

A STATISTICS MODULE THAT INTERACTIVELY ENGAGES UNDERGRADUATE MEDICAL STUDENTS

Sophie Lee and Eirini Koutoumanou
Great Ormond Street Institute of Child Health
University College London, London, UK
sophie.a.lee@ucl.ac.uk

The General Medical Council within the United Kingdom requires all new doctors to be able to 'apply scientific method and approaches to medical research' (2009). Despite this, medical students are often reluctant to engage in statistical training and remain disinterested in the subject. This paper details how the Health Research Methods module offered to 3rd year medical students undertaking an integrated Bachelor's degree (iBSc) in Paediatrics and Child Health was re-designed to adopt a more interactive approach using SPSS computer software to better motivate the class. Students are required to apply statistical methods within real-life settings using example datasets and interpreting the findings appropriately. The module training also links directly to their mandatory research projects for which they usually collect the primary data.

BACKGROUND

At University College London (UCL), Bachelor of Medicine and Bachelor of Surgery (MBBS) students are required to undertake an integrated Bachelor of Science (iBSc) during their third year which allows students to focus on a specific area of interest followed by a research project at the end of the year. There are currently 18 different iBSc programmes available to MBBS students including Paediatrics and Child Health, Oncology, Medical Anthropology, Neuroscience, and Global Health. Students are required to select 4 programmes in order of preference and are allocated based on availability. Paediatrics and Child Health is consistently over-subscribed meaning students who are accepted usually have very strong personal statements and previous achievements, making them a highly motivated group of keen learners.

Medical students' lack of interest in the field of statistics and the issues this presents has been well documented in the past (Ojeda, 1999) despite the increasing recognition of it as a core aspect of medical professionals' careers. In the United Kingdom, the medical professional guidelines set by the General Medical Council require medical graduates to 'apply scientific method and approaches to medical research' (General Medical Council, 2009) before they can graduate and become fully qualified as medical professionals within the UK. These guidelines do not specify the level or amount of statistical knowledge that must be provided to students but the inclusion of this condition ensures students are aware of its necessity within the medical profession. Despite this, doctors still often fail to recognise the value of statistics and research methods during their undergraduate studies (Miles et. al., 2010).

Many studies have sought to find the most appropriate method of delivering statistical material to undergraduate medical students, often using problem-based learning and active approaches to engage students and encourage them to play a more active role in their module. Bland (2004) argued that failing to incorporate statistical training into the main curriculum could lead to the marginalisation of the subject and that, despite the difficulties in implementation, statisticians should fight to integrate statistics and research methods training as much as possible into the main teaching of medical students. Although the iBSc students are more motivated than most as they are undertaking a research project which often requires quantitative methods, they still consider the topic as a 'necessary evil' and remain disinterested.

THE HEALTH RESEARCH METHODS MODULE: PREVIOUS PRACTICES

The Centre of Applied Statistics Courses (CASC) has been providing statistical support in various forms to iBSc students in Paediatrics and Child Health since the 2010/11 academic year. Over the years, the way this statistical support has been delivered has been updated based on student feedback, technological developments and pedagogical research. In this paper I detail the evolution of this module from its inception to the current form offered in the year 2017/18, the lessons learned from teaching this particular group of students and the plans to improve this module in the future.

Statistical support was first offered by CASC to the iBSc students in the form of a compulsory module, Health Research Methods. This module first ran in the academic year 2010/11, prior to this students undertaking a quantitative research project were required to approach the in-house statistical support service with their individual projects. The Health Research Methods module consisted of 40 hours of teaching, with 36 of those hours taking place in a traditional lecture setting and the remaining 4 hours spent introducing the statistical package SPSS in a computer lab. Students took a 2-hour multiple choice exam at the end of the module but received no other formal statistical support from CASC. Feedback from the module was generally positive (the mean rating for the overall quality of the education offered by the module was 4 out of 5 based on feedback from 13 participants) but contained some comments that suggested this method of delivery was not optimal for this audience. Three students complained that the days spent in the classroom were too long and they struggled to stay engaged with the material. Two requested to spend longer learning SPSS and applying the methods as this was more useful for their research project. Finally, 2 students undertaking qualitative projects complained that they did not get support for their projects and did not feel it was fair to offer a completely quantitative module without a qualitative alternative. The module was adjusted slightly in the academic year 2011/12 based on feedback from students to incorporate 9 shorter quantitative lectures (3 hours per session) and 2 two and a half hour qualitative sessions delivered by a lecturer from another team (making 37 hours of teaching in total). The course was still taught in a traditional lecture style setting with one SPSS session taking place after the completion of all quantitative lectures.

