Impact of Learning by Objectives in Design & Manufacturing Courses

Basel Alsayyed Ahmad
Department of Mechanical Engineering
United Arab Emirates University
Al Ain, UAE
balsayyed@uaeu.ac.ae

Abstract

In this paper the author presents an experiment for teaching advanced design and manufacturing courses with the objective to maximize the learning experience based on course outcomes. A design and manufacturing course was selected to run the experiment with two male sections and two female sections. The course outcomes were drafted based on the mechanical engineering program objectives. The focus is on fulfilling as many of the program outcomes as possible, however, the level of fulfilling a program objective by a course outcome is also monitored. This paper focuses on increasing the hands on experience of the students as well as introducing more computer and technology content in the course. Every activity will be evaluated quantitatively and qualitatively. Based on the progress in a regular semester, the students' performance is monitored and adjustment of theory versus practical experience is done accordingly. Initial results reveal that the sooner the practical part of the course is introduced the better results will be for both understanding the practical as well as the theoretical part of the course.

Keywords
ABET, educational strategies, teaching design and manufacturing, theory vs. practical

Introduction:
As more and more programs in universities all over the world are switching towards learning by objectives, it is becoming a need to have the relationship between objectives and course activities established and controlled. In this paper focus is on identifying what matters most for the learning process. Teaching students in the 21st century is ought to be different from last century. Students are more computer oriented than ever before. They can engage more with computer related activities than just abstract theories. In the future, the role of engineers must change. As more focus is shifted to small and medium companies, however, global and with entrepreneurialism as the main stream for future of engineering employment. As UAE is trying to build a knowledge-based "services" economy, engineering education has to change and more technology in the education and work of the engineering has to be introduced.

In this paper the author has monitor the performance of students in a learning environment, which is unique to the United Arab Emirates University. Male and female students have different campuses, however, taught by same instructors and use shared labs. The focus is on many objectives:

1) Male versus female performance in the practical part of the studied courses
2) Compare the performance of all students (males and females) with different teachers
3) Performance during the semester versus the midterm and final exam

Linking the learning strategy to the learning outcomes and to the program outcomes is essential in ABET accredited programs. Many feedback models were sited in literature. Thurlings [1], studied the different feedback models and their impact on the effectiveness of feedback and feedback processes. His findings show "that regardless of the learning theory effective feedback is goal- or task-directed, specific, and neutral". Strobela [2], studied the role of authenticity in design-based learning environments. He examined current conceptualizations of authenticity as principles to design learning modules and environments within engineering education as well as proposed a systematical model for authenticity. His focus was on pre-college engineering education. Sunthonkanokpong [3], studied the socio-technological challenges, engineering education must anticipate and adapt to dramatic changes in terms of engineering practice and instruction. Downey [4], studied the fundamental challenge to the jurisdiction of engineering work and the rapid technological change posed on the engineering education in chemical engineering and

other engineering fields. He proposed to integrate the problem definition into the engineering education. Winging [5], presented a strategy for continuous education in engineering. He stressed the need for a country policy and the need to improve on teachers' quality and strengthening the link between the university and the enterprise. Brown [6], studied the understanding of feedback by teachers and its influence on the type and quality of feedback that they provide. He studied 518 New Zealand practicing teachers feedback and related to practices these teachers considered to be feedback. Nine feedback factors and four practices factors were identified and studied statistically and concluded that "New Zealand teachers' understandings of feedback were strongly focused on improving learning instead of enhancing student well-being".

This study focuses on a mechanical engineering course as an example for developing the strategy for teaching mechanical engineering courses. All current literature points towards the need for change. The proposed strategy to include practical and computer integration in the mechanical courses taught to engineering students of today to prepare them to be the engineers of tomorrow.

Mechanical engineering program:

The department of mechanical engineering at UAEU offers a very distinguished general mechanical engineering program to graduate students as mechanical engineers with no specific field within mechanical engineering. Although the program has four different baskets for students to select four elective courses from, still the degree awarded is a bachelorette of science in mechanical engineering. This study selected the "Introduction to Computer Aided Manufacturing" course to analyze the performance of students in four different sections the course were offered in the past four years.

