DEVELOPING RESEARCH LITERACY IN ACADEMIC MEDICAL RESEARCH INSTITUTIONS: INTRODUCING AN ONLINE MODULAR COURSE IN BIOSTATISTICS AND EPIDEMIOLOGY

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We describe our project to develop research literacy amongst medical residents in an academic medical research institution via an online modular course in biostatistics and epidemiology. Traditional introductory courses to statistics and epidemiology in this context have historically generally failed due to their esoteric rather than practical focus, the inflexible in-class format with fixed timeslots and locations, and the cumulative loss of knowledge associated with missing one or more lectures. Our use of real-world clinical data sets and the online modular course format eliminates these barriers. This course format leverages the synergistic relationships between content, pedagogy, and technology by employing video pod casts and accompanying lecture notes, open-source software for interactive graphical exploration of statistical concepts, and live online tutorials. Medical residency program directors can select any subset of modules to create customized courses for their programs. The course is delivered using Moodle and there are no associated registration costs for students.

BACKGROUND

Implementation of hospital-based research methods courses to teach medical and allied health professionals have traditionally achieved limited success (Ambrosius & Manatunga, 2002; Deutsch, 2002). In particular, classical in-class teaching initiatives suffer from a number of problems including poor attendance, diversity of backgrounds/needs of learners often not being addressed, and the need to accommodate varying and typically inflexible clinical schedules. Also, successive lectures tend to assume cumulative knowledge acquisition from prior lectures; missing an earlier lecture can render future lectures incomprehensible, which often leads to decreased attendance as the course progresses. In addition many attempts at developing online courses are often static reproductions of slides and books that do not facilitate communication between students and instructors, or students and students. The absence of simple modes for interaction and communication has been identified as a major factor in the failure of such courses. The online course format is particularly suited to address many of these issues in statistical education as it leverages the synergistic relationships between content, pedagogy, and technology (Moore, 1997). Computer-assisted learning and virtual classroom concepts are increasingly becoming recognized as a necessary evolutionary development in medical education (Greenhalgh, 2001).

As biostatistics and epidemiology provide the underpinnings of research methodology in the health sciences, it is essential that a basic facility in these fields be acquired. Whereas the traditional approach to teaching has been to concentrate on computation, and mathematical formulas and theory, this course will focus on concepts, data analysis and interpretation, and statistical reasoning (Gal, 2002; Moore, 1997; Rumsey, 2002). However, focusing on delivering concepts without exposure to underlying, sometimes complex, mathematical principles requires considerable and innovative use of graphical displays and use of concrete and context-specific examples using real data (Utts et al., 2003). Clinicians being sufficiently research literate to engage in multidisciplinary research collaborations with biostatisticians/epidemiologists is more productive than proceeding alone on the basis of introductory courses (Cobb, 1992; Garfield 1999), and increases the chances of successful research funding applications (Parker, 2000).

THE PROBLEM

Courses in statistics for non-statisticians are generally viewed by students as “difficult and unpleasant” and by instructors as “frustrating and unrewarding” (Garfield et al., 2002). Medical students tend to be skeptical toward computer-assisted learning and need to feel that the curriculum is relevant to their clinical training (Tudor, 2006). Therefore it is important to provide live sessions

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that are distinct and complementary to the online material, content that is relevant to clinical practice, and opportunities for interactive learning (Vogel & Wood, 2002; Astin et al., 2002).

Student attitudes toward statistics may influence the degree to which students develop statistical thinking skills and whether those skills are applied in the real-world context (Gal et al., 1997), and so negative attitudes can hinder learning (Cashin & Elmore, 2005). Therefore it is critical that online courses are effective and engaging. However, developing online courseware requires a very different skill set than that required for traditional in-class instruction. Specifically, new and constantly evolving technologies must be embraced to at least replicate and at best improve upon the in-class format.

Meaningful learning is promoted through cognitive activity such as selecting, organizing and integrating knowledge (Mayer, 2004). Thus, in addition to learning by doing and discussion, students learn by thinking, so guidance, structure and focused goals are integral to teaching.

IMPORTANCE FOR POSTGRADUATE MEDICAL EDUCATION

The disciplines of Biostatistics and Epidemiology provide a rigorous framework for evaluating quantitative evidence in the health sciences (Herman et al, 2007), and lend themselves to computer-based teaching (Velleman, 2000). The portability of biostatistics and epidemiology principles across clinical research contexts makes the course relevant across medical specialties.

Evidence-based medical practice is critical for delivery of quality patient care (Bland, 2004; Sackett et al., 1996). Research provides the foundation of evidence-based medicine and shapes clinical practice. Therefore sufficient mastery of sound research methodology is essential. However, a lack of statistical and epidemiological expertise has been identified to be at the core of widespread flawed research published in the medical literature (Altman, 2000). The literature clearly identifies the large deficit in statistics and research methods training of physicians (Ambrosius & Manatunga, 2002; Taylor et al., 2000). However, despite this recognition, medical school curriculums have generally not successfully addressed this weakness in their training programs (Windish et al., 2007).

