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Teaching epidemiology and biostatistics: medical students' views on the content and instructional strategies of an introductory course

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The inclusion of epidemiology and biostatistics in the undergraduate medical curriculum is essential in this era of evidence based health care. Despite this, teaching this topic often results in the students feeling confused and the teachers discouraged. At The University of the West Indies, Mona, Jamaica, students in the first semester of their third year are routinely asked to complete an evaluation form at the end of an introductory course in epidemiology and biostatistics. Students' views on course content and instructional strategies for the year 2009 are presented here. The majority of students reported that the material presented was useful in helping them to interpret or carry out research in the future. They reported marked improvement in their ability to read, understand and critique the medical literature. Lectures were considered to be the most effective instructional method overall but less than one fifth of students thought biostatistics was effectively taught through that method. Students seemed to favour a teacher-centred learning environment although an appreciation for certain features of a learner-centred approach, such as participation in student-led group presentations, was evident. We conclude that a combination of instructional methods is useful to teaching epidemiology and biostatistics to medical students. It is necessary to identify the unique features of the different approaches that make them beneficial and use this information to better design teaching/learning programmes, with special consideration for the specific subject area being addressed. An enabling environment, including suitable teaching staff and infrastructure that actively engages learners using a variety of approaches, is essential to the teaching/learning process for epidemiology and biostatistics. Application of the principles taught in this course during their clinical rotations will also help to consolidate the learning experience.

Key words: instructional strategies, medical education, epidemiology, biostatistics

Introduction

Learning is a complex process. Psychologists and researchers in education have, over time, proposed several models and theories aimed at providing explanations for how learning takes place (Cassidy, 2004). Theories in learning that have received much attention include those focusing on the existence and roles of learning styles (Cassidy, 2004; Connor, 2012; Kraemer, Rosenberg & Thompson-Schill,

2009). The resultant models are usually multidimensional, focusing on different aspects of the individual and the learning environment, and typically culminate in categorising individuals as particular types of learners (Connor, 2012). A spin-off from an acceptance that people learn differently is to tailor instructional strategies and methods to suit individual learning styles or utilize a variety of instructional strategies and methods in the teaching process.

Instructional strategies can be classified into two main groups: teacher-centred or learner-centred. In a teacher-centred approach the focus is on the teacher who is viewed as the source of information and provides same to students with usually no interaction among the students. Learner-centred approaches tend to be more collaborative and students work together and interact with the teacher to discover and understand new information. The teaching/learning environment in the Caribbean has been described as teacher-centred but more recently there has been increasing interest in and support for learner-centred environments resulting in proposed and actual changes in the formats of educational programmes (Bernard & Cummings, 2003; Byron & Rozemeijer, 2001; Williams, 2005). The learner-centred approach has been endorsed by the American Psychological Association (APA) and 14 learner-centred psychological principles have been identified which address factors that influence learning for all learners and provide a framework within which to design or develop learner-centred environments (APA, 1993, 1997). At The University of the West Indies, Mona (UWI, Mona) support for the learner-centred approach is evident in the operations of the Instructional Development Unit (IDU) which offers "training for staff in the principles and practices of learner centred teaching" (UWI, Mona: online).

Merrill (2000) supports the 'content-by-strategy' approach and suggests that instructional strategies should firstly be determined by the content to be taught and the goals of the instruction process. Learning styles and preferences can then be used to fine-tune the basic instructional strategies. Teachers might find it useful to provide instruction in a variety of methods rather than trying to determine the learning style of each student and adapting instructional strategies. Class size is an additional component that must factor in the decision for using one particular instructional strategy instead of another. Teacher-centred strategies using methods such as lectures have been noted to better suit large classes while learner-centred approaches using methods such as class discussions have been deemed better suited to small class sizes (Weston & Cranton, 1986).

Physicians are increasingly called upon to practice evidence-based health care. Evidence-based health care involves the systematic application of the best available research results (evidence) when making decisions about health care for an individual patient or an entire population. To do this, the physician is expected to be able to read and understand the findings of the latest research and apply the findings in such a way that the patient receives optimal care with available resources according to their personal wishes. In an attempt to provide an introduction to this concept early in the medical career, programmes in medical schools across the world

typically include a course in epidemiology and biostatistics at the undergraduate level.

