The feedback will additionally involve reflection on the clarity and functionality of the new concept maps.

Value to student researchers

Through involvement in this project, students will be welcomed as new researchers into a community of practise where their prior knowledge can be validated and used for the benefit of future students. As well as enhancing their self-efficacy as future researchers, [17] this experience will expose them to the dynamics of working and communicating effectively in a multidisciplinary research team. It may also help to address current concerns over disincentives for medical graduates to pursue research on graduation [18, 19]. Furthermore, these opportunities should assist in meeting the requirement for UK medical graduates that they “Function effectively as a mentor and teacher, including contributing to the … review of colleagues, giving effective feedback, and taking advantage of opportunities to develop these skills.”[1]

Acknowledgements

Thanks is due to Mr Matthew Hammond (eLearning Developer, CMVM Learning Technology Section) for sharing his insight into functionality of existing technology for constructing concept maps and for directing me to relevant literature in this area.

References

An overview of Preparing medical students for self-directed learning in statistics:
What should we expect of tomorrow's doctors? – Margaret MacDougall


