Statistical Concepts – An early Introduction into a Biomedical Engineering Curriculum

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Introduction

This paper presents the results from an initial introduction of statistics to the biomedical engineering students when they are sophomores based the seniors' request to provide this earlier experience. The testing results and student course assessments provide additional information for the next time the course is taught. In the future, a paper will be presented on the trends in class performance over a five-year period and the results of senior interviews about the utility of early introduction of statistics.

Background

As documented by ABET criteria for BME, statistic is a very significant requirements for biomedical engineers. Discussions with both BME graduate students and industry has specifically indicated a desire for students to have a proficiency in statistics.

Previously, BME 271 was used as an introduction to biomedical engineering with an emphasis on team projects with oral and written presentation. By covering six areas, the students were able to individually present to "different audiences" on the specific task for the research area. Since all students had completed the topics of statics and particle dynamics, the biomechanics area has always included calculations and exam problems where statics and dynamics are applied to a biomechanics situations.

However, the combination of a statewide reduction in credit hours and the difficulty in students determining the application of various mathematic and engineering processes resulted in a new combined focus for this course.

Because of need to develop a perspective of understand of statistics, multiple exposures to the topics is useful. In recent interviews with seniors, they have agreed that they have taken a good course in statistics, but it was difficult to relate to "real applications". Although they used the concepts in the BME laboratory course, it took extensive time to really see what to apply. They expressed a desire to see some of the material utilized earlier in their courses.

The new BME 271 course will provide students with some experience in presentation related to three areas in BME. The initial area is cell and tissue engineering with a focus on determining the best area for a planned corporate research. The second area is biomechanics. This area is will combine statistic, statics, and particle dynamics for the solution of simple problems. Based on group measurements, the range of values for joint loading will be assessed. The last part of the course will involve a combination of instrumentation and imaging. The added aspects are the considerations of A/D conversion, Fourier Analysis, and systems modeling.

Methods

Lectures are seldom effective to provide student with the retention of information; however, laboratory experiences are costly and difficult for large classes. Statistics did provide an opportunity for groups to collect information in a reasonable manner for future use. The students were given the "laboratory experience" of measuring the length of the distal phalanx, the finger, and the forearm. The students provide their sex, height, weight, and body fat in a method for confidentiality. The data was collected and randomly distributed to different groups. The groups provided the information to the instructor by EXCEL files, which were then combined. The students were provided this information in a single Excel file.

The lecture provided the information on the concepts on mean, standard deviation, normal distribution, student T distribution and chi-squared distribution. The students were shown how to compute the range of values for a particular probability, the precision range for the mean and the precision range for the standard deviation. A section of text material was provided. The students used the data to calculated the statistical values for the class as a whole, the class separated into male – female, and for ratios of lengths to heights. They were asked to assess what ideas seemed to produce the least variations in precision means and variances. The final aspect was the relationship to anthropomorphic data.

With class sizes greater than 40, homework and grading become a significant problem. To improve performance, quizzes were given on each Friday for the last month of the course. Quiz scores were based on the presents of the individuals in the class and the quizzes were used to identify problems and answer questions from the class.

Results

The majority of the students completed the assignments. The students used mixture of hand calculations and EXCEL. The review before the exam showed that many students had done the calculations, but they did not really understand what they had done. The exam showed a wide variation on the scores for the statistics problem. The mean score was 64% and the standard deviation was about 6%. However, the scores on the statistics were in the same bracket as the statics and dynamics problems on the exam. In all three cases, the standard deviations were of the same magnitude.

The posed exam solution and the quizzes did contribute a significant improvement on the final exam. The students did a calculation of the range of values of a statics model using the student T approach. The final average was 90%.

Conclusions

Based on the final testing results, the students do have an understanding of some simple concepts of statistics and their potential application to biomedical engineering. The students were able to understand the concept of using distributions to try to determine ranges of values for products and analysis. They have been able to understand the potential for application to determining the results from research. The students have also been able to see how to use a standard tool (EXCEL) to be able to judge their measurement results.

However, some concepts for improvements are planned for the next year. The introduction of measurement concepts and some simple homework problems will be introduced before the "measurement Lab" is conducted. A combination of hand calculations and comparisons to EXCEL will be required. Finally, quizzes will be introduced on every Friday to stimulate understanding and asking individual questions.

The objective of this section of material was to provide a better understanding of the applications and concepts for the Statistics course for Engineers that will be taken during the students junior year. The students will be interview when they are seniors and they will also be evaluated in the senior biomedical laboratory course to see if progress has resulted from this introduction.

Student course assessments suggested that some additional time be provided for the statistical material and that some more simplistic reading material be provided. The new curriculum may provide some additional time for this topic. I have been reviewing Statistics for People Who (Think They) Hate Statistics by N. Salkind. The concepts are easy to read even though they are not directed toward engineering students.