

**AC 2009-1311: SUPPLEMENTAL TEACHING AIDS AND QUALITY
ENHANCEMENT PLAN FOR MECHANICAL ENGINEERING PROGRAM AT
ALABAMA A&M UNIVERSITY**

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Supplemental Teaching Aids and Quality Enhancement Plan for a Mechanical Engineering Program at Alabama A&M University

ABSTRACT

Most mechanical engineering majors experience difficulties in their major courses like Statics, Dynamics, and Strength of Materials. It seems appropriate to increase the chances of success of students by developing Supplemental Teaching Aids (STA) that are user-friendly and highly accessible to students. This paper examines the relationship between Supplemental Teaching Aids and Quality Enhancement Plan (QEP) for a Mechanical Engineering program. The developed material along with the lecture will target the retention rate increase within the Department of Mechanical Engineering. It will also enhance the quality of education as well as learning process in Mechanical Engineering Courses. To make it viable commercially accessible software such as Microsoft PowerPoint Presentation is selected as the development environment. The tool developed will accompany a particular topic in the Mechanical Engineering courses and will utilize features of the PowerPoint such as flybys, narration etc. to present the selected topic in a simple, step-by-step, and easy to understand manner. In this case a topic in ME231- Strength of Materials course was selected as a test bed. First, lecture was given to all the students without utilization of the STA. Twenty students were selected to participate in the survey that assessed their understanding of the selected topic. Feedback obtained from the survey was positive and initial results indicate that further development of such tool will enhance the educational quality within the AAMU.

INTRODUCTION

Quality Enhancement Plan (QEP) has been one of the central issues for Alabama A&M University. The plan addresses the question of “how to improve the quality of learning process within AAMU.” The role of QEP is particularly pronounced in the context of retention activities. There may be several viable options for enhancing the learning process in a particular classroom. For instance, using audio and visual aids, utilization of multimedia, incorporation of projects into the course material or combination of above to name a few.

Alabama A&M University (AAMU) is a land-grant historically black university. The University is located at the northeast outreach of Huntsville, Alabama, an important world center of expertise for advanced missile, space, electronic, research and development. AAMU provides a scholarly environment for teaching and research. As a historically black institution, the University seeks to address the special needs of capable students disadvantaged by systems and circumstances which have thwarted their efforts and chances for normal educational opportunities. A continued responsibility for this element of our society is strongly embedded in the mission of the University. The department of Mechanical Engineering is a relatively new program that started in fall of 1998 with two students. That number increased to 5 in the second year, 10 in the third year, 50 in the fourth year, 100 in the sixth year and 150 in the seventh year. Historical data within the department of Mechanical Engineering indicates that out of the total number enrolled, 30 percent of the students lost to other programs are within the freshmen level standing. That number showed a reduction to 10 percent in the sophomore year, 5 percent in

junior standing and nearly zeros in the senior level. Therefore, retention is a dominating factor that will affect the student population within the department.

Based on the difficulties that most mechanical engineering majors experience in their major courses like Statics, Dynamics, and Strength of Materials, it seems appropriate to increase the chances of success of students by developing Supplemental Teaching Aids (STA) that are user-friendly and highly accessible to students. This paper examines the relationship between Supplemental Teaching Aids and Quality Enhancement Plan (QEP) for a Mechanical Engineering program at Alabama A&M University. It is expected that the teaching aid developed along with the lecture will enhance the retention rate within the Department of Mechanical Engineering. It will also enhance the quality of education as well as learning process for selected topics in Mechanical Engineering Courses. Microsoft PowerPoint Presentation is selected as the development environment. The tool developed will accompany a particular topic in the Mechanical Engineering courses and will utilize the advanced features of the PowerPoint such as flybys, narration etc. to present the selected topic in a simple, step-by-step, and easy to understand manner. In this case a topic in ME231- Strength of Materials course was selected as a test bed. First, lecture was given to all the students without utilization of the STA. Approximately 20 students were selected to participate in the survey that assessed their understanding of the selected topic. Feedback obtained from the survey was positive and initial results indicate that further development of such tool will enhance the educational quality within the AAMU.

