WHY DOCTORS FIND LEARNING BIOSTATISTICS AND EPIDEMIOLOGY DIFFICULT: LESSONS LEARNT FROM CPSP WORKSHOP USING CIPP MODEL

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ABSTRACT

BACKGROUND: Acknowledging the pivotal role of biostatistics in practice of Evidence-Based Medicine, Universities and medical schools worldwide have incorporated courses on medical statistics in their curricula. Pakistani medical students lack an adequate background of mathematics and consider statistics difficult to learn. College of Physicians and Surgeons Pakistan (CPSP) has introduced a mandatory workshop on Biostatics and Epidemiology for supervisors and trainees.

AIM: This study attempts to evaluate the perceptions of supervisors and trainees regarding the effectiveness of CPSP workshop.

METHODS: A quantitative cross sectional descriptive study was conducted on a cohort of 56 participants (26 supervisors and 30 trainees) from Shaikh Zayed Hospital, Lahore using Stufflebeam's CIPP Model employing a 20 item 5-point Likert Scale questionnaire. Domains analyzed were: Context, Input, Process and Product.

RESULTS: Seventy five percent acknowledged the importance of statistics, 78% preferred clinical subjects over statistics and 85% suggested introducing the subject in pre-clinical years. Eighty five percent believed that the best time to introduce statistics was pre-clinical years. Fifty seven percent of the participants believed that learning statistics and epidemiology required a very strong background of mathematics, 66% found the workshop relevant to their needs but library resources were inadequate. Instructors' knowledge and conduct was rated good to excellent. Teaching sessions were rated low being focused on calculations, not relevant to real health issues, boring and less time allocation. Forty five percent found assessment accurate, 56% gained skills in reading scientific papers, 52% could better interpret data after attending the workshop while 44% gained skills to design and analyze research. Satisfied clients were 55%, 61%, 46% and 55% in Context, Input, Process and Product domains respectively. Overall 54% of the participants were satisfied with the workshop with faculty members reporting a more positive and satisfied attitude than trainees.

CONCLUSION: Participants acknowledged the importance of biostatistics but considered the subject a formidable exercise. CPSP workshop was rated a good effort by only half of the participants. Reservations expressed were mainly about the methodology employed. It is proposed that the subject should be an examinable subject introduced in pre-medical years employing a constructivist approach. CPSP should incorporate mandatory evaluation in theory or OSCE examinations in Part II FCPS examinations in all disciplines.

KEY WORDS: Biostatistics, CIPP Model, Evaluation, Perceptions, Barriers to learning.

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INTRODUCTION

With the first randomized clinical trial traced back to 1940's[1] medical science entered a new era of practice called "Evidence Based Medicine" (EBM). This landmark study signaled the beginning EBM in 1966.[2] Government departments, funding agencies and research organizations now insist on informed decisions based on scientifically conducted research and evidence.[3,4] With the internet-based information explosion a doctor needs to read approximately 19 articles per day per year[5] to keep up to date. Biostatistics which is an essential skill dealing with the collection, analysis and interpretation of data is at the core of EBM[6] and helps in coping with this information overload clinicians and researchers alike should be well versed with

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techniques aimed at interpreting and evaluating this information.[7]

Medical schools worldwide have introduced courses on biostatistics in their curricula.[6] Unfortunately majority considers this as an additional burden. This observation is universal and not limited to Pakistan alone.[8-11] Despite inclusion of formal teaching in biostatistics, medical professionals lack the necessary skills to analyze data and draw valid conclusions.[12,13] Pakistani medical students lack a strong mathematical background in pre-medical years and perceive statistics a difficult subject to learn.[14] A very brief introduction to the subject appears in Community Medicine MBBS curriculum. Students memorize statistical definitions without an awareness of the importance of biostatistics. Recognizing this lacuna in undergraduate training, College of Physicians and Surgeons Pakistan (CPSP) has introduced a mandatory workshop for postgraduate trainees aimed at sensitizing the participants to the vital role statistics plays in their research and patient management.

This study analyzed the effectiveness of CPSP workshop focusing on the following two issues:

a. What are the perceived barriers to learning biostatistics?
b. What are the best strategies in learning the subject?[15,16]

The CIPP Model developed by Stufflbeam.[17-19] comprising of four components (context, input, process and product evaluation) was used for summative evaluation of the CPSP workshop. The objectives were to evaluate the perceptions of FCPS Supervisors and Trainees about effectiveness of CPSP Biostatistics Workshop as a learning tool, and to compare the perceptions of faculty and trainees.

