

IMPACT OF COMBINING MULTIPLE ACTIVE PARTICIPATORY TEACHING METHODS ON STUDENTS' PERFORMANCE AND PERCEPTION ABOUT BIOSTATISTICS COURSE

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ABSTRACT

Background:

Biostatistics course is an important subject for undergraduate health science students to understand medical research and during clinical decision making. But teaching this subject is more complicated due to finding appropriate teaching style. This study evaluated the impact of combining multiple participatory teaching styles on student's performance and perception about biostatistics course.

Methods:

This study employed Gray box evaluation method using mixture of quantitative and qualitative data. Quantitative data has been collected using pre and post test questionnaire, and white space questions to collect qualitative data. Descriptive statistics alongside correlation analysis was used to analyze the quantitative data while qualitative data was thematically analyzed.

Result:

Students' performance about biostatistics showed a significant improvement on all the assessed areas including reading scientific articles, collecting, organizing, analyzing, presenting and interpreting statistical data after attending the course sessions (Pvalue: 0.007). The perception of students has also made significant improvement in most assessed areas

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except in the interest of students about biostatistics which was not statistically significant (Pvalue: 0.39). Qualitative results has been summarized in 4 main themes namely “Combination of multiple teaching styles was fruitful and advantageous”, “Acquiring skill of data collection was the best thing acquired”, “Calculation sessions was the worst experience”, “Data analysis and interpretation topics needs to learned more”.

Conclusion:

The present study found that combining multiple participatory teaching has significantly improved the performance and perception of students related to biostatistics but further improvement on the teaching styles is required to improve students’ interest in the calculation sessions of the course.

Keywords: Multiple teaching styles; Active teaching; Biostatistics; Perception; Performance; Evaluation; Impact;

1. INTRODUCTION

Biostatistics course for undergraduate health science students is really an important subject and basically a fundamental tool for conducting and understanding medical research, it also helps in scientific reasoning during clinical decision making, but on the other side it is a complex and difficult subject to teach and ensure that undergraduate students acquire the skills and knowledge of biostatistics ^(1,2). This is due to contradictory views on the appropriate teaching methodology that best suits the course. Some authors suggest that only the concepts should be taught to students ⁽³⁾. While other authors argue the need for a balanced knowledge and skill related to calculations with their respective clinical reasoning and basic understanding of the concepts ^(4,5).

Another influential factor in teaching this subject is the students’ perception related to biostatistics most students think that the subject is important for their career but difficult to learn because of their inherited fear of mathematics and calculation. This fear affects their interest and motivation to acquire the necessary skills which also results in difficulties or challenges when students start to do their final thesis project ⁽¹⁾.

Poor knowledge of statistical skills by health professionals leads to poor understanding and involvement of numerous research processes including, the selection of an appropriate sample size for a study, the method of data collection, presentation of statistical results and appropriate interpretation of results from statistical tests, which leads to wrong and misleading conclusion. In the past the focus of teaching biostatistics course was improving only the cognitive aspects of the students, whereas many current studies highlight the importance of non cognitive aspects of the course such as the attitude of the students towards the subject. And their acquired skills as well. Several studies demonstrate that students' perception is an important factor in achieving the desired course outcomes ^(6, 7). This shows how statistics is a multidimensional subject which requires a combination of multiple teaching approaches for better student outcomes ⁽⁸⁾.

A more recent multi-site study and Meta analysis by (Milic, 2016) demonstrated that most medical students have positive attitude towards biostatistics at the beginning of the course. But in the meanwhile student's prior attitude about statistics which is directly linked to their previous knowledge and attitude on mathematics subjects greatly affects the attitude developed at the end of the course, which will have an impact on students' competency and performance later. Thus, the study concluded the need of identifying ways to positively change student's attitude and perception while teaching biostatistics course ⁽⁹⁾.