FACTORS AFFECTING RETENTION

In most programs, retention plays a fundamental role on the student population. This issue may become more pronounced in upper level engineering courses, since by then a considerable amount of resources has been spent on training of the students. A number of reasons are attributed to the loss of students from a given engineering program. For example the students might change major to another program, might “drop off” the school altogether, might find jobs and abandon their educational objectives or perhaps discontinue for a short period of time and start again later. Although it is nearly impossible to eliminate loss of students from the program, it is possible to minimize this loss by implementing several tactics. Critical factors affecting the retention of the students within the mechanical engineering program at AAMU are class attendance and participation, early exposure of potential students to mechanical engineering topics, advising, student competitions, participation in summer internship programs, participation in externally funded research projects, and utilization of multimedia and other technologies for understanding of topics.

Class Attendance and participation: One of the major factors that lead to the students dropping the class in a particular semester is the issue of attendance. Often students miss too many classes (due to a variety of reasons). The missed classes lead to lower performance in the class which consequently ends up with the student having to drop the class. On the other hand it is not often feasible for the instructor to take class attendance, especially if the enrollment is high in a given class; even so, if the attendance is taken it is not easy to track down on the attendance history of the student. One method proposed here will address both the issues of increase attendance and

will eliminate the need for the instructor to take the attendance while saving a valuable class time. The method proposed here is to prepare an attendance sheet with the format shown in Table 1.

Table 1. Sample sign up sheet used in the classes

Please sign your name in the corresponding column				
	Name	Monday (1/16)	Wednesday(1/18)	Friday (1/20)
1	Joe Brown			
	...			
	...			
20	Jack Smith			

Then pass on the sheet in the class and have the students sign their name in the corresponding row. The advantage of this format is that it is easy to trace the attendance history of a student and hence immediately be able to contact the student and consult him/her about his/her performance.

Early Exposure of the potential students to Mechanical Engineering Topics: This is an important issue in which the idea is to maintain contact with the Mechanical Engineering students within the first two years of their college. Traditionally, the curriculum in the department was set up in such a way that once the prospective Mechanical Engineering Majors took ME 101-Introduction to Mechanical Engineering, they lost contact with the ME faculty until the second semester sophomore or first semester junior. Two additional changes were made to the curriculum which caused the interaction within ME faculty and the ME majors to increase. The changes are addition of ME 103-Engineering Drawing and Graphics and ME 104-Introduction to computer programming to the curriculum. Although there is no formal study in support of this claim, but these changes appear to be instrumental in increase in retention of the ME students. Since there are no pre-requisites for any of the ME 101, ME 103 and ME 104 courses, the students, in theory, maybe able to take all there courses in one semester. However, if these courses are ordered in such a manner so that each is taken in three consecutive semesters as opposed to all in one semester, it may be possible that the retention figures will improve even further. The reason is that the students will have contact with a Mechanical Engineering faculty and therefore their progress in other non-major but vital courses (such as Calculus and Physics courses) maybe monitored and managed.

Advising: One of the central issues to the retention is the advising. Traditionally the prospective mechanical engineering students were advised at the university college. In most cases, the students were required to take a set of specific course which at times may not have been compatible with the curriculum of the ME department. Through the request of the ME department, the students who had declared ME as their major were referred to the ME office and from there they were assigned an advisor within the department of Mechanical Engineering. The idea for this change was for the department to have a closer contact with the students and to be able to monitor their progress more closely. Consequently in case the students had problems with a particular course, they could go to a specific faculty who was familiar with their academic progress and could offer meaningful advice to them. The advisors are provided with forms that keeps track of the progress of each student. The students are reported to their corresponding

advisor during the registration period and report their performance to the advisor and as well as decide on the courses that they should take in the following semester.

Student Competitions: There are a number of national competitions that are sponsored with various government and non-government organizations and are tailored mostly towards the application and synthesis of Mechanical Engineering concepts to various engineering projects. One such program is the “Great Moonbuggy Race” sponsored by NASA Marshall Space Flight Center. It is believed that participation of the students in these completions will increase the exposure of the students to other fellow mechanical engineering students and hence will motivate them in pursuing their careers. On the other hand, participation in the competitions will give the students a hands on experience in which they can appreciate the classroom knowledge and it’s application to real-world engineering problems. Indeed it is observed that the participating students have enhanced their performance in various courses. It is therefore imperative to gain funding for such competitions on a permanent basis. Faculty within the department is encouraged to write proposals to secure funding in support of such competitions.

