

## Impact of Novel Enhanced Learning on Results for Courses on Control Systems and Biostatistics in Medical Electronics Programme

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**Abstract**— Enhanced learning is an important effective pedagogical tool which helps students to understand the concepts better. Assessment Tool is a concept to be used as against the mundane assessment method. This paper gives an experience report of the first author in implementation of two important courses taken by the students of department of Medical Electronics in two different semesters. The courses under consideration are with no laboratory attachment and so the students fall short of experiencing the outcomes for different concepts of the subject. An assessment tool was therefore introduced in the form of usage of a software tool to implement the concepts learnt in theory. The novel assessment tool usage introduced was assessed to quantify the effect of practical exposure. The improvement thus seen had a normal distribution in the scores obtained by students and looked ideal for the range of student group which usually had a skewed pattern.

**Keywords** - *Assessment Tool; Biostatistics; Control Systems; Teaching beyond syllabus*

### I. INTRODUCTION

Problem based learning or project based learning is a interesting concept usually adapted in the teaching-learning process in engineering education. The two courses under consideration for analysis of project based learning are Biostatistics and Control Systems.

Biostatistics deals with the application of statistics for analysis of the biological and medical data. Biological data may include the study of certain behavior of an organism which is represented in numbers. The medical data includes the data from the hospitals and prevalence of a disease in a region. The topics taught in the syllabus include Basics of biostatistics which includes important terms used in Biostatistics. It also focuses on the probability concepts where most of the data needs probability to derive any logical conclusions. It deals with descriptive and inferential statistic and type of distributions. The main focus in Medical data would be on Normal distribution and its analysis. The course also deals with testing of given hypothesis and giving a reasonable conclusion. The ANOVA is also a part of this course where there are more than two groups of data to be compared. The design of an equation using correlation and regression is also introduced in this course [1].

Control system is a course which deals with the design and stability of any system. This includes introduction of types of control systems. It also had focus on analysis

stability of mechanical and translational systems. The course was further divided into time response analysis and frequency response analysis. The time response analysis includes first order and second order system analysis. The analysis of different types of methods of stability is also discussed in the class. This includes RH Criterion, Nyquist Plot, Polar Plot, Root locus Technique and bode plot [2].

### II. PARTICIPANTS / STUDENTS

There were 44 students who had registered for the Control Systems course in which there were 35 students who had registered for the first time in January 2014 to May 2014 IV Semester. These 35 students were compared against 38 students in previous academic semester from January 2013 to May 2013.

There were 22 students who had registered for the Biostatistics course as it was elective course January 2014 to May 2014 IV Semester. In Semester from January 2013 to May 2014 there were 30 Students considered. Both the courses considered had only lecture but not practical, tutorial or self-study.

### III. COURSE OUTCOMES

Course outcomes also called as learning outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. In other words, learning outcomes identify what the learner will know and be able to do by the end of a course or program. The Medical Electronics programme was evaluated for Tier I accreditation by National Board of Accreditation (NBA) [3] in February 2014 and the programme is provisional accredited for two years with effective from 1<sup>st</sup> July 2014.

#### A. Control Systems

The control Systems had five course outcomes adapted as follows.

- CO1: Apply KVL and KCL for mathematical modeling of linear systems.
- CO2: Understand Time response analysis of control systems for first order and second order systems.
- CO3: Learn different methods of Stability analysis.
- CO4: Learn stability analysis techniques in the design of systems.
- CO5: Learn frequency response analysis.

B. *Biostatistics*: The course outcomes are,

- CO1: Construct the most suitable basis that simplifies the solution of a problem and develop the best method for probability and predictability.
- CO2: Use the concept of Biostatistics to simplify the data aspect to solve problems.
- CO3: Understand concepts of Distributions for simplification of usage to analyze biomedical/biological data.
- CO4: Use current techniques, skills necessary for computing practice.
- CO5: Design and evaluate a given problem and test the correctness of the analysis.

This course doesn't concentrate on self-study and open ended experiments [4][5]. Hence, it was required to introduce the students to the concepts of assessment method in order to have more understanding of the course as well as apply in real practical situations in real world.