METHODS

This was a Cross-sectional Quantitative Comparative study conducted at Shaikh Zayed Postgraduate Medical Institute (SZPGMI), Lahore. All participants were required to have completed the mandatory CPSP Biostatistics Workshop within last one year. Sample size for the study was calculated using nomogram developed by Gore and Altman[20] using data from study by Butt and Khan.[21] The calculated sample size using simple random sampling from eligible and consenting FCPS Trainees and Faculty was 30 in each group. Twenty six faculty members and thirty trainees returned the data collection forms after informed consent. Data were collected using a 20 item Likert scale questionnaire which was developed jointly by a subject specialist in statistics, a medical education expert and 6 trainees excluded from the final study. This instrument was derived from four different studies already reported in the literature[22-25] and hence it was already validated. The 20 item Likert scale questionnaire recorded responses on a scale of 1 to 5 (1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree and 5 = Strongly agree).

Data was analyzed using IBM SPSS Statistics version 20. Response to each of the 20 Likert scale questions were presented as frequency. A higher score was associated with a more positive attitude. Questions 4, 14 and 15 were reverse coded since a lower score indicated a more positive attitude. A composite score for each domain was obtained by adding the scores of all the questions in that particular domain.

Scores were presented as Mean ± Standard Deviation. For analysis of positive and negative attitudes, strategy suggested by Zamalia[26] was adopted where a score of 2.5 or less was considered a negative attitude and a score of 3.5 or above was considered a positive attitude. For comparison of perceptions of faculty and trainees an independent sample t-test was used. Chi square was used to compare proportions. For all comparisons a p value ≤ 0.05 was considered significant. The study was approved by Institutional Review Board of Shaikh Zayed Medical Complex, Lahore.

RESULTS

There were 30 trainees (22 males and 8 females) and 26 faculty members (20 males and 6 females) in this study. Mean age of faculty was 41.45 ± 6.75 years and mean age of trainees was 29.27 ± 3.07 years.

Results of analysis of all four domains appear in Table 1 and table 2 presents comparative analysis of faculty and trainee perceptions. Table 3 presents analysis of satisfaction level of participants.

Context domain

Seventy five percent of the respondents agreed that statistics and epidemiology are essential skills for any researcher. Seventy eight percent found clinical subjects more interesting than dealing with statistics. Eighty five percent believed that the best time to introduce statistics and epidemiology was during the pre-clinical years. Fifty seven percent of the participants believed that learning statistics and epidemiology required a very strong background and knowledge of mathematics. Faculty and trainee opinion was similar on these aspects.

Overall satisfaction with context of workshop was 55% with trainees displaying greater satisfaction (Table 2).

Input domain

Workshop content was declared relevant to their needs by 66% versus 12.5% who disagreed (p = 0.001). Fifty one percent were able to apply the workshop concepts to their practice. Classroom environment was rated good by 78.6%. Teaching facilities and instructor's attitude were rated good by 74% and 65% respectively. Forty one percent found library resources adequate. Sixty one percent respondents were satisfied with input domain. Opinions of faculty and trainees were comparable on all parameters.

Process domain

Seventy three percent of the faculty and 80% of the trainees were satisfied with knowledge of the instructors, 73% of the trainees and

65% of the faculty found the instructors interactive, 42.8% of participants found that sessions focused on concepts and not calculations, 51% were able to clearly see the relation between statistics and their practice of medicine at this level, 57% declared lack of adequate practice and only 33% considered workshop time was adequate. Overall satisfaction was 46% with no difference between faculty and trainees.

Product domain

Nineteen percent of faculty and 43% of trainees felt the instructors did not do an accurate post-workshop assessment of learning objectives, a better understanding of Biostatistics was acknowledged by 73% of faculty versus 43% of trainees (p = 0.023), improved skills in data interpretation and problem solving was reported by 69 % faculty versus 40% trainees (p = 0.030) gaining skills in research design were acknowledged by 50%. Overall satisfaction level was 55%.