Collected Data:

The data for four groups (sections) of students over the past four years have been collected. A different instructor teaches each section and two sections were male sections and the other two were female sections. The tables below show the collected data. The data includes the course work during the semester that is mainly the lab work related to CNC-programming and CNC-manufacturing. It also includes the midterm and final grades separately. Minitab is used to help analyze the data and graph relevant relations among the data. Table 1 shows the grades for the first instructor. This data is for a female section.

Table 1: First Instructor Grade Report, Female Section

Student No.	Course Work	Mid Term	Final	Total
Student # 1	56.7	14.25	21.5	92
Student # 2	54.5	15	20.3	90
Student # 3	55.5	12.9	23.3	92
Student # 4	53	12.75	18.8	85
Student # 5	56.7	15	25	97
Student # 6	55.8	15	21.3	92
Student # 7	48.8	13.5	17.5	80
Student # 8	52.8	14.7	19.3	87
Student # 9	49,0	14.4	22.8	86
Student # 10	55.1	13.95	20.5	90
Student # 11	57	11.7	23	92
Student # 12	54.7	15	24.8	94

Table 2 Shows The Grades For The Second Instructor. This Data Is For A Female Section.

Table 2: Second Instructor Grade Report, Female Section

Student No.	Course Work	Mid Term	Final	Total
Student # 1	55	15	21	91
Student # 2	58	14	18	90
Student # 3	53	17	20	90
Student # 4	59	13	18	90
Student # 5	54	13	20	87
Student # 6	51	13	17	81
Student # 7	56	18	19	93
Student # 8	57	14	15	85

Table 3 Shows The Grades For The Third Instructor. This Data Is For A Male Section.

Table 3: Third Instructor Grade Report, Male Section

Student No.	Course Work	Mid Term	Final	Total
Student # 1	47	13	20	80
Student # 2	47	18	22	87
Student # 3	44	14	19	77
Student # 4	46	16	20	82
Student # 5	47	17	21	85
Student # 6	48	18	25	91
Student # 7	46	13	16	75
Student # 8	46	16	18	80
Student # 9	47	17	26	90

Table 4 Shows The Grades For The Fourth Instructor. This Data Is For A Male Section.

Table 4: Fourth Instructor Grade Report, Male Section

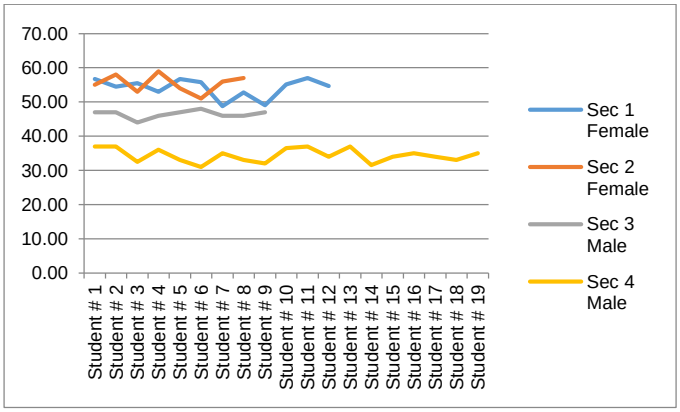
Student No.	Course work	Mid term	Final	Total
Student # 1	37	22	26	85
Student # 2	37	24	29	90
Student # 3	32.5	21	21	75
Student # 4	36	21	23	80
Student # 5	33	21	28	82
Student # 6	31	21	28	80
Student # 7	35	23	27	85
Student # 8	33	19	23	75
Student # 9	32	17	24	73
Student # 10	36.5	25	28	90
Student # 11	37	24	35	96
Student # 12	34	24	27	85
Student # 13	37	22	25	84
Student # 14	31.5	23	23	78
Student # 15	34	14	19	67
Student # 16	35	17	20	72
Student # 17	34	20	23	77
Student # 18	33	23	21	77
Student # 19	35	22	19	76

Data Analysis:

Below in table 5 all the course works during the semester for all the section, males and females from the different instructors are shown. In graph 1, it is obvious that regardless of the instructor females performed during the semester better than males. However, different sections performed relatively different with the biggest different highlighted by section 4 performance. Many other factors could have made the difference, i.e. the instructor, the size of the class.