Another mixed study done using surveys and series of focus group discussions to explore the view of students about how, when and what they want to study about biostatistics, found that students feel a sense of inadequate knowledge and lack of confidence on biostatistics course resulted from inadequate support provided while taking the course. They also highlighted the need of initial statistics training prior to the course and found very crucial in using scientific articles; small group discussion and virtual learning as their usual and preferred pedagogical approach ⁽¹⁰⁾. This study concentrated on looking for appropriate teaching designs to teach biostatistics course that can increase the chance of students active learning and improve both the knowledge and skills they obtain from the course to put theoretical aspects into practice

This study evaluated a biostatistics course to undergraduate 3rd year midwifery students at EAU using a combination of multiple active teaching styles that motivate student participation and involvement where appropriate throughout the course such as, interactive lectures, small group

discussion, The simple 5 steps teaching style and simulation approach. This interactive teaching methods are joined together to help students develop not only the cognitive aspect of the course but also to the affective and psychomotor domains as well in accordance with the blooms taxonomy ⁽¹¹⁾.

At the end of the course the impact of combining multiple active participatory teaching styles on students' performance and perception about their gained knowledge and skills related to biostatistics course was evaluated using the following specific objectives.

- To evaluate the gained knowledge of students about biostatistics course before and after attending the course sessions.
- To analyze the effect of combining multiple teaching styles on students' perception about their gained knowledge and skills related to the course.
- To correlate the grades students obtain from their written exams and practical group assignments to identify which teaching method works best for the students.

Since educational evaluation is an important strategy to improve the quality of education through analyzing the educational contributions of the input and the process used to the outcomes achieved ⁽¹²⁾. This study was small scale evaluation study using Gray box approach to determine how the inputs and the processes used to teach biostatistics course to 3rd year midwifery students at the university affected the desired outcomes of the course in order to improve the pedagogical approaches necessary to teach biostatistics course by evaluation ⁽¹³⁾. Results from this study will be transferable in component form, since context was considered to assess the perception of students related to the course.

2. METHODS

2.1. Study Design And Study Population

This study used a Gray box evaluation method, to evaluate the impact of combining multiple participatory teaching approaches on students' performance and perception about biostatistics

course delivered to 3rd midwifery students at Edna Adan University, Hargeisa Somaliland. The study population was all 3rd year midwifery students (n=30).

2.2. Brief Course Description

This biostatistics course was taught to 3rd midwifery students of the university, the planned time frame to cover was 6 consecutive weeks from 1st February to 15th March 2021, with a 3 hour session twice a week. And this was part of a change that the university is undergoing this time. Therefore the main aim of this course was to transmit a comprehensive basic understanding and application of statistical knowledge, which includes, basics of data collection, organization, analysis and interpretations of medical data, acquire skills of data analysis using SPSS statistical software.

In order to achieve the desired course objectives, a combination of multiple student centered teaching styles were employed in order to encourage active participation of students. The common teaching styles employed includes, interactive lecture using the classical and problem oriented structure ⁽¹⁴⁾, to deliver the main idea and introductory information about each session followed by a small group discussion methods using the assessable training model ⁽¹⁵⁾, This method was especially applied during critically reading and analyzing scientific articles since a number of articles were used to help students better understand how to read and understand articles and for a number of class work formative assessments. The main aim of applying small group discussion method was to help silent students get an opportunity to be engaged in the class activities, work in groups and be interactive while in the discussions

The simple 5 steps teaching style ⁽¹⁶⁾, to teach sections related to calculation were also applied in this course, which is a crucial teaching style that can encourage student engagement and involvement while teaching sessions about calculation. And finally Simulation method ⁽¹⁷⁾, was used to teach and help students acquire the skills of data analysis using SPSS Statistical software version 20 using a practical and real data collected by the students while in the course (Table 1) shows a detailed structure and plan of the course.

Throughout the course different student centered class work activities has been carried out as a formative assessment and at the end of the course students had two summative assessments. A written midterm and final exam aimed to assess the theoretical gained knowledge of students

about biostatistics. Students took their midterm exam on the 4th week of the course and the final written exam at the end of the course. These two written exams accounted for 70 percent of the overall course marks.