DISCUSSION

Recognizing the importance of biostatistical knowledge in research and patient management, Universities and medical schools worldwide are focusing on developing statistical literacy. In Pakistan biostatistics tuition as well as evaluation in MBBS is very rudimentary and most students opt not to learn the subject. As Wood very aptly commented "assessment drives learning".[27] What is not assessed will not be learned! Recognizing this lacuna in undergraduate training, CPSP has introduced a mandatory workshop in Biostatistics and Epidemiology for both supervisors and trainees. Workshop planners very carefully evaluated the need for the workshop, identified existing gaps and priorities and developed an appropriate syllabus. This cross sectional study addressed the perceptions of faculty and trainees about the effectiveness of the workshop in improving their knowledge of the subject and also to as-

TABLE 1: PERCEPTIONS OF PARTICIPANTS

	Strongly disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly agree n (%)
Context evaluation					
Q 1 Statistics and Epidemiology are essential skills required to practice present day medicine	2 (3.6)	5 (8.9)	7 (12.5)	27 (48.2)	15 (26.8)
Q 2 I find clinical subjects more important than doing mathematics	0	5 (8.9)	7 (12.5)	33 (58.9)	11 (19.6)
Q 3 Teaching in statistics and epidemiology should be taught in pre-clinical years	4 (7.1)	0	4 (7.1)	30 (53.6)	18 (32.1)
Q 4 Teaching and Learning Statistics and Epidemiology requires a very strong foundation of mathematics	1 (1.8)	8 (14.3)	15 (26.8)	27 (48.2)	5 (8.9)
Input evaluation					
Q 5 Content was relevant to my needs	0	7 (12.5)	12 (21.4)	36 (64.3)	1 (1.8)
Q 6 I can apply what I learnt to my practice	2 (3.6)	14 (25)	11 (19.6)	24 (42.9)	5 (8.9)
Q 7 Class room environment was good	0	5 (8.9)	7 (12.5)	37 (66.1)	7 (12.5)
Q 8 Teaching facilities were adequate	1 (1.8)	4 (7.1)	10 (17.9)	34 (60.7)	7 (12.5)
Q 9 Instructors had a helpful attitude	3 (5.4)	6 (10.7)	11 (19.6)	28 (50)	8 (14.3)
Q 10 Library resources were adequate	1 (1.8)	16 (28.6)	16 (28.6)	19 (33.9)	4 (7.1)
Process evaluation					
Q 11 Instructors were knowledgeable	2 (3.6)	5 (8.9)	6 (10.7)	37 (66.1)	6 (10.7)
Q 12 Instructors were interactive	3 (5.4)	4 (7.1)	10 (17.9)	33 (58.9)	6 (10.7)
Q 13 The course focuses on the concept of interpretation more than calculations.	1 (1.8)	9 (16.1)	22 (39.3)	22 (39.3)	2 (3.6)
Q 14 I realized the relevance of Epidemiology & Statistics to the real health issues.	0	5 (8.9)	21 (37.5)	27 (48.2)	3 (5.4)
Q 15 There was lack of practicing exercise for these topics	3 (5.4)	2 (3.6)	19 (33.9)	28 (50)	4 (7.1)
Q 16 Time for workshop was adequate	6 (10.7)	17 (30.4)	14 (25)	17 (30.4)	2 (3.6)
Product evaluation					
Q 17 Instructors did an accurate post workshop assessment of learning objectives	6 (10.7)	12 (21.4)	13 (23.2)	22 (39.3)	3 (5.4)
Q 18 I have understood the main concepts of Epidemiology & Statistics	1 (1.8)	10 (17.9)	13 (23.2)	27 (48.2)	5 (8.9)
Q 19 My skills improved in data interpretation and solving problems	1 (1.8)	18 (32.1)	7 (12.5)	25 (44.6)	5 (8.9)
Q 20 I gained skills to design research	4 (7.1)	11 (19.6)	14 (25)	20 (35.7)	7 (12.5)

