

## MEDICAL STUDENTS AND STATISTICS CHALLENGES IN TEACHING, LEARNING AND ASSESSMENT

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*Over the last fifteen years, graduate entry programmes for admission to undergraduate MBBS courses have become increasingly popular in the UK. At St. George's, University of London, students entering the graduate entry MB BS programme will have a first degree in any discipline whilst some have further degrees. Challenges typically arise when teaching and learning medical statistics. Students do not necessarily expect to study statistics at medical school, whilst confidence and expertise varies depending on the student's previous degree and how long ago they studied mathematics. The presentation will focus on how teaching of medical statistics when integrated with the basic and clinical sciences, plus learning through group work can help address heterogeneity in students. In particular students are encouraged to be independent, identifying and meeting their own individual learning needs in order to progress.*

### BACKGROUND

The teaching of medical statistics is a core component of the undergraduate curriculum in United Kingdom (UK) medical schools. However, it was only in 1967 that the General Medical Council (GMC) recognised the importance of this discipline and recommended teaching in medical statistics and/or biometric methods be included in all doctors' training. Presumably this was because of the increasing use of statistics in medical research papers, plus the need for doctors to assimilate knowledge and evidence for their practice.

In 1979 the proportion of 18 to 19 year olds in the UK that entered higher education was 12 per cent—by 2010 that has risen to 36 per cent (HEFCE, 2010a). This increase in student numbers was primarily a result of a UK government initiative to widen access and enhance participation in higher education. The vision has been to promote and provide the opportunity of successful participation in higher education for anyone who could benefit from it. In particular the aim was to ensure equality in opportunities for men and women, all ethnic groups, mature students and disabled students. In particular, the introduction of the Special Educational Needs and Disability Act in 2001 (HEA, 2010c) has meant that all UK universities are required to provide equal opportunities for students with any disability. The widening access to higher education has been described as moving towards a “mass system” (Gosling, 2005).

There has been a rise in student numbers for medical schools larger than the national average for further education. Between 1997 and 2006 the numbers of medical school places rose from 3,749 to 6,194, representing a 71 per cent increase (HEFCE, 2010b). This increase in numbers has in part been due to the introduction of graduate entry programmes for admission to undergraduate MB BS courses. Such programmes are designed specifically for graduates who may either want a change in career or who were not successful when they first applied to study medicine. Not all graduates join such programmes straight after completing their first degree. Graduate entry programmes are four years in length, compared to the traditional five- or six-year MB BS course that students join when leaving school at 18 or 19 years of age (Rushforth, 2004).

Although there has been an increase in the numbers of medical school places between 1997 and 2006, the average number of applications per place fell for the first part of this period at least (MacManus, 2002). Along with the result of widening access and participation, medical education in the UK is no longer exclusively for the highly selected student. Medical students have become increasingly heterogeneous in respect of age, culture, disability and previous educational experiences. This has meant that there is no longer common ground in the students' understanding of the purpose of medical education and also in the ways that they study and learn.

In the changing face of higher education, with greater heterogeneity of students entering medical school, there is the need to develop and provide continuing support of the different learning needs. The teacher-centred model where academics simply lectured and discharged vast

quantities of information in a didactic manner is no longer adequate. Medical education in the UK has undergone considerable reform, with changes in curriculum content and delivery. This change has paralleled that in students as they have become increasingly heterogeneous in their learning needs. It is not obvious to what extent changes in curriculum content and delivery were initially a direct result of changes in students' learning needs. However, how medical education is currently delivered accommodates students' different learning needs and styles.

The radical reform of UK undergraduate medical education began in 1993 when the GMC first published *Tomorrow's Doctors*, making recommendations for change in curriculum content and teaching delivery. In their vision of *Tomorrow's Doctors* the GMC set out the knowledge, skills and behaviour that students must demonstrate by the time they graduate. Emphasis was placed on a shift from gaining knowledge to a learning process that included the ability to evaluate data as well as developing the skills to interact with patients and colleagues. The GMC were keen that modern education theory and research influenced teaching and learning. Furthermore, students should be exposed to a variety of teaching and learning opportunities incorporating a balance between small and large teaching groups, practical classes and opportunities for self-directed learning. Over and above all, it was stressed that the clinical and basic sciences should be taught in an integrated way. Over the last 15 years medical education has moved away from a teacher-centred approach to one that is more student-centred. Students are encouraged to identify their own learning needs and to find ways of achieving them. The student is identified as an adult learner who takes responsibility for their own learning.

## THE PROBLEM

As described above, medical students have become increasingly heterogeneous in respect of age, culture, disability and previous educational experiences. This has meant that there is no longer common ground in the students' understanding of the purpose of medical education and also in the ways that they study and learn. Any issues raised by the heterogeneity in the students' abilities will no doubt vary between disciplines, and then be compounded for students entering medical school on a graduate entry programme.