The second summative assessment was a group work practical assignment designed to assess the practical aspect of the course, All students in the class were divided in to 5 groups each with 6 students on week one of the course. Each group chose a single topic for statistical study and practiced the necessary skills of biostatistics. All groups have collected their own data using questionnaire then organized their data and put in to tables, they analyzed/presented their data using SPSS software and finally interpreted their finding. This was submitted and presented on the final day of the course as part of their second summative assignment which was counted as 30 percent of the course assessment.

2.3. Data Collection

This study collected both quantitative and qualitative data. The quantitative data was collected through a similar pre and post test questionnaire (n= 28 and 29) respectively to assess the knowledge and perception of students about biostatistics subject before and after the course. Question items in this questionnaire were divided in to two sections, first section was assessing the perception of students about biostatistics, its importance and usefulness for midwifery department (5 question items), the second section assessed the knowledge status of students about the course before and after taking the course (5 question items), all questions In both sections were closed questions with four possible answers designed in line with likert scale method ⁽¹⁸⁾ from 1 to 4 with 1 being “Strongly disagree” and 4 “Strongly agree”.

The post test questionnaire also included an additional section to create a qualitative data using white space questions (5 question items), this questions were assessing the perceived attitude of students about how the course went and what they felt about that. All the questions in the questionnaire were prepared by the principal authors using literature ⁽¹⁹⁾, which was further validated up on discussion with experts from King’s College Somaliland Partnership. Pretest has also been done to similar level nursing students of the university to ensure validity and reliability of the questions and made necessary improvement using feedback.

In addition the study also compared the gained results of students from their both summative assessments, results from the 2 theoretical written exams; comprising 70% of student's total marks were compared with the remaining 30% practical group assignment to evaluate the correlation between the two assessments

2.4. Data analysis

Quantitative data was first cleaned and checked for errors and entered in to SPSS version 20 for analysis. Descriptive statistics using frequencies, percentages, mean and standard deviation were used to compare results from the knowledge and perception of students before and after the course. Student's t-test was also applied to find the correlation between the two summative assessments. While the White space qualitative questions were thematically analyzed.

2.5. Ethical consideration

This study has obtained an approval from the ethical committee of the EAU. Study participants were not in any potential risks or harms, all the participants of the study were asked to give their informed consent after full explanation of the study objectives, confidentiality and anonymity of the participants were assured.

3. RESULTS

In the academic year 2020-2021, A total 30 midwifery third year students have been enrolled in a biostatistics course as part of their semester courses, all of them were females (n=30(100%)) and were all asked to participate in this educational evaluation study after explaining the objective of the study before beginning the class and at the end of the course as well. 28 and 29 students has participated in the pre and post test questionnaire (Response rate: 93% and 97%) respectively. Below results demonstrate the knowledge and perception of students before and after attending biostatistics course at the university.

3.1. Perception of Students about Biostatistics Course

The perception of students before and after attending the course has been evaluated by 5 question items and has been summarized in table 1 Which shows that majority of the students

enrolled in the course has agreed on the statements “statistics is an important subject for midwifery”, “I like mathematical courses” and “I am interested in taking this course” before and after attending the course. In all the assessed areas there was small improvement in the number and percentage of students who answered 3 “Agree” and 4 “Strongly agree” after filling the post test questionnaire which was not statistically significant (P-value: 0.397). Hence this study identifies that student’s perception especially their interest in mathematical courses like biostatistics didn’t improve significantly as a result of attending the course.

Table 1: Student’s perception about biostatics (number and percentage of students who answered 3 “agree” or 4 “strongly agree” before and after)

Rate yourself from 1 to 4 about your perception on biostatistics	Pre course N= 28	Post course N= 29
Biostatistics is an important subject for midwives	24 (85.7%)	28 (96.5)
I am interested to take this course)	25 (89.3)	26 (89.6)
I personally like mathematical courses	14 (50)	16 (55.2)
I understand the main concepts of biostatistics	11 (39.2)	26 (89.6)
I believe that the knowledge and skill that I acquire from this course are fundamental for my future professional performance	20 (71.4)	25 (86.2)