TABLE 2: COMPARISON OF MEAN FACULTY AND TRAINEE SCORES

	Faculty Score A	Trainee Score B	P value A vs B
Context evaluation			
Q 1 Statistics and Epidemiology are essential skills required to practice present day medicine	4.04 ± 0.99	3.70 ± 1.05	0.225
Q 2 I find clinical subjects more important than doing mathematics	3.88 ± 0.86	3.90 ± 0.80	0.945
Q 3 Teaching in statistics and epidemiology should be taught in pre-clinical years	4.08 ± 0.79	4.0 ± 1.20	0.783
Q 4 Teaching and Learning Statistics and Epidemiology requires a very strong foundation of mathematics	3.58 ± 0.80	3.40 ± 1.0	0.475
Composite score context domain	3.89 ± 0.22	3.75 ± 0.26	0.437
Input evaluation			
Q 5 Content was relevant to my needs	3.54 ± 0.81	3.57 ± 0.67	0.888
Q 6 I can apply what I learnt to my practice	3.58 ± 0.94	3.03 ± 1.09	0.054
Q 7 Class room environment was good	3.77 ± 0.65	3.87 ± 0.86	0.639
Q 8 Teaching facilities were adequate	3.88 ± 0.65	3.63 ± 0.96	0.266
Q 9 Instructors had a helpful attitude	3.65 ± 0.93	3.50 ± 1.13	0.586
Q 10 Library resources were adequate	3.15 ± 0.92	3.17 ± 1.05	0.962
Composite score input domain	3.59 ± 0.25	3.46 ± 0.30	0.432
Process			
Q 11 Instructors were knowledgeable	3.65 ± 0.74	3.77 ± 1.0	0.647
Q 12 Instructors were interactive	3.58 ± 0.90	3.67 ± 1.0	0.732
Q 13 The course focuses on the concept of interpretation more than calculations.	3.35 ± 0.74	3.20 ± 0.92	0.522
Q 14 I realized the relevance of Epidemiology & Statistics to the real health issues.	3.69 ± 0.67	3.33 ± 0.75	0.069
Q 15 There was lack of practicing exercise for these topics	2.50 ± 0.76	2.50 ± 1.0	1.000
Q 16 Time for workshop was adequate	3.00 ± 0.98	2.73 ± 1.17	0.364
Composite score process domain	3.29 ± 0.46	3.20 ± 0.50	0.742
Product evaluation			
Q 17 Instructors did an accurate post workshop assessment of learning objectives	3.42 ± 0.90	2.77 ± 1.22	0.02
Q 18 I have understood the main concepts of Epidemiology & Statistics	3.73 ± 0.87	3.20 ± 0.96	0.36
Q 19 My skills improved in data interpretation and solving problems	3.62 ± 0.98	2.97 ± 1.06	0.22
Q 20 I gained skills to design research	3.65 + 1.05	2.93 + 1.11	0.17
Composite score product domain	3.60 + 0.13	2.96 + 0.17	0.001

sess possible barriers and difficulties in learning the subject.

Evaluation model used for this project was CIPP framework popularized by Stufflebeam.[19] This summative evaluation is expected to provide important information for workshop planners to reassess the aims and objectives of the workshop, teaching and training methodology, and difficulties perceived by participants.

Context Evaluation

Majority of the participants acknowledged the importance of statistics in practice of modern day evidence-based medicine and this is similar to the findings by Khan and Mumtaz[28,] Windish et al.[10], West and Ficalora[8], Ahmad et al.[29], Daher et al.[30], Batra et al.[31] and Hren et al.[32] Despite this approach biostatistics is given lesser importance by the trainees and clinicians relative to other subjects with 78% participants finding clinical subjects more interesting. Sahai and Ojeda[33], West and Ficalora[8] and Miles et al.[23] have also referred to this aspect in their research. Almost half of respondents in Daher et al.[22] study admitted that they would prefer clinical subjects over biostatistics. Predominant opinion from faculty and trainees was that the subject should be taught in the pre-clinical years (85%). This was similar to the results reported by Miles et al.[23] An almost universal observation reported in literature[8,10,11,14-16,34] that understanding statistics requires a very strong foundation of mathematics was also echoed by over half of the participants in this study. This is a reflection of greater appreciation of the role of statistics by participants and aligned with the correct decision of CPSP in introducing mandatory faculty and trainee workshops. It is suggested that a revamping of tuition in undergraduate years with more emphasis on relating the importance of biostatistics to the practice of EBM should be the starting point. Focus should be on inculcating a research culture encouraging and developing analytical abilities using real life social or demographic assignments rather than rote memorization. Preferably the subject of biostatistics should be an examinable subject at MBBS level which will ease the load on postgraduate training.