At the core of epidemiology is studying the distribution and causes of health-related states in populations. Undergraduate epidemiology and biostatistics courses focus on explaining how evidence is gathered and summarised and also emphasise the importance of research in informing clinical and public health decision-making. Despite the importance of this subject area in medical school, studies have found that students often have negative experiences with teaching and learning epidemiology and biostatistics. Historically, students have expressed indifference (Ernster, 1979), a failure to grasp relevance, and a view of the subject as having little importance relative to subjects in clinical areas (Novick, Greene & Vogt, 1985). Instructors have their share of frustrations and report unfavourable evaluations by students amidst repeated adjustments to improve strategies for greater student interest and more favourable learning outcomes (Marantz, Burton & Steiner-Grossman, 2003). Perhaps the increasing popularity of evidence-based medicine and the proliferation of published research has had some impact on students' views over the years as in recent times they have reported agreement on the relevance of epidemiology and biostatistics to real health issues and their future roles as clinicians (Astin, Jenkins & Moore, 2002; Daher & Amin, 2010; Ocek et al. 2008).

In the United Kingdom, the General Medical Council (GMC) has stipulated that "[medical] students must have different teaching and learning opportunities that should balance teaching in large groups with small groups. They must have practical classes and opportunities for self-directed learning" (GMC, 2009, p. 51). With regard to the instructional methods used in teaching epidemiology to medical students, researchers have found that case and problem based learning approaches and methods that encourage interaction between students and lecturers receive more favourable ratings from students (Dyke, Jamrozik & Plant, 2001; Marantz, Burton & Steiner-Grossman, 2003). Approaches that allow students to work in small groups were also desired (Daher & Amin, 2010) and students reported a more enriching learning experience when these approaches are utilised (Dyke, Jamrozik & Plant, 2001). Traditional lectures have rated less favourably when compared with problem based instructional methods, though no difference in overall academic performance has been seen (Dyke, Jamrozik & Plant, 2001). Students have reported that epidemiology and biostatistics courses contain too many didactic lectures (Daher & Amin, 2010; Ocek et al. 2008) which, though interesting, are difficult to understand (Daher & Amin, 2010).

Teaching and learning epidemiology and biostatistics at UWI, Mona

As part of their training at UWI, Mona, medical students are required to take a course in epidemiology and biostatistics in the third year of their programme. The course is given at the start of the third year and aims to introduce students to the role of research in the practice of medicine; to encourage the judicious use of research

information; and to kindle an interest in knowledge creation through research. Students are expected to develop an enquiring attitude to the acquisition and use of the available evidence to inform health care delivery. An average of 170 students receive a total of 46 hours of instruction in research methods, epidemiology and biostatistics through four main instructional methods, namely: lectures, assigned readings, seminars (peer group discussions around a published research article and the issues presented therein, led by a discussion guide and with faculty as resource), and student-led group presentations on assigned topics. Students also undergo continuous assessment through ten short quizzes: one on each seminar day. At the end of the course students are expected to be able to locate current research information on a health related topic from print and electronic sources; read, analyse, interpret and critique the medical literature; discuss how references to the medical literature can be integrated into clinical decision-making; and explain the concepts and principles of the scientific method.

It has been suggested that a multi-strategy approach using different instructional methods would be beneficial to the teaching/learning of epidemiology and biostatistics (Astin, Jenkins & Moore, 2002). For example, core principles and concepts can be taught using the traditional lecture format whereas skills such as critiquing the medical literature and using evidence in clinical decision-making may be better taught through practical exercises in small groups.

Since its introduction the course has undergone several changes to reduce the number of teacher-led didactic sessions and facilitate more self-directed learning and small group discussions. Additionally, several of the content areas which were traditionally taught in public health epidemiology courses and were not immediately applicable to the clinician were removed from the teaching timetable. Increased emphasis was placed on how epidemiology could be used in clinical practice and the role that this training could have in providing evidence-based care. The statistical sections were simplified with more focus on the interpretation of the findings rather than derivation or calculation of test statistics. The module was also moved to the start of the third year - a less busy time in the medical students training course with less competition from the more demanding basic sciences such as anatomy.

Overall, instructional methods should be guided by evidence-based practice (EBP). This refers to the use of research and scientific studies as a base for determining the best practices in a field. While emphasis on EBP began in the 1990s with a focus on medical decision-making (Sackett, Richardson, Rosenberg & Haynes, 1997) it has since been applied to other professions, including education (Justice & Fey, 2004). Part of this process involves the evaluation of teaching strategies. In this paper, we evaluate the opinions of third year medical students of UWI, Mona on the usefulness of course content and various instructional strategies as well as their general comments regarding the course.