3.2. Knowledge of Students about Biostatistics Course

The present study found that the knowledge of students has significantly improved after attending the course sessions (table 2), this was evaluated by a similar 5 question items pre and post test questionnaire designed in line with the major course objectives. From all the assessed areas including the skill of reading a scientific article, collecting, analyzing, presenting and interpreting a statistical data the student number and percentage showed a statistically significant improvement (P-value: 0.007). Similarly the mean score of all the assessed areas has also significantly improved (see table 3). Hence this study demonstrates the importance and usefulness of combining multiple active teaching styles for a better student performance

on biostatistics subject and for a better future teaching practice that could best suit the course as well.

Table 2: Student's knowledge status about biostatistics (Number and Percentage of students who answered 3 "Agree" or 4 "Strongly Agree" before and after)

Rate yourself from 1 to 4 about your ability on biostatistics	Pre course N = 28	Post course N= 29
I can read and understand scientific research articles	18 (64.2%)	26 (89.6)
I can collect statistical data using (observation, interview, questionnaire)	13 (46.4)	24 (82.7)
I can perform statistical data analysis using manual and SPSS	11 (39.2)	22 (75.8)
I can present statistical data using tables or charts	16 (57.1)	26 (89.6)
I can write results of a statistical analysis with correct interpretation	10 (35.7)	22 (75.8)

Table 3: Average value response (mean \pm standard deviation), before and after completing the course.

<u>Perception status before and after</u>	<u>Pre course assessment</u>	<u>Post course assessment</u>	<u>P value</u>
• Biostatistics is an importance subject for midwives	3.53 \pm 0.74	3.79 \pm 0.49	0.397
• I am interested to take this course)	3.21 \pm 0.75	3.51 \pm 0.68	
• I personally like mathematical courses	2.64 \pm 1.19	2.82 \pm 1.10	
• I understand the main concepts of biostatistics	2.32 \pm 0.98	3.55 \pm 0.68	
• I believe that the knowledge and skill that I acquire from this course are fundamental for my future professional performance	3.14 \pm 1.20	3.58 \pm 0.7	
<u>Knowledge and skill before and after</u>	<u>Pre course</u>	<u>Post course</u>	<u>P value</u>
• I can read and understand scientific research articles	2.71 \pm 0.97	3.41 \pm 0.77	0.007
• I can collect statistical data using (observation, interview, questionnaire and documented sources)	2.60 \pm 0.74	3.44 \pm 0.94	
• I can perform statistical data analysis using manual and statistical software systems like SPSS	2.21 \pm 1.13	3.20 \pm 1.04	
• I can present statistical data using tables or charts	2.60 \pm 0.95	3.58 \pm 0.78	

• I can write results of a statistical analysis with correct interpretation	2.28 ± 0.81	3.27 ± 1.06	
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3.3. Qualitative results

In the post test questionnaire students were asked to provide a detail answers to white space questions (5 question items) about what they felt on the pedagogical teaching styles applied in the course (The combination of multiple active participatory styles). Students provided only positive feedback about their feeling on the teaching approach. Below results demonstrate analysis of the white space questions using short summaries after similar answers being coded together to form the below 4 themes.

Theme 1: Combination of multiple teaching styles was fruitful and advantageous

Majority of the students participated in the study highlighted that combining multiple active teaching styles was very important and useful method for teaching biostatistics as it helped them understand and learn basic skills of the subject in accordance with the course objectives, it also helped in grasping the major ideas and theories related to the usefulness of biostatistics. Beside that more than half of the students in the class showed that they were quit interested in all the sessions as they were getting more access to be involved in what is going around them during the course sessions.

“The class was very interesting and we had a chance to participate in many class work activities that was very interesting” (Student number 9).

“The course has been taught using different teaching styles like theory and practice which was very good and helped us to learn basic skills like data collection, analysis and interpretation” (Student number 16)

Theme 2: Acquiring skill of data collection was the best thing

13 students agree that acquiring the skill of data collection specially using questionnaire was one of the best thing they have learned from the course as they had an opportunity to collect a real data for their first time ever using questionnaire which was created by them, this practice session attracted students to appreciate the session and use the opportunity provided to collect a real data from their own questions.