Input

Sixty five percent of the participants were satisfied with the content of the workshop and had found it relevant to their needs reflect-

TABLE 3: COMPARISON OF SATISFACTION LEVEL OF FACULTY AND TRAINEES IN 4 DOMAINS

	Faculty n = 26		Trainees n = 30		P value*	
Level of satisfaction	Satisfied n (%) A	Not Satisfied n (%) B	Satisfied n (%) C	Not Satisfied n (%) D	A vs C	B vs D
Evaluation of Context Domain	10 (38.5)	2 (7.7)	21.5 (71.6)	4.2 (14.1)	0.026	0.738
Evaluation of Input Domain	16 (61)	4 (16)	17 (61)	7 (24)	0.783	0.682
Evaluation of Process Domain	14 (53)	5 (19)	12 ((40)	7 (23)	0.481	0.970
Evaluation of Product Domain	17 (65.3)	3 (11.5)	13 (45)	10 (33)	0.210	0.112

Participants expressing neutral view were excluded from this analysis* Based on Chi-square test

ing wisdom of workshop planners to include what was needed by the participants. However, only 50% declared that they could apply the concepts learnt. Adult learners welcome learning that is relevant to their needs and this aspect was also identified by Sana et al.[34] who identified relevance of teaching to clinical practice, applicability to research and consideration of academic performance of students and faculty attitudes as factors influencing success of their Clinical Epidemiology Curriculum program.

In identifying possible barriers to learning, 75% were satisfied with the classroom environment, teaching facilities and attitude of the instructors indicating a successful planning strategy to conduct the workshop while 30 declared library facilities as inadequate. Similar views were expressed by participants in study reported by Daher and Amin[30] and Nowacki.[35]

Improvement is suggested in syllabus which should be modular with work stations in workshop venue to provide ample opportunities for practice. Online library resources especially quizzes and modules that gradually build knowledge in a constructivist approach are recommended.

Process

Participant rating of instructors was at or above 60%. This is the main strength of the workshop and reflects careful selection of the facilitators. However, a different picture was seen regarding opinions about the training sessions. Only 42% were of the opinion that the course focused more on concepts rather than calculations. Several other authors have also suggested that teaching statistics to medical graduates requires a greater or exclusive focus on conceptual; teaching than mathematical calculations.[23,33,36] Reformers in teaching statistics have suggested adopting a constructivist approach rather than a pedagogical strategy.[37] Possible factors influencing workshop effectiveness were (1) no chance to practice application of concepts and (2) time for workshop inadequate. Possible amendments could include (1) A more conceptual approach with less emphasis on mathematics. (2) Using real life data (3) Formal lectures should be replaced by interactive learning modules (4) Increasing time exclusively for biostatistics by holding workshop separate from dissertation writing.

Product

Assessment by the instructors was declared accurate by 44%. No formal summative assessment in the form of an examination was done and hence validity of this opinion is questionable. Evaluation of course outcomes revealed that half the participants had understood the concepts of statistics and epidemiology, were be able to read journals, interpret data and solve problems. Less than half were of the opinion that they had gained the necessary skills to design their own research and do statistical analysis themselves. This is lower than data reported by Inam[38] in which over 90% students enrolled in their statistics course found it useful and productive. A positive outcome of formal biostatistics courses with innovations has also been reported by Nowacki.[35] A greater emphasis on experience in analyzing data of studies designed by participants themselves and drawing conclusions is one solution. Facilitators should discuss studies with good and flawed designs in interactive manner to reinforce analytical concepts. Additional factor could be pre-test post-test evaluation and mandatory evaluation some months after workshop to assess whether or not learning has been satisfactory.

CONCLUSION

This study has provided important information about strategies in teaching the subject of biostatistics to medical professionals. Doctors and trainees by virtue of their fast held belief that mastery of statistics requires a very strong background of mathematics tend to consider statistics a formidable and unwelcome obstacle. Attitude of medical professionals is reflected in their almost universal dislike for the subject and stems from the heterogeneity of students and doctors entering the profession with varying academic backgrounds and mathematical abilities.

This study suggests that a change in approach to teaching the subject is required by adopting the following strategy:

a. Introduction of the subject of statistics for high school and college students.
b. Amendments in HEC approved vertically integrated MBBS cur-

riculum to include Biostatistics as an independent examinable subject taught by professional biostatisticians employing principles of adult learning and a constructivist approach.

c. Separate standalone workshop on biostatistics with practice on using SPSS program based on real life data and projects.
d. CPSP should introduce formal evaluation of the concepts of biostatistics and epidemiology discussed and taught in their workshops as part of FCPS Part II theory or OSCE examination in all disciplines.

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The study was part of AKB Masters in Health Professions Education. GW supervised the dissertation, and was involved in every part of the analysis, idea's development, and write-up. AAK facilitated in data collection and editing the drafts of this manuscript.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

ETHICS APPROVAL

The approval/permission was obtained from Institutional Review Board of Shaikh Zayed Medical Complex, Lahore.

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