Table 5: Course Work for All Sections

Student No.	Sec 1 Female	Sec 2 Female	Sec 3 Male	Sec 4 Male
Student # 1	56.70	55	47	37
Student # 2	54.50	58	47	37
Student # 3	55.50	53	44	32.5
Student # 4	53.00	59	46	36
Student # 5	56.70	54	47	33
Student # 6	55.80	51	48	31
Student # 7	48.80	56	46	35
Student # 8	52.80	57	46	33
Student # 9	49.00		47	32
Student # 10	55.10			36.5
Student # 11	57.00			37
Student # 12	54.70			34
Student # 13				37
Student # 14				31.5
Student # 15				34
Student # 16				35
Student # 17				34
Student # 18				33
Student # 19				35

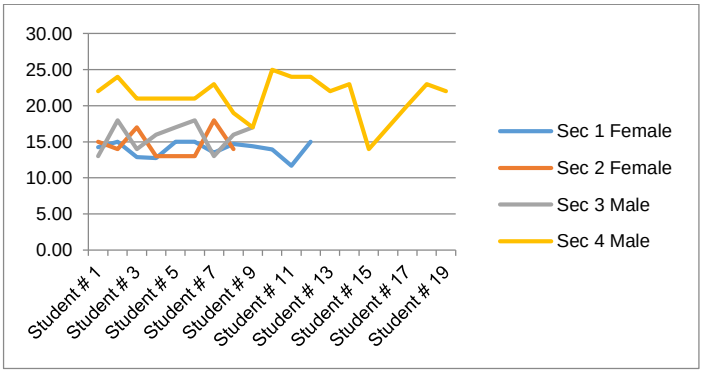


Graph 1: Course Work for All Sections

In table below the data for the four sections is listed to analyze the performance of all sections based on midterm results.

Table 6: Midterm For All Sections

Student No.	Sec 1 Female	Sec 2 female	Sec 3 Male	Sec 4 Male
Student # 1	14.25	15	13	22
Student # 2	15.00	14	18	24
Student # 3	12.90	17	14	21
Student # 4	12.75	13	16	21
Student # 5	15.00	13	17	21
Student # 6	15.00	13	18	21
Student # 7	13.50	18	13	23
Student # 8	14.70	14	16	19
Student # 9	14.40		17	17
Student # 10	13.95			25
Student # 11	11.70			24
Student # 12	15.00			24
Student # 13				22
Student # 14				23
Student # 15				14
Student # 16				17
Student # 17				20
Student # 18				23
Student # 19				22

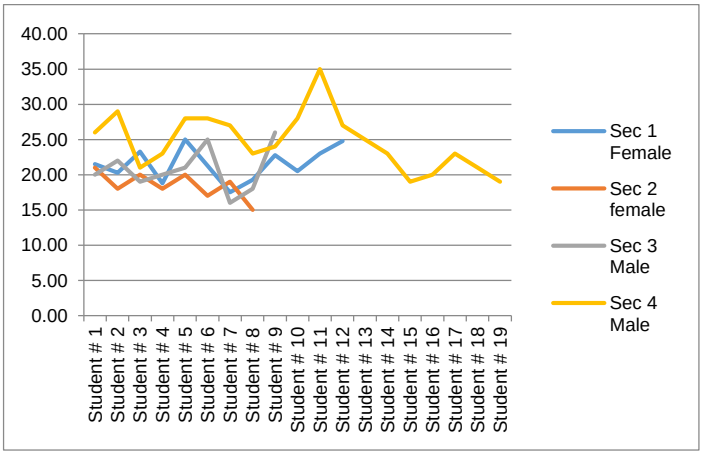


Graph 2: Midterm for All Sections

Based on the midterm, section 4 outperformed all other sections. In general when students thinks they are doing ok, they relax and thus their performance start going down. On the other hand, if they think they are doing bad they start putting more effort and thus their performance improves. In table 7 below the final grades for all sections are listed and in graph 7 all results are shown for the different sections.