#### IV. EVALUATION PROCEDURE

The evaluation was done in two major parts. They are Continuous Internal Evaluation (CIE) and Semester End Examination (SEE). Both CIE and SEE had questions containing theoretical questions and problematic questions in which more weightage was given to problematic questions. However, the detailed question paper is out of preview of this paper.

##### A. Course Structure and Evaluation

Each non-integrated which is not associated with laboratory component had the following structure

- Each course has five units.
- The 50% of the marks are for CIE and 50% of marks are for SEE.
- In CIE, The students are given three tests out of which only best of two tests will be considered for final marks.
- Each test is given and evaluated for 40 marks and will be reduced to 20 marks. Two tests are considered totally amounting to 40marks.
- The rest 10 marks are for two written quiz or assessment tool of 5marks each. The questions are given and evaluated for 20marks and finally reduced to five marks.
- In SEE, the students are supposed to answer for 100 marks out of 140 marks. The obtained marks are reduced to 50% of the marks which will be SEE.
- The 50marks of CIE and 50marks from SEE are added and graded as in Table 1

#### V. ASSESSMENT TOOL

The first written quiz was having 20 questions whereas the second quiz was made as assessment tool for 5marks. This was adapted for both the courses viz., Biostatistics and Control Systems.

Table 1: Marks- Grade table

| Level        | Out-standing | Excellent  | Very Good    | Good       | Average    | Poor      | Fail |
|--------------|--------------|------------|--------------|------------|------------|-----------|------|
| Grade        | S            | A          | B            | C          | D          | E         | F    |
| Grade Points | 10           | 09         | 08           | 07         | 05         | 04        | 00   |
| Marks (%)    | ≥ 90         | ≥ 75 - <90 | > =60 - < 75 | ≥50 - < 60 | ≥45 - < 50 | ≥40 - <45 | < 40 |

##### A. Control Systems

The students were made into groups of 2 or 3 from the same class and were trained on National Instruments LabVIEW basics. This aspect was beyond the syllabus, since the curriculum did not specify usage of any tool for learning the concepts. The teams of students were assigned to work on LabVIEW for implementing the problems taught in lecture class. The problems consisted of the following divisions

1. Evaluation of given Transfer function
2. First order time response
3. Second order time response
4. RH Criterion
5. Root Locus Plot
6. Bode Plot
7. Nyquist Plot
8. Applications of the above topics in Medical Electronics

The above topics were implemented by the students and it was evaluated as Assessment Tool instead of Quiz II. This was a computer based training which is already a proven effective technique [7].

##### B. Biostatistics

The students were made into groups of 2 or 3 from the same class and were trained on Basics of Microsoft Excel. This aspect was beyond the syllabus since the curriculum did not specify usage of any tool for learning the concepts. The teams of students were assigned to work on Microsoft Excel for different statistical method and come with a conclusion based on the data downloaded from the websites given by the course instructor. The websites suggested for accessing ethically cleared medical data are as given below. The students could use these links or also any other of their choice.

- <http://www.ihe.ca/publications/health-db/>
- [http://dhsprogram.com/data/dataset/India\\_Standard-DHS\\_2006.cfm?flag=0#sthash.ho6NQPh4.dpbs](http://dhsprogram.com/data/dataset/India_Standard-DHS_2006.cfm?flag=0#sthash.ho6NQPh4.dpbs)

- <http://libguides.gwumc.edu/content.php?pid=35489&sid=261041>
- <http://apps.nccd.cdc.gov/cdi/Default.aspx>
- <http://www.vicc.org/biostatistics/about.php>
- <http://statisticsworldwide.com/data>
- <http://stat.wto.org/Home/WSDBHome.aspx?Language=>
- <http://www.infochimps.com/datasets>
- <http://l-lists.com/en/lists/dz3a5t.html>
- <http://www.who.int/research/en/>
- <http://www.infochimps.com/datasets>

The students were asked to perform the following analysis on the data downloaded

1. The pivot table from the data
2. Frequency distribution table
3. Histogram and frequency polygon
4. Regression Analysis
5. Correlation
6. Analysis of Variance (ANOVA)

The above topics were performed by the students and evaluated as Assessment Tool instead of Quiz II.