Despite the adjustments made to the course, teaching staff found the students were disengaged during sessions and unmotivated as they felt they already knew the material that was covered. During the years 2012/13, the module leads decided to forgo formal statistical training in favour of ad-hoc statistical support for students undertaking quantitative projects. Students were given access to notes from the Health Research Methods module and SPSS training guide but were not taught in a classroom-setting. CASC offered statistical support to students for their projects on a one-to-one basis in meetings booked through the statistical support service within the Institute. This meant that students received personalised advice exclusive to their project. Students who did not feel quantitative methods were relevant to their projects did not feel they were wasting time for an extra module. However providing one-to-one support is far more time-consuming than lectures and adds an extra level of complexity when students attend the meetings with a misconception or not enough clarity about a method/statistical test.

In 2013/14 it was decided that failing to offer formal statistical training to support student projects was unacceptable and that the Health Research Methods module was not the optimal strategy for this group of students. As a compromise, statistical training was carried out using tutorial sessions that were tailored to cover topics relevant to students' projects. In the first term of the academic year, students were asked to prepare a short presentation introducing their intended project and giving a brief overview of the methods they intend to carry out; these presentations were not assessed but gave teaching staff an idea of the material that needed to be covered in tutorials. Students were also given a day of SPSS training to ensure they were aware of how to apply methods taught throughout the tutorials. This structure was repeated in 2014/15.

Since 2015/16, tutorials and SPSS sessions have been combined to provide a more interactive experience for the students. Rather than teach the theory and software separately, application of theoretical methods has been demonstrated on the software concurrently. The teacher would introduce a statistical concept, for example the two-sample t-test, show the theory behind the methods and work through an example. The teacher would then show how to apply this method using SPSS with an example dataset. After covering all intended topics in a session, students were given exercises and research questions to address using SPSS. Teachers found that the students appeared more motivated to engage with the material and less distracted as the lecture was broken into smaller sections. The sessions were compulsory but not formally assessed and students that attended the sessions were entitled to statistical support for their research projects via 'drop-in sessions'. Two project drop-in sessions were scheduled to take place in the spring term to offer students one-to-one statistical support. At least 3 members of the CASC team were available to offer guidance on projects; the sessions were completely optional. Before attending a drop-in session, students were required to complete a 'Statistical Project Plan' form which outlined their study aims, variables

included in the analysis and their intended methods. Students' feedback was that they found this useful as it required them to think critically about their study designs and made it easier to select appropriate analysis methods. This format was repeated in the academic year 2016/17.

One of the main problems with offering statistical support in tutorials that were 'compulsory' but not part of an official module and had no formal assessment was that some students did not attend every session and had gaps in their knowledge when it came to tackling their research projects. In the 2016/17 academic year, the final 2 tutorials had just 8 out of the total 20 students in attendance. Students were only entitled to attend the drop-in sessions if they had attended the relevant tutorial session for their query (unless they had extenuating circumstances). A number of students that did not attend the tutorials tried to attend these drop-in sessions as they realised too late that they did not have the quantitative skills needed to complete their project. As they were not entitled to the additional help unless they attended lectures, the programme was forced to provide additional funding to students to seek statistical consultancy.

It is difficult to formally compare feedback between these formats as this was only recorded for formal modules and tended to have quite poor response rates. We received 5 comments from 20 students in 2016/17 related to the statistics module – 3 were fairly positive, saying they felt it was very useful for their projects and they enjoyed the introduction to SPSS. Two of the comments mentioned that the length of sessions were too long (they were 3 hours with a short break) and one said it was not helpful to their project. The general consensus from speaking to students and programme leads was that the statistical support was very much necessary (particularly as the majority of students were undertaking quantitative projects) but there was not enough motivation to attend all sessions as they were not assessed.