“Learning how to make a questionnaire and collecting our own real data was the best thing I learnt from the course, it was something I never see it before” (Student number 5)

Theme 3: Working on calculations was the worst thing

More than half of the students argued that working on statistical calculations was the worst thing they had while in the course and they mostly claim that mathematics is not their favorite subject and that they don't like learning mathematics as it is a more difficult and challenging subject compared to other courses.

“I always don't like mathematical courses because it is always difficult subject for me even during the school time” (Student number 22)

“The course was very interesting from all sides, except working on calculations which was the worst thing I had in the class because calculations are not my favorite” (Student number 18)

Theme 4: Data analysis and interpretation sections needs to be learned more

Quit a number of students suggest that they would like to learn more on sections in the course specially data analysis and interpretation which they claim a shortage of time to be the major influential factor and that they want to spend some more time on learning that sections afterwards.

“I would like to learn more on the topics like data analysis and interpretation because these topics need more time to practice and grasp the major concepts in it” (Student number 10)

“I will give some more time to learn sections like data analysis and interpretation as these are a very important part of the course and somehow complicated to learn” (Student number 27)

3.4. Correlation between student's written exams and practical group assignment grades

This study also evaluated the correlation between the written exam grades (midterm and final exam) as part of the first summative and the practical group assignment activity as the second summative (n=30). The overall average grade for the written exams was 7.1 ± 1.2 and that of the practical group assignment was 8.2 ± 0.7 out of 10 points. Even though the later practical

activity was graded as group of students this correlation analysis showed that there was a significant positive correlation between the mean grades of the written exams and that of the practical group assignment ($P < 0.03$, $r = 0.42$). Hence combination of the above mentioned interactive teaching styles to improve the cognitive and psychomotor aspect of the students has positive correlation and compliment with one another which could be helpful for future plans in designing appropriate pedagogical approaches to teach biostatistics course.

4. DISCUSSION

Biostatistics course for undergraduate midwifery department is quit important for many reasons, it is the first chance students got an exposure of reading a scientific article with understanding and learn how to apply the best available evidence for practice, but teaching this course is quite difficult and complicated in Somaliland where students are not interested in mathematical courses. In the past though the common teaching style used to teach this course was the traditional lecturing system currently it's been shifted to combined multiple participatory styles with the aim of motivating students to be active in the class and increase their interest related to statistics for a better student performance and perception. For this reason, this study is set to evaluate how combined teaching approaches affect the students' performance and perception related to biostatistics course.

Before the start of the course 64.2% of the students were able to read a scientific article, another 46.4% were able to collect statistical data using either observation, interviews and questionnaire while 39%, 57% and 35% were able to analyze, present and interpret statistical data respectively. After attending the course the results has significantly improved to 89.6% able to read scientific article, 82.7% able to collect statistical data while another 75%, 89% and 75% were able to analyze, present and interpret statistical data respectively which was statistically significant ($P=0.007$). This finding is in line with a study conducted by (Gore et al. 2012) ⁽¹⁾ which showed that student's knowledge on biostatistics has significantly improved after combining theoretical and practical activities to teach biostatistics. Hence the application of multiple active teaching styles shows that it significantly improves the knowledge and performance of students towards biostatistics which could be beneficial for future designing of the course teaching pedagogy.

Even though there was no previously published study which evaluated the four specific teaching methods that was applied in this course there were some studies that evaluated combination of multiple teaching styles. A prospective study by (Milic, et al 2016) ⁽²⁰⁾ comparing obtained results of students in statistics course from a group with a total face to face traditional teaching method with another group using a combined teaching methods which includes having class hours added with online hours and use of multimedia materials “blended learning”. Found that both student groups obtain similar grades on the theoretical knowledge but after performing an adjusted analysis of factors students with higher grade on their other studies preferred the “blended learning approach” and the authors strongly argue that considering different teaching approaches could always be an effective and attractive compared to the traditional lecturing approaches. Another study by (Bernardo et al 2004) ⁽²¹⁾ evaluating the effectiveness of combining lectures, video sessions and collaborative group activities on experimental surgery training to medical students found also good results In terms of students acquired knowledge and perception related to the teaching approach.