Method

Participants and procedures

On the final day of their epidemiology course, students were asked to anonymously complete a course evaluation form, designed by course instructors, to get feedback about the course in general, as well as aspects of content and instruction in particular. In 2009 a paper based evaluation form was distributed at the end of a compulsory attendance session and students were asked to complete the forms on the spot. While the number of students in attendance on that day is uncertain, it is known that 161 students were enrolled in the course. The data presented here represent the views of 64 students who returned completed evaluation forms.

The instrument

A questionnaire addressing course characteristics such as content, objectives and instructional methods was used to obtain students' opinions. Student perceptions regarding the usefulness of course content and instructional methods to meeting specifically stated outcomes were assessed using a forced-choice, 4-item scale. The options given were *greatly, moderately, slightly* and *not at all*. Students were also asked to indicate which instructional methods they considered effective/not effective. In attempting to find out students' feelings about the area of research having completed the introductory course, students were asked to select the response from the following options *exciting/stimulating, challenging, boring* and *unsure*, which most accurately described their sentiments. Finally, open ended questions were included to obtain information on any or all aspects of the course that were found particularly beneficial; recommendations for improvements of the course, and general comments.

Data analysis

For closed ended questions the proportion of students selecting each response is reported. In each instance non-response was noted so that denominators reflect the numbers of students responding to the particular item. Responses for instructional methods were analysed in two ways: separately for each subject area and combined such that an overall rating of *effective* was given as long the instructional method was rated *effective* for at least one subject area. For open ended questions, the data were analysed using content analysis.

Results

Sixty-four students from the class of 161 students returned completed evaluation forms resulting in a response rate of approximately 40%.

General course content

Regarding general principles of research and epidemiology, a majority of students (97%, n=62 and 94%, n=6 respectively) thought the material covered was moderately or greatly useful in helping to prepare them to carry out or interpret research in the future. A lower proportion (75%, n=48) felt the same was true for core statistical methods.

Four main course objectives

The majority of students felt the course helped in some way to improve their ability to: explain the concept and principles of the scientific method; locate current research information on a health related topic from written and electronic sources; read, analyse, interpret and critique the medical literature, and discuss how references to the medical literature can be integrated into clinical decision-making. In each case only 5% or fewer thought the course did not help at all. The area in which the greatest proportion of students reported improvement in their ability was that of explaining the principles of the scientific method: 89% (n=57) stated that their ability was either greatly or moderately improved. For each of the other areas the proportions of participants reporting great or moderate improvement in ability are: 75% (n=48) [locating current research information]; 78% (n=50) [read, analyse, interpret and critique the medical literature], and 83% (n=53) [discussing how references from the literature can be integrated into clinical decision-making].

Instructional methods

Table 1 shows the proportion and number of students rating each instructional method as effective. The proportion of students who provided a response (the item response rate) for each method is also indicated. Item response rates ranged from 62-77%. The method which the highest proportion of students reported as effective was lectures, followed by group presentations, seminars and assigned reading. Lectures in biostatistics received the least favourable rating among lectures and also among instructional methods with 18.4% (n=9) of participants deeming it effective. Lectures in the other two main subject areas were rated more favourably. Group presentations generally received favourable ratings: it is noteworthy that for epidemiology the proportion of students rating lectures as effective did not differ much from the proportion rating group presentations as effective whereas for biostatistics the proportion of students rating group presentations as effective was nearly four times greater the proportion rating the lectures as effective. Assigned reading and seminar discussions were rated as effective by 31% (n=15) and 43% (n=20) of respondents respectively.

Table 1. Proportion (and number) of students rating each instructional method as effective, with corresponding item response rate

Instructional method and subject area, if appropriate	Proportion and number of students rating method as effective (% (n))	Item response rate (%)
Lectures, biostatistics	18.4 (9)	77
Lectures, epidemiology	82.5 (33)	62
Lectures, research methods	66.7 (28)	66
Lectures, overall	86.7 (39)	70
Assigned reading	31.3 (15)	75
Group presentations, biostatistics	6.2 (30)	69
Group presentations, epidemiology	82.9 (34)	64
Group presentations, overall	86.0 (37)	67
Seminars	42.6 (20)	73

With regard to their overall perceptions on research, 37.5% of participants (n=24) indicated that, having completed the course, they would describe the area of research as challenging; 26.6% (n=17) said they are unsure about how to categorise it; 21.9% (n=14) said they think it is boring, and the remaining 10.9% (n=7) said they would describe it as exciting. Two students (3.1%) did not provide a response to this question.