THE HEALTH RESEARCH METHODS MODULE: THE PRESENT AND THE FUTURE

Following on from the 2016/17 academic year and previous experiences, teaching staff realised that the way statistics was taught to iBSc students must be updated. After discussions with the programme lead, it was decided that the Health Research Methods module should be reprised and offered to iBSc students but the structure would be completely changed. The material covered would remain very similar to the original module but SPSS and practical applications would play more of a central role in the delivery of the course.

Responding to student feedback received from previous cohorts, sessions were kept at 3 hours with a 20-30 minute break in the middle. The module became optional so students undertaking qualitative project need not attend sessions not useful or relevant to their research. SPSS was formally added to the list of learning objectives for the module and all learning would be SPSS-centred meaning students would apply concepts learnt within class using SPSS rather than performing calculations by hand (as was the case in the original module) to make them more relevant to their future work as well as their projects. Students were formally assessed in the spring/summer exam period with a 2 and half hour exam that consisted of a combination of multiple choice questions and an SPSS task.

For every new module offered as part of a degree programme in UCL, proposals must be submitted to and approved by the relevant department and faculty. This can mean a lengthy process involving extensive paperwork. As this module was established, the department agreed that it could be reintroduced in the new format via a 'module amendment' submission which requires far less external scrutiny, particularly when only carrying out what constitutes 'minor' amendments (changing less than a third of the learning outcomes). A GPC form (module amendments) was completed and accepted with the addition of SPSS to learning outcomes and an SPSS task included in the final exam.

Health Research Methods was offered to students starting their iBSc in Paediatrics and Child Health in October 2017. Students were required to take four compulsory modules (Health Services for Children, The Child and Community, Critical Appraisal of Primary Care and Paediatric Practice, and Tertiary Care and Complex Childhood Disorders) and one of two optional modules (Health Research Methods or Maternal and Child Health in Developing Countries offered by the UCL Institute of Global Health). This presented the first challenge as the module required at least 5 out of the 20 students to take this optional module to justify running it. I decided to take Bland's (2004) advice and fight to include formal statistics training into the curriculum by delivering a talk at the

students' induction day which stressed the importance of quantitative methods in doctors' careers and the value of statistical support that would be provided for their research projects. For the 2017/18 academic year, 19 out of 20 iBSc students chose to take the Health Research Methods module rather than Maternal and Child Health in Developing Countries.

Despite this module still running at the time of submitting this paper, there has been a number of teething issues faced. After the third lecture I met with the student representative who gave feedback he had received from other members of the class that they felt unchallenged by the material and felt they already knew what was being taught. He said he realised that the content covered in the first few sessions was necessary to their understanding of statistics as a whole but felt too long had been spent on simple methods. It also became clear from this discussion that there was considerable overlap between the first 2 lectures of my module and another compulsory module the students had taken in their first term, Critical Appraisal. This overlap should have been acknowledged by programme leads when the change of module documentation had been reviewed but was missed. This feedback made me realise the importance of receiving and reviewing up to date learning objectives for all modules in a programme in good time to ensure they complement each other. It also highlighted the need for a flexible module that can be adjusted to take account of the class's initial level of understanding whilst focusing on areas of weakness. The method of delivery has been changed and the pace at which the content is covered has been adjusted substantially based on this feedback from students and discussions with student representatives.

I used the students' feedback to restructure lectures, ensuring that more time was spent applying methods using SPSS whilst also ensuring that enough time was spent explaining concepts so students understood the nuances behind each theory. As students seemed fairly comfortable with basic statistical theory, I covered simpler topics at a quicker pace and included more complex ideas such as transformations that were originally only going to be covered later in the course. Despite the change of pace, students still seemed easily distracted and unmotivated to learn the topic even when applying the methods themselves using SPSS. I realised that traditional lectures, even when supplemented with practical demonstrations and exercises, were not effective for these students. They required a more active approach that involved less listening and more applied learning. I decided to teach the second half of the lectures using a flipped classroom structure which left lecture time free for students to engage with the material in a more practical setting.