Participation in Summer Internship Programs: Summer internship programs have similar affect as in Student Competitions. Students participating in summer internship are able to enhance their class performance by applying their class room knowledge to real world engineering problems that are of interest in the government and industries interest. Past few years several of the ME students have been able to participate in the programs sponsored by Oak Ridge National Laboratory, NASA Marshall Space Flight Center, and Rolls Royce Corporation to name a few. One additional measure may be implemented to further harness the benefits of the Summer internship program. That is if an additional seminar or class is included in the ME curriculum so that the students who have participated in the program may present their research work (provided that their research is not subjected to export or copy rights of the organization) and expose other students to the real world engineering problems. It is believed that such class would prove to be extremely valuable for retention, especially retention at the Freshmen and Sophomore level.

Participation in financially supported projects: Financially supported research projects attract prospective students in the programs and, thus, increases the number of eventual potential graduates that include under-represented minorities. These potential graduates would be useful hands in the interdisciplinary fields involving science, mathematics, and or engineering. The existence of financial support to the under-represented minorities is an attractive feature to enhance retention rate at the sophomore level for concentrating studies in engineering disciplines. Citing evidence of project oriented financial support for the students is an attractive technique for motivation. This motivation assures students in multi task projects and thereby builds strength. This strength reflects students’ learning and directs them towards completing their educational goals in engineering. In a true sense these potential graduates may involve in as many multidisciplinary tasks as they may encounter in the working arena.

SUPPLEMENTAL TEACHING AIDS

Multimedia techniques for teaching over the internet, or teaching via video are being widely used by many schools within the past few years. Engineering core courses such as Statics, Strength of Materials, Fluid Dynamics, etc. are more easily taught and understood by direct student-

instructor interaction. Since teaching such courses relies heavily on drawing free-body diagrams, sketches, and writing of equations, the dynamic interaction between the instructor and the student becomes almost a necessity. On the other hand the amount of material needed to be covered in these courses dictates the instructors to teach them at a relatively fast pace that may result in a shorter time per concept ratio. Therefore, a development of Supplemental Teaching Aids (STA) will be beneficial in understanding engineering topics as stepwise comprehension of engineering concepts in the essential part of the learning process. Such tool is particularly effective for classes with a large enrollment.

Technology has reached a level at which computers are abundant within the campuses, and in fact many students own a personal computer or a laptop. The inexpressiveness of memory and hard disk spaces has made it possible to store large files (on the order of 100 MB) quite easily. With the addition of multimedia features in PowerPoint and popular word processing software, it is possible to develop tools to assist students to better understand the engineering topics. Features such as flybys, step-by-step addition of images to a slide and narrations has made it possible to present the topic in a simple and understandable format.

In many cases when the students have difficulty understanding the concept, it is necessary to see the instructor for further clarification of the topic. Often the instructor's office hours may not match the students schedule and in many cases the students might simply dismiss a meeting with the instructor to discuss the topic. One method of addressing this issue is to utilize Power Point presentation to develop teaching aids that is specific to a given topic for each course. The power point presentation will utilize the multimedia and especial effects such as narration, etc. to explain the topic.

A library of topics for each course would explain a particular topic clearly to students without the physical presence of the instructor and is beneficial for the understanding of the topic in more depth. A sample of a supplemental teaching tool used in the class for ME 231- Mechanics of Materials is shown in Appendix A. Feedback was taken from a pool of 25 students regarding the usefulness of this tool. A copy of the survey used is attached in Figure 2. To establish a better understanding of the impact of the teaching tool on the students' understanding of the topic a number of factors were considered in the survey tool such as (1) whether or not the topic was new to them, (2), do they own a personal computer or have access to one, (3) was the material covered in class clear before they use the STA, (4) and finally did they feel material was more clear to them after using the STA.