Before the start of the course the perception of students related to the importance of statistics for midwives was 85%, while nearly 71% of the students believed that what they learnt from the course will be fundamental for their future career, this results has improved after attending the course to 96% and 86% respectively which was not statistically significant. This result indicates that the perception of the students about the importance of the subject and its usefulness for future career was quit good before the class which could be linked to previous information students got from other instructors, friends or family members..

Interest and motivation are always important for effective teaching learning process. Almost half 14(50%) of students participated in the pre test agreed that they are not interested in mathematical courses and lacks adequate motivation to study the course even though 25(89%) of the participants mentioned they are interested in this particular biostatistics course; after participating in the course a very small improvement has been made only 16(55%) and 26(89.6%) mentioned that they are interested in mathematical courses and biostatistics course respectively which was not statistically significant (Pvalue: 0.37). this finding demonstrates that students attitude and specific perception on mathematical courses didn't improve as a result of this intervention which could be linked to their previous attitude on mathematics being a difficult subject to learn. This is also similar with other studies ^(22, 1) in which 53.87%

of the participants suggest that biostatistics is a very difficult subject as its related to mathematics which is not a favorite subject for most of the students in medical science.

The pretest questionnaire also identified students perception about what they already know or understand about the basic skills of statistics and found that only 11(39%) had some idea about statistics. After completing the course significant improvement were made on students perception about their gained skill related to statistics 26(89%) of the students felt that they developed basic skills of biostatistics. this finding is inline with a study by (Rubio et al 2018) ⁽¹⁹⁾ on the impact of participatory teaching methods on medical students' perception of their abilities and knowledge of epidemiology and statistics showed the perception of students about their gained knowledge and understanding of a scientific article, performing, analyzing and interpreting statistical data has improved in 80-90% after attending the course. This suggests that applying a combination of participatory and active teaching styles could significantly improve the confidence and perception of students about their gained skill related to statistics.

A recently published study on assessing the usefulness of various activities carried out with pedagogical content in applied statistics course showed that the perception of students about being engaged in the overall class activities, working and collaborating with other students was an advantageous process that helped them achieve a certain meaningful course objectives related to biostatistics course (Rubio et.al 2016) ⁽²³⁾. While this study experienced that combining multiple active teaching styles with multiple student class work activities also showed positive significant results that can re-assure the above results. Nearly all the students in the class showed their interest and appreciation in the teaching pedagogical methods applied in this course.

This evaluation study also found that there is a positive correlation between the written theoretical exams and the practical group assignment. From the personal point of view this shows that the applied pedagogical teaching styles for this course to teach the theoretical sections and the practical skills were quit constructive and complementary to one another. However the correlation coefficient ($r=0.42$) was low-moderate which could be affected by the fact of assessing different learning aspects at a time, the written exam measured only the knowledge perspective of the course and the practical group assignment measured the necessary practical skills to apply statistical knowledge.

Major limitations of the present study included the use pre-post test which might not be the ideal design to do an impact evaluation, the lack of control group for comparison was another limitation additionally the present study reflects only on the current condition of the 3rd year midwifery students of this assessed university and therefore might not be generalized for all since context was taken into account.

Strength of the study included the use of gray box evaluation method using a mixture of quantitative and qualitative data which seems a bit detailed and informative. Statistical tests have been used to provide evidences and improve the credibility and reliability of the findings. Consequently generalization of the study could be proposed since contents of the study could be transferrable in component form.

5. CONCLUSION

The present study found that the combination of multiple active participatory teaching styles has significantly improved the performance of students in terms of their theoretical knowledge and practical skills related to biostatistics course and their perception regarding their abilities of performing basic statistical tasks but it doesn't significantly improve attitude and interest of students about calculation related sessions and mathematical subjects like biostatistics.

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