Flipped or inverted classrooms reverse the traditional lecture-style by requiring students to learn material provided to them before scheduled lectures and spending time in the classroom carrying out what would previously be considered homework; "inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (Lage et. al., 2000). Studies have found this type of course delivery can improve students' attitude to statistics (Carlson & Winquist, 2011) but there is still a lack of formal evidence to show whether this method of delivery improves student outcomes (Bishop & Verleger, 2013). There are many different methods of providing this type of learning; I have chosen to record myself talking over the presentation as I would during a traditional lecture and demonstrate the application of these methods using SPSS to students; I have supplemented this material with links to written course notes. The reason I have chosen to do it this way is so that students can choose the method that best suits their learning style. Students also have the option to skip sections they feel are too slow or unchallenging for them and spend more time listening to the more complex methods they may not be as comfortable with. Lecture time is used to incorporate problem-based learning into the module, a common technique used to teach within medical schools in the UK and around the world (Wood, 2003). Students are split into groups and each group is provided with real data and asked to formulate a research question the data could have been collected to answer; students then carry out a miniature research project attempting to answer the research question using methods they have learnt through the course. Afterwards they are asked to present their project to the other groups, discussing the methods they used and the reasons they chose them; other groups then provide peer feedback which encourages critical thinking.

LESSONS FROM 2018 AND PLANS FOR THE FUTURE

The importance of statistical training with practical applications, even for students who are not undertaking a research project as part of their assessments, should not be underestimated. Over the past 7 years of providing this sort of support it is clear that software (whether SPSS or another statistical programme) should be a main focus of any material and that traditional classroom-style lectures should be avoided as they fail to engage students. My main aim for this module was to make it more interactive and engaging for the students and to show that statistics is not just a necessary evil but an interesting, useful skill for their studies and future career. I have realised how important it is to engage students in the beginning of the module as their enthusiasm in the first lecture quickly dissipated when covering introductory topics meaning that it was hard to keep their attention when more difficult material was introduced. Modules should be flexible enough to change pace based on the level of students and previous statistical experience; the material covered should also complement other modules undertaken by students within the same programme whilst avoiding too much overlap.

Although the module has not finished at the time of submitting this paper and formal feedback has not been received, I have already started to think about how the module can be improved for the next academic year. Students are generally homogeneous but their previous statistics exposure will differ; I think a short pre-module quiz on Moodle, the UCL online learning management system students are given access to as part of their studies, would help to gauge an idea of the different levels across the class. The quiz would contain a range of questions on topics covered in the course and try to identify common misconceptions and areas that students may not have covered before. The quiz would not count towards their final grade and results will not be posted as this is purely to help with the organisation of the module. Students will have access to the right answers if they wish but they will not be required to revise these problems before the module starts. This quiz can also be used to inform the teacher of how much of the material covered in previous modules that may have some overlap (in this case, the Critical Appraisal module) has been fully understood and whether any of it needs to be re-visited. The quiz results will be combined with up to date learning objectives from these other modules to ensure less overlap and more concise lectures are delivered covering topics students are familiar with.

Although the flipped classroom structure seems more appropriate for this group of students due to their lack of concentration within classes and requests for more hands-on practice, more research is required to ensure that this method is accessible to all students regardless of their background and needs. Reasonable adjustments must be made to accommodate disabled students, particularly students with hearing impairment who may struggle listening to the lecture. One student in the 2017/18 class is profoundly deaf and uses lip-reading to put lectures into context; this was unknown to me and meant that she felt disadvantaged by the new format. To overcome this, I am working with the student to use software that adds subtitles to the recorded audio and I will record my face while speaking so students can lip-read whilst following slides if they need to. This student will give me guidance on how to make my lectures more accessible for hearing impaired students so no other students with these types of disabilities feel disadvantaged in the future whilst taking this module.

The Health Research Methods module has made some progress towards the aims of being interactive and engaging enough to make iBSc students excited by statistics and research methods. The current form is a vast improvement on the previous versions in terms of engagement with the material and student attendance (compared to when the support was offered as tutorials). From informal discussions with students, they appear to already be using the material covered in lectures to adjust their research projects and attempt to address their research questions. Allowing students to interact with data they are familiar with and see for themselves how the methods taught can be useful, has meant students no longer see statistics as a necessary evil but a useful skill to make them better students and, in future, better doctors.

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