PREVIOUS EFFORTS

Traditional introductory courses on statistics and epidemiology in academic medical research institutions have generally failed for numerous reasons. Many courses have focused excessively on esoteric mathematics rather than practical applications. Many online courses have simply provided Microsoft PowerPoint slides, while some provide online computer simulation models. Medical residents are increasingly web-savvy and expect online courses to employ modern web-based technologies. Educational models that leverage the synergies between content, pedagogy and technology are increasingly recognized as necessary for cost-effective, accessible, and innovative delivery of medical education (Greenhalgh, 2001). Studies, such as Cramer et al, (2007), suggest podcasts are effective for improving student learning outcomes.

COURSE MODULES

The core set of course modules include, Introduction to Epidemiology, Study Design I - Experimental, Study Design II - Observational, Statistical Methods for Meta-Analysis, Systematic Reviews, Systematic Searching of the Medical Literature, Research Ethics, Data Collection and Management, Descriptive Statistics, Analysis of Variance, Statistics in Diagnostic Testing, Modeling Strategies I, Modeling Strategies II, Measurement, Sample Size, Receiver Operator Characteristic Curves, Survival Analysis, and Reporting Study Results; with additional modules under development, including Measuring Agreement, Measures of Risk, Critical Appraisal.

CONTENT DEVELOPMENT

The LaTeX system for document preparation (Knuth, 1984) is used in conjunction with the R language for statistical computing (R Development Core Team, 2007), and the Sweave package in R, to generate all slides and graphics; this allows for optimal representation of graphical and statistical concepts in a consistent and coherent fashion, as well as providing an ideal development environment for making revisions and additions to learning modules and graphical tools. This approach is consistent with sound literate statistical programming principles.

The commitment to open source tools enables students to download R and the ResearchMethods package written in R under General Public License from the Comprehensive R Archive Network at http://cran.r-project.org/. R runs on Microsoft Windows, Mac OS X, and Linux. The graphical tools and data sets contained in the ResearchMethods package are developed for interactive exploration of statistical concepts presented in the modules.

CONTENT DELIVERY

The course is accessed via the website http://ResearchMethods.dal.ca and is delivered using Moodle which ensures robustness, scalability, and sustainability due to minimal course administration costs. The Dalhousie University Integrated Learning Online streaming media servers host the video content which is accessible via Really Simple Syndication (RSS) and can be viewed either online inside browsers with an installed QuickTime plug-in, or offline either in iTunes or on an iPod.

The course is organized into independent modules, enabling selection of sub-sets of the available modules to create customized courses that meet the specific needs of individual medical residency programs. Completion of an entrance Medical Residents Survey of Attitudes Toward Statistics (MRSATS) releases the course modules to students. Modules have associated multiple-choice content mastery quizzes that must be completed with a pass grade for students to be issued a certificate of completion; quizzes can be re-taken with penalty incurred for incorrect answers to discourage students from random guessing. Completion of an exit MRSATS is also required for issuance of the certificate of completion, and in conjunction with responses to an entrance MRSATS will provide an assessment of change in attitudes toward statistics.

Interaction between students and instructors is achieved both asynchronously and synchronously. Discussion forums asynchronously allow students to post questions/comments and instructors to either post replies to the forum, or to a blog, which then act as an FAQ repository. Live webinars enable synchronous communication, and are conducted using a webcam, document sharing, whiteboard and chat tools. These webinars can be recorded and archived using the Sclipo Live Web Class Plug-in for Moodle.

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CONCLUSION

We have developed a curriculum for an introductory course in biostatistics and epidemiology targeted at mathematically disinclined medical residents. We consider it of critical importance that the course focuses on concepts and methods illustrated with real-world data, rather than on complex mathematical jargon and proofs and excessive focus on formal probability theory.

The pedagogical approach we have taken in developing and delivering the course is multi-faceted and based upon cognitive learning supported by active learning. The course is developed on the assumptions that learning is achieved through guidance, structure and focused goals in teaching, and with hands-on experience and discussion by learners.

The course has been developed on several key principles, 1) provide an environment for students to set their own pace, place and time of learning, 2) motivate with real data/problems, 3) foster interactive exploration, 4) foster critical appraisal skills, 5) use a variety of computational tools including computer simulation methods, and 6) use modern web-based applications to enable both synchronous and asynchronous interaction between students and instructors.

This course aims to provide a relevant and practical introduction to statistical concepts and methods, to improve attitudes towards statistics among mathematically disinclined medical residents, and to improve research literacy amongst medical residents.

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