#### VI. RESULT AND RESULT ANALYSIS

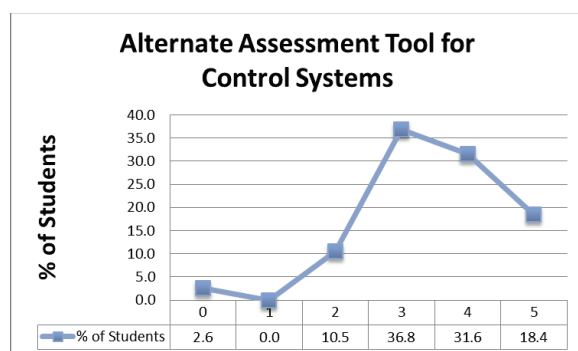


Figure 1: Assessment Tool marks obtained out of 5 for Control Systems

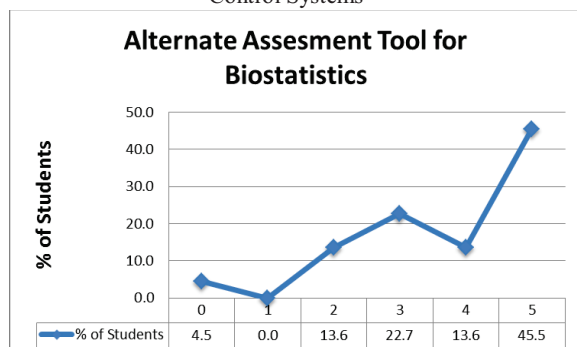


Figure 2: Assessment Tool marks obtained out of 5 for Biostatistics

Figure 1 and 2 shows the marks obtained for Control Systems and Biostatistics. In the above graphs it is seen that more number of students got 5/5 in the Assessment tool. The marks were awarded based on the novelty, selection of data, interpretation of the data, graphs obtained and the report with applications.

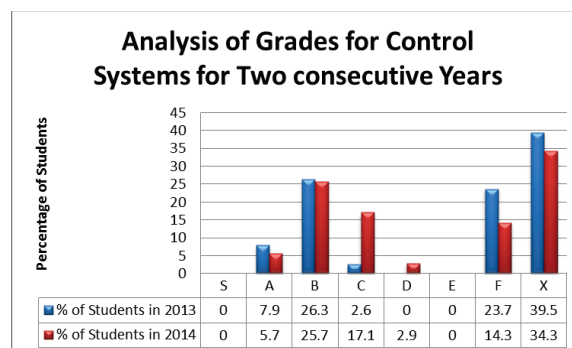


Figure 3: Grades in Control systems for Two successive years

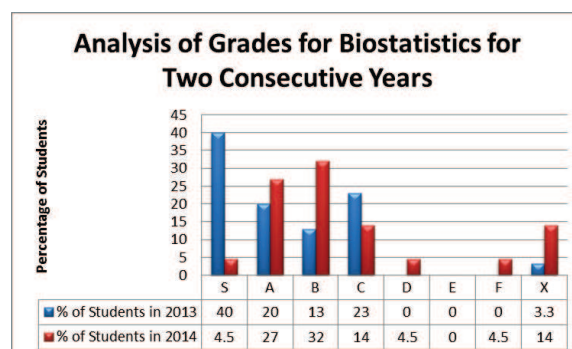


Figure 4: Grades in Biostatistics systems for Two successive years

The courses taken for consideration are of the kind non-integrated taught by the first author. One of the courses is Biostatistics which is an elective for the electrical science cluster students. The second course under consideration is Control Systems which is a department core subject and non-integrated course. The extra learning was suggested for the benefit of the students under the guidance of the first author. This was imposed as an assessment tool instead of one of the written quiz. The students were evaluated for five marks. The scores obtained by the students achieved a normal distribution for both the courses and also decreased number of F graders.

The figure 3 shows the percentage of students obtained the S to X grades in Control Systems. The usage of assesment tool has decreased the number of X grades. X graders are given an opportunity to write the SEE exam again if they have more than 85% of attendance and more than 29 marks in CIE. There is also decrease in F graders (failures) after implementation of the Assessment tool. There

is tendency of the graph approaching normal distribution than the previous year.

The figure 4 shows the percentage of students obtained the S to X grades in Biostatistics. It is seen that the results follow normal distribution in the batch which had undergone the assesment tool than the batch which has not had assesment tool. The figure also depicts the teaching learning process is better as well as the results follow normal distribution in year 2014 than in year 2013 which was skewed to the left.