Traditionally there have been problems in teaching medical statistics to undergraduate medical students. Students may not necessarily expect to study statistics at medical school. Despite the best efforts of teachers, however, medical statistics is seen as inherently mathematical and irrelevant (Altman & Bland, 1991). There is tremendous capacity for heterogeneity in students' abilities when studying statistics at medical school. Students will vary in the level to which they have studied mathematics or statistics prior to studying medicine. The ability and confidence of students when studying statistics at medical school will depend on the grade to which they studied mathematics or statistics, and how long ago. Students entering the graduate entry programme at St. George's have a first degree in any discipline – including the arts and sciences. Some students may have studied statistics at part of their previous degree or for a higher qualification. Approximately 5% of all students at St. George's, University of London have been identified with some learning disability. Dyslexia is probably the most commonly identified disability. As all students are assessed on the same learning objectives, careful consideration needs to be given to the teaching of medical statistics to students with such disabilities.

The heterogeneity in student abilities has presented challenges in the teaching, learning and assessment of medical statistics. The traditional methods of teaching that were evident twenty five years ago, including theoretical courses delivered in large lectures are no longer acceptable. There is a need to change how medical statistics is taught and learnt, not least to reflect the GMC's recommendations in their publications *Tomorrow's Doctors* (1993, 2003, 2009). The teaching, learning and assessment of medical statistics must be more student-centred with integration with other disciplines. Even before the GMC published *Tomorrow's Doctors*, medical statisticians were advocating the need for integrated teaching with clinical sciences to enhance student learning (Evans, 1990). Since then there has been a move away from more theoretical based courses to ones that practice research and critical appraisal skills, in particular using evidence-based medicine to teach medical statistics (Morris, 2002). However, it is not obvious to what extent such approaches have met the GMC's recommendations for change in curriculum content and teaching delivery,

whilst accommodating heterogeneity in student levels. Approaches to teaching medical statistics on the Graduate Entry Programme at St. George's, University of London are discussed.

## TEACHING AND LEARNING

### *General Ethos*

The general ethos of medical statistics teaching on the Graduate Entry Programme is to ensure that learning has a direct relevance to experiences on the wards as medical students and future careers once qualified. Students are not expected to know formulae or complex methodology—the emphasis is placed on appreciation and application to the individual patient. Teaching alongside other disciplines is encouraged, particularly clinical communication skills. Large group teaching has been effectively removed and replaced by seminars or workshops. Assessment has been changed to reflect these changes in teaching.

### *Delivery – Problem Based Learning*

At St. George's, teaching on the Graduate Entry Programme is principally delivered using problem based learning (PBL). Emphasis is placed on student-centred learning, with the student expected to be an independent adult learner. Small interactive groups of students discuss clinical scenarios using a structured approach (Wood, 2003). Each group has a tutor that initiates so-called “triggers” in the clinical case or scenario, helping students identify their own learning needs. Students then undertake the necessary learning to meet the identified learning objectives. This learning is typically done independently, subsequent to which the group comes back together to share their understanding and knowledge. PBL overcomes many of the problems around studying and learning that arise out of student heterogeneity. PBL also encourages and develops both team work and communication skills. Typically there will be two or three PBL tutorials in a week, with identification of learning objectives and subsequent feedback done in a piecemeal fashion.

PBL triggers to initiate student discussion about statistical concepts have been successfully introduced. For example the application of test results following antenatal screening. The student may be challenged to identify if they have any learning needs around the definition of screening indices such as sensitivity and positive predictive value. Part of the trigger may also encourage students to discuss how such results are communicated to the expectant mother. Such prompts may proceed or follow a seminar on screening tests. Such learning must be student-centred and achievable, and ultimately have a direct application in future patient care. Typically PBL has time constraints and triggers centred in medical statistics will be limited. Whilst tutors have notes to ensure students meet the full extent of their learning objectives, the triggers must also be achievable for the tutor.

### *Large Group Teaching versus Small Group Teaching*

Large group teaching is generally very cost efficient and can be very effective. However, lecturing large groups tends to encourage passive learning (Cantillon, 2003). It does not encourage student-centred learning and does not provide much opportunity for the development of the student as an adult learner.

Large group teaching has been effectively removed and replaced by seminars or workshops whereby students are given some knowledge, and then encouraged to solve problems or work through scenarios in small groups. Typically half of the year group is taught at a time, splitting up into small groups. Obviously such teaching requires a seminar room as it would not work well in a lecture theatre. The groups then collectively feedback their learning and understanding. Small groups play a valuable role in the all round education of students (Jaques, 2003). Discussion in small groups encourages students to discuss meanings and concepts, whilst developing confidence in talking the language of medical statistics.

Small group teaching has facilitated the integration of teaching of medical statistics with other disciplines, including clinical communications skills, clinical and research ethics, plus clinical skills. Students have reported they enjoy these teaching sessions and help them see how medical statistics can be applied in clinical practice. Such teaching is based on the suggestion that

the “ability to retrieve an item from memory depends on similarity between condition or context in which originally learned, and context in which retrieved” (Prideaux, 2005).