CONCLUSIONS

In this paper the effect of using a Supplemental Teaching Aids (STA) that are user-friendly and highly accessible to students was developed for the mechanical engineering majors. This teaching aid was developed due in part to the difficulties that the students experience in the core courses like Statics, Dynamics, and Strength of Materials. Microsoft PowerPoint Presentation is selected as the development environment. The tool developed accompany a particular topic in the Mechanical Engineering courses and utilized the advanced features of the PowerPoint such as flybys, narration etc. to present the selected topic in a simple, step-by-step, and easy to understand manner. In this case a topic in ME231- Strength of Materials course was selected as

a test bed. At this stage there is no data regarding the effectiveness of the tool on the retention rate of the students. Approximately 20 students were selected to participate in the survey that assessed their understanding of the selected topic. Preliminary feedback based on the survey given to the students indicates the teaching aid developed along with the lecture will enhance the retention rate within the Department of Mechanical Engineering. It will also enhance the quality of education as well as learning process for selected topics in Mechanical Engineering Courses. Initial results indicate that further development of such tool will enhance the educational quality within the AAMU.

Appendix A- Sample Survey form.

Biographical Data:

Rank: Freshman Sophomore Junior Senior

GPA? 3.5-4.0 3.0-3.5 2.5-3.0 2.0-3.5 below 2.0

Please answer the following questions:

1	Did you receive the supplemental Learning Aid for this topic?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2	Do you own a personal computer that could be used with the supplemental Learning Aid?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
3	If you do not own a personal computer could you access one easily?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
4	Is this the first time that you are taking this course?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
5	Is this the first time that you are exposed to this topic?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
6	Were the material explained inside the classroom clear?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
7	Did you use the supplemental learning Aid in addition to the material explained within the classroom?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
8	Did you do the homework without or with using the supplemental Learning Aid?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
9	In general how comfortable do you feel with this topic if you used the Supplemental Learning Aid? Rate from 1-10		

Comments:

APPENDIX B

Slide 1

Positive Convention for Analysis of Beams

If you analyze the members from left to right for shear, downward direction is positive and for moment, counter clockwise (ccw) direction is taken as positive

If you analyze the members from right to left for shear, upward direction is positive and for moment, clockwise (cw) direction is taken as positive

Slide 5

Driving Shear Equations

Consider the first section: $0 \leq x \leq \frac{L}{2}$

$$\Sigma F_y = 0$$

$$V - \frac{F}{2} = 0 \quad \text{or} \quad \boxed{V = \frac{F}{2}}$$

Next consider the second section $0 \leq x \leq L$

$$\Sigma F_y = 0$$

$$V + F - \frac{F}{2} = 0 \quad \boxed{V = -\frac{F}{2}}$$

Slide 2

Example 1

Consider the beam shown in the following figure.

The beam is supported at ends A and B and a force of Magnitude F is applied at the center of the beam.

Our objective is to draw the shear and bending moment diagram for this beam.

Slide 6

Plotting the Shear Diagram for the Beam

Slide 3

Calculating Reaction Forces

The first step is to calculate the reaction forces at A and B. From Symmetry it is evident that both R_A and R_B are equal To $F/2$. We can also calculate the reaction forces by:

$$\Sigma M_A = 0 \quad \Sigma F_y = 0$$

$$F \frac{L}{2} - R_B L = 0 \quad R_A + R_B = F$$

$$R_B = F - R_A = F - \frac{F}{2} = \frac{F}{2}$$

$$R_A = \frac{F}{2}$$

Slide 7

Moment Equation for $0 \leq x \leq \frac{L}{2}$

Valid for: $0 \leq x \leq \frac{L}{2}$

$$\Sigma M = 0$$

$$M - \frac{F}{2}x = 0$$

We draw the free body diagram (FBD) for the beam: The external Forces and Moments are ... $F/2$ at the support and ...

The moment M at the point where the beam is cut. We denote the distance from origin to the point of cut as x. We are now ready to write the moment equation: $\boxed{M = \frac{F}{2}x}$

Slide 4

Examining Shear Loads

Slide 8

Plotting the Moment Diagram for the Beam

Figure 1. Sample of PowerPoint presentation used as a supplemental teaching aid. The example shown here is about analysis of beams which includes narration, and flybys (not shown here).

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