## VII. STATISTICAL ANALYSIS

The research statement or hypothesis under consideration is to determine if there is a significant difference in the effects of the enhanced teaching and regular teaching as measured by the marks obtained in the Semester End Exam (SEE). This study used SPSS (Statistical Package for Social Sciences) to compute the descriptive statistics. The descriptive statistics was done on both. It involves a dependent variable of continuous nature. They are the marks obtained by Assessment tool (Quiz2). This was done on two groups' independent groups and on two independent courses. The first groups were previous group of students who did not have the experience of enhanced learning with mundane written quiz and the other groups were having the experience of using the software tools for learning and understanding the concept apart from mundane learning. The sample sizes (N) for both the courses were greater than mostly 30.

The descriptive statistics considered were the following

- Mean: The average of all the values of the same sample.
- Median: This separates higher values of the data to the lower values of the data set.
- Mode: The mode is the most repeated value in the data set.
- Standard Deviation and variance: The deviation from the mean value of the data.
- Measure of asymmetry of probabilistic distribution data.

### A. Inference for Control Systems

From table 3, the decrease in mean shows that the enhanced learning has positive impact on the learning as it implies the mean is seen at almost mid-point inferring the normal distribution of score. The median is exactly dividing the data into two halves. The mode is the most repeated value which is decreased. Standard deviation and variance is increased which implies that there is more of spread wrt mean. The skewness is decreased which approaches nearer to zero increasing the symmetry. Finally, the inference is that enhanced learning has impact on effective pedagogy.

### B. Inference for Biostatistics

From table 3, there is improvement in mean which shows that the enhanced learning has made the students score more. The median is exactly dividing the data into two halves. The mode is the most repeated value which is decreased. Standard deviation and variance is increased which implies that there is more of spread wrt mean. The skewness is decreased which approaches nearer to zero increasing the symmetry. Finally, the inference is that enhanced learning has impact on effective pedagogy and the distribution is approaching normal distribution.

Table 2. Descriptive statistics for control Systems.

| Descriptive Statistics for Control Systems |       |           |                   |
|--------------------------------------------|-------|-----------|-------------------|
|                                            |       | QUIZ_Grp1 | QUIZ_Grp2         |
| N                                          | Valid | 35        | 38                |
| Mean                                       |       | 4.2727    | 3.3182            |
| Median                                     |       | 4.0000    | 3.0000            |
| Mode                                       |       | 5.00      | 3.00 <sup>a</sup> |
| Std. Deviation                             |       | 1.00849   | 1.23463           |
| Variance                                   |       | 1.017     | 1.524             |
| Skewness                                   |       | -2.539    | -.802             |
| Std. Error of Skewness                     |       | .409      | .357              |

Table 3. Descriptive Statistics for Biostatistics

| Descriptive Statistics for Biostatistics |       |           |           |
|------------------------------------------|-------|-----------|-----------|
|                                          |       | Quiz_grp1 | Quiz_grp2 |
| N                                        | Valid | 25        | 30        |
| Mean                                     |       | 3.8333    | 3.9524    |
| Median                                   |       | 4.0000    | 4.0000    |
| Mode                                     |       | 4.00      | 3.00      |
| Std. Deviation                           |       | 1.08543   | 1.16087   |
| Variance                                 |       | 1.178     | 1.348     |
| Skewness                                 |       | -.860     | -.535     |
| Std. Error of Skewness                   |       | .427      | .501      |

### VIII. CONCLUSIONS

The analysis of effect of assessment tool i.e enhanced learning with respect to two important courses namely Control Systems and Biostatistics in IV and VI semesters respectively, offered by department of Medical Electronics in B M S College of Engineering, Bangalore. The assessment has decreased the number of F graders in Control Systems and the results of Biostatistics have approached Normal distribution when compared to the results without assessment tools. The normal analysis is in sync with the statistical analysis.

The future aspects include having assessment tool for all the courses for the benefit of the students to achieve good results and increase the confidence of the students and teachers confidence justifying effective pedagogy. Any research is incomplete without statistics, especially courses like Biostatistics should be taught by defining and proving the hypothesis on the data collected from the field (Hospitals, Public Health Centres (PHC), etc). This will help the students to understand the significance of the course.

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