### *Grouping*

One way of overcoming heterogeneity in student abilities is to split students into homogeneous groups. There appears to be limited recent educational literature regarding heterogeneous versus homogenous grouping. Kerckhoff (1986) reported that for 11 to 16 year old British school children, those students in high ability groups gained more than students in low ability groups when compared to children who had not been split on ability. Boaler, William and Brown (2000) also reported analogous effects in children of similar ages. Furthermore, teaching in homogeneous groups had largely negative profound effects upon students and their learning experiences, whilst students were generally unhappy with such divisions.

In the first two or three cohorts of the Graduate Entry Programme there was some demand from students to be split into groups based on their prior knowledge of medical statistics. As all students are assessed on the same learning objectives, it was not obvious why students should have advocated this. It is possible that students with greater knowledge felt frustrated by those with a little if any prior knowledge of the topic. Equally those with little knowledge may have felt intimidated by their peers. Those students that had already been taught statistics in some capacity may have thought they could learn additional material over and above the core-curriculum. Interestingly there was no demand from students to be split into groups based on prior knowledge in other subject areas. Grouping based on student’s abilities or previous experiences regarding statistics was not introduced at St. George’s. As with PBL and the advantages that small group discussion brings, student heterogeneity is encouraged in teaching medical statistics—it encourages dissemination of knowledge and ideas between students in a variety of ways that individual lecturers can not deliver.

### *Students with Special Needs*

An increasing number of students have special needs or some disability. This may include students with dyslexia, visual, hearing or physical impairment. It may be beneficial that teaching aids, including PowerPoint presentations and resource notes are made available electronically to all students before the teaching. Students with dyslexia or visual impairment may find it beneficial to alter the font, font size and colour scheme of presentation to suit their own needs. Moreover, students with special needs may find it beneficial to prepare for the teaching in order to be able to enhance their engagement in their learning. We should be careful in thinking that all students with special needs are at some disadvantage – indeed they may be gifted and talented.

The importance of strong voice projection and eye-contact with the audience at all times can not be stressed enough. Whilst such attributes are good teaching skills, they are essential for students with physical, hearing or visual impairments. Such students may employ professional note-takers or communication support workers to assist in their learning and note-taking. However, it is not obvious how such note-takers or support workers would engage in teaching that includes small group work. If there were at the edge of a small group and not contributing, their very presence could have profound effects on group dynamics. Nonetheless, probably the most important issue is to ensure that everyone is aware of their presence and that there are sufficient handouts.

At St. George’s there has been a suggestion that voiced-over PowerPoint presentations are made available to students. Whilst not all teaching and learning would be suitable, it could be beneficial not only for students with special needs who may fall behind in a session, but more generally for all students when revising.

Whilst it is important to be aware of the needs of some students, it would not be sensible to tailor teaching and any resource materials uniquely to them. Whilst the needs and learning styles of students are very heterogeneous, they are on a continuum. Therefore, the student group should be considered as a whole, and small factions should not be afforded special attention at the expense of everyone else.

### Assessment

Assessment drives learning – namely how students are assessed drives how students learn. It is therefore imperative that students' assessment reflects how they are taught and subsequently learn. This concept is a powerful tool that encourages students to adopt deep rather than surface learning strategies. At St. George's students are assessed in a variety of ways, including short answer questions (SAQs) and objective structured clinical examinations (OSCEs).

Short answer questions reflect the small group work that students undertake as part of their learning. Each SAQ consists of a brief scenario outlining results from a peer-reviewed publication, followed by two or three short questions. The first question may ask the student to interpret, for example, a relative risk plus its associated confidence interval. Following that, the student may be asked to apply that information in a particular clinical scenario or patient consultation. There is not always one unique model answer, and students can gain marks with a variety of responses so long as they are coherent and relevant.

The use of objective structured clinical examinations (OSCEs) to assess medical statistics is to the author's knowledge a unique approach. In an OSCE tasks may be performed on a patient, simulated patient or manikin. Assessment is against a structured marking schedule incorporating a checklist of criteria by a single assessor. The use of a structured marking schedule ensures reliability. Medical statistics can be assessed using an OSCE when integrated with another discipline—typically one that is clinical. Joekes, Sedgwick and Hall (2009) have described how OSCEs may be used to assess student's understanding and communication of risks, as applied to antenatal screening test results plus mortality in cancer patients based on a Kaplan-Meier survival curve.

### CONCLUSION

An increase in the numbers of students that enter medical school in the UK has led to heterogeneity in students' abilities. This has led to challenges when teaching medical statistics, how students' learning is facilitated and assessment. At St. George's, a variety of approaches have been adopted and developed to overcome differences in students' understanding of the purpose of medical education and also the ways they study and learn. These changes have primarily been in response to the GMC's recommendations for change as detailed in *Tomorrow's Doctors*. Teaching of medical statistics needs to be integrated both into the curriculum as a whole and also across disciplines. We encourage teachers to look for common ground and think creatively. The challenge to teachers today is to make education more stimulating and motivating. New ways of assessment have been developed at St. George's in order to reflect new approaches to teaching and learning.

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