Open ended questions

It was commonly expressed by the students that reading published research articles was beneficial. Among the benefits they cited were: the activity encouraged critical thinking; it taught them how to read, understand and interpret the literature; it increased familiarity with and understanding of terminology used, and it prepared them for the future. The group presentations, quizzes and seminars were also considered beneficial by many students.

The students expressed their recommendations for improving the course: one recurring sentiment was that quizzes should be followed by discussion with complete explanations of correct and incorrect responses. It was also thought by some that seminars should be fewer in number and have less time for student-student discussion and more time for explanation by faculty. It was further suggested that members of faculty need to be equally competent and to be in complete agreement on all issues. It was also recommended that in general, more time be spent on explaining concepts and that simpler language be used. Some also felt it is important to structure the timetable so that lectures introducing main concepts are always given before the seminar focusing on those issues. Students felt that a different approach is needed for teaching statistics; they suggested small groups in tutorial type settings and also more time.

Students felt that in general the course was well organised. Some thought that it was time consuming and that the classroom setting was not conducive to group discussions. Specific lecturers were identified and commended for their good teaching while others were identified as needing improvement.

Discussion

The response rate was lower than expected. Besides asking students to complete the evaluation forms, no other measures were used to promote participation. The data collection strategies did not include any methods to encourage participation by students who may have been absent from class on the day the evaluation forms were given. Additionally, students were asked to complete the forms on site and were not afforded the option of completing and returning forms at a later date. These factors may have influenced response rates.

While "there is no agreed upon standard for a minimum acceptable response rate" (Fowler, 2009, p. 51), the possible biases associated with non-response cannot be ignored. One major concern is that of selection bias and its potential effect on generalisability of research findings. The apprehension here is that the persons who respond may be significantly different from those who do not respond and so reports will be made about a small group of persons who may very well be atypical of the target population. Despite obtaining responses from only 40% of the target population the researchers are confident that the data are useful for understanding students' perceptions about the course. Our confidence comes from the following three considerations:

1. A homogenous study population is less prone to bias from low response rates than a heterogeneous population. The reason for this is that with a more or less homogenous population even a small percentage of participants can resemble the wider population. We argue that the third year medical class represents a relatively homogenous population as far as it relates to general characteristics that could influence the area under study. Participating in the same medical training programme, these students are all in the first semester of their third year (pre-clinical) and performing at similar academic levels. The majority of them are in their first degree programme and have studied in Caribbean schools at the secondary level. This homogeneity provides some amount of resistance against the ill effects of low response rates, though it must still be acknowledged that individual experiences may still differ in a common setting.

2. The absence of a preponderance of extreme responses suggests that the obtained opinions do not represent 'tail-ends' of the distribution of responses/opinions in the population but rather the 'middle' where the bulk of the responses lie. Researchers always need to consider the factors that motivate persons to participate in surveys. This becomes especially

important when response rates are low. Persons who feel strongly about an issue in either direction would perhaps be more motivated to respond in a survey on that issue than persons who do not. The absence of overwhelming polarisation in the responses received suggests that even though only a few persons responded, they represent a cross section of views and not just particular extremes.

3. Research findings are in agreement with anecdotal information as the responses reported are comparable to views that were repeatedly expressed by students during interactions with faculty over the duration of the course.

Students reported a general feeling of being adequately prepared to carry out research or interpret research in the future having covered material relating to general principles of research; general principles of epidemiology, and biostatistics. This speaks to general agreement about the appropriateness of the material covered and to the activities of carrying out and interpreting research. Any objective verification of students' level of preparedness is, however, beyond the scope of this paper.

The four main course objectives that were previously stated reflect essential skills that practitioners in this paradigm of evidence-based medicine need to possess. With the majority of respondents stating that they felt the course helped in improving their abilities in those areas, even in the absence of objective assessment of these abilities, it can be said that some measure of success was achieved. Specifically for critiquing the medical literature and discussing how references can be integrated in clinical decision-making, having at least eight out of every 10 students stating that their abilities have been improved is remarkable and encouraging. Courses in epidemiology and biostatistics report varying degrees of achievement with respect to these objectives: Daher and Amin (2010) reported that only 53% of students indicated that they had gained skills to read scientific articles at the end of a four week course in their second year of medical school. While for a course specifically structured to focus only on critical reading at a university in Pakistan, Bazmi Inam (2007) reported that 100% of students said they found the course useful for understanding research articles. They, however, expressed varying levels of comfort in appraising different sections of articles: the proportion of students strongly agreeing that they were more comfortable in conducting appraisals, having completed the course, was highest for the introduction and discussion sections (90% and 97% respectively) and lowest for the results (31%). Just over half (54%) strongly agreed that they were more comfortable appraising the methods section. For all sections, no more than 14% disagreed or strongly disagreed that that they were comfortable in doing appraisals following the course. The study went further to provide an objective assessment of competence as students were given published research articles to apprise. The mean score for the group was 74.3 ± 9.1 out of a possible 100, suggesting that there was not much disparity between students' actual and perceived competency levels.

The preference for case based learning approaches as has been observed elsewhere (Dyke, Jamrozik & Plant, 2001; Marantz, Burton & Steiner-Grossman 2003) was not readily apparent in this present study as seminars and assigned reading (which would have facilitated this approach) were rated least effective of all instructional methods. Although in response to open ended questions students stated that they found reading research articles beneficial, some still called for fewer seminars and shorter discussions among groups and more time for the facilitator to explain. This suggests that there may be an underlying preference for teacher-centred instructional strategies and some resistance to learner-centred strategies where students take greater responsibility for and play more active roles in the teaching/learning process.

Credence is given to the 'content by strategy' approach when the ratings for lectures and group presentations are examined closely. Although rating most effective of all methods, lectures were not similarly rated for all subject areas. The results indicate that the students were uncomfortable with the didactic approach for biostatistics and did not find it to be effective. They seemed to prefer the student-led group presentations which involved group work for preparation and then explanation of concepts to their peers. The data do not distinguish whether students found being involved in the preparatory and delivery activities to be helpful to their own learning experience or whether it was receiving tutelage from one's peers that proved beneficial. The recommendations for biostatistics to be taught differently with specific suggestions for tutorials further reinforce the students' limited appreciation for a didactic approach to this subject. Astin, Jenkins & Moore (2002) recommended small interactive teaching groups for the teaching of statistics and epidemiology, stating that discussion and feedback would ensure that concepts are clearly understood. It should be acknowledged that in conceptualising the seminars, the desire was to create a setting for discussion of epidemiological and statistical components of a published research article as well as to evaluate the evidence. For students, on the one hand, to rate seminars as ineffective and request that their numbers be reduced and then on the other hand to request tutorial type settings seems contradictory. This raises the question of whether the effectiveness of the seminars was lost in their execution rather than in their concept. Students indicated in responses to open ended questions that the classroom setting was not conducive to several small group discussions and that faculty did not appear to agree on all issues or to be of equal competence. This is supported by Astin, Jenkins and Moore (2002) who reported that while small teaching groups are useful there are usually difficulties and limitations to implementing these approaches including the shortage of capable faculty and available classroom space.

Conclusion

Third year medical students at The University of the West Indies, Mona generally reported that the introductory course in epidemiology and biostatistics is useful in helping them to interpret the medical literature and to carry out research in the

future. Students seem to have a preference for a teacher-centred learning approach but appreciate interactive sessions and group work. Students' perceptions of the effectiveness of instructional methods vary depending on the specific subject area. One limitation of this present work is the low response rate; however, its effect in this specific case is likely to be minimal, as previously discussed. Another drawback is the inability of the instrument to specifically identify the factors that led to students' chosen responses. This was mitigated somewhat by the use of open ended questions which, though largely non-specific (asking students just to make comments and recommendations) provided some insight into these factors.

Although the importance of teaching epidemiology and biostatistics in medical school is generally accepted in the context of preparing doctors-in-training with the requisite skills to practice evidence-based health care, there is still some debate around how the content should be delivered for maximum student satisfaction and performance. We have demonstrated that different instructional strategies and methods can be successfully incorporated into teaching programmes, but an enabling environment, including suitable teaching staff and infrastructure, and active learners are essential to the process. Future work should consider how, if at all, learner and teacher characteristics such as age, gender and academic/professional history affect how instruction is delivered and received. Efforts to further reinforce the principles taught during their clinical rotations would strengthen the impact of the module. It would also be useful to explore whether academic performance is influenced by utilisation of different instructional strategies.

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