Table 7: Final Exam For All Sections

Student No.	Sec 1 Female	Sec 2 Female	Sec 3 Male	Sec 4 Male
Student # 1	21.50	21	20	26
Student # 2	20.30	18	22	29
Student # 3	23.30	20	19	21
Student # 4	18.80	18	20	23
Student # 5	25.00	20	21	28
Student # 6	21.30	17	25	28
Student # 7	17.50	19	16	27
Student # 8	19.30	15	18	23
Student # 9	22.80		26	24
Student # 10	20.50			28
Student # 11	23.00			35
Student # 12	24.80			27
Student # 13				25
Student # 14				23
Student # 15				19
Student # 16				20
Student # 17				23
Student # 18				21
Student # 19				19



Graph 7: Final Exam for All Sections

Relatively the performance for all sections is not different. However, still section 4 is relatively better.

As more and more technology is getting into our life, our students are not an exception. Students are the core of all the educational process. The new strategy is based on recognizing the student's ability in computer and communications technology. Based on the new students' capabilities, the course method of teaching has to change. The new strategy raises one level above the current traditional strategy. It is a very establish fact that the engineer of today have much resources and materials available for his use that few decades ago; hence, it will only be more in the future. Thus the challenge is not to make the students get into an endless stream of information and knowledge about a certain topic, and get over swamped without the actual know how of how to use this info and knowledge. Also, having student to do things by their hands is more interesting to them than just learning theories, it is suggested as part of the new strategy to introduce the practical part of the course as early as possible to the attention of the students and interest. The new strategy calls for different info and knowledge to be structured such that it is handy to be used per need, including the theoretical versus practical parts. Classification and ontology of the knowledge is paramount for the efficiency of the future engineers. As the above studied example, the author expects that other courses behavior is

similar if not the same. However, before implementing the new strategy a huge groundwork is needed. When the student enters the college, the freshman courses should gradually get him/her into the mode of a new way of studying. Memorization does not help much. However, understanding and ability to apply the learned knowledge is what will shape up the future engineer and distinguish one engineer from others. The author is currently working on restructuring some courses to fit the new strategy. The course outcomes are re-interpreted to fit the new strategy and also and a follow up mechanism with graduating engineers to get their feed in the course is sought.

Conclusion

This paper studied 4 sections of the introduction to CAM course performance. It looks at the males and females sections with different instructors. Results show that the performance is relatively not different. However, as more technology such as WhatsApp, Facebook and Instagram is introduced and integrated into the learning process; it shows that students are more engaged and enthusiastic about the learning process. Furthermore the instructors are able to follow up with the students more on their progress and making sure that the objectives are fulfilled as the course is progressing. The author is introducing the use of more technology as well as an extensive classification of the knowledge in the course area to be able to teach the students how to use the needed knowledge to fulfill the objectives of the course. The student will graduate from the course not only with the basic knowledge in the course, but also with the keys to open up the right box of knowledge for the real life problem when at work.

References

1) Marieke Thurlingsa, Marjan Vermeulenb, Theo Bastiaensa, Sjef Stijnena, 2013, Understanding Feedback: A Learning Theory Perspective, Educational Research Review, 9:1–15.
2) J. Strobela, J. Wanga, N.R. Weberc M. Dyehoused, 2013, The Role of Authenticity in Design-based Learning Environments: The Case of Engineering Education, Computers & Education, 64:143–152.
3) Wisuit Sunthonkanokpong, 2011, Future Global Visions of Engineering Education, Procedia Engineering, 8:160–164.
4) G. Downey, 2005, Are Engineers Losing Control of Technology: From 'Problem Solving' to 'Problem Definition and Solution' in Engineering Education, Chemical Engineering Research and Design, 83/6:583–595.
5) Wenjing Li, 2012, The Status and Developing Strategy of China's Continuing Engineering Education, Procedia Engineering, 29:3815–3819.
6) Gavin T.L. Brown, Lois R. Harris, Jennifer Harnett, 2012, Teacher Beliefs About Feedback Within an Assessment for Learning Environment: Endorsement of Improved Learning Over Student well-being Original Research Article, Teaching and Teacher Education, 28/7:968-978.

Biography

Dr. Basel Alsayyed is an assistant professor at the department of mechanical engineering in the United Arab Emirates University. With over 16 years of experience in academia in many colleges and universities, and over 12 years of industrial experience, most of which are in the American automotive industry, Dr. Alsayyed has a passion for education in general and teaching in particular. Teaching is an art, a trust, a valuable transformation of students using certain methods and tools, and it is holy, are all part of his belief. He practices it in all aspects of his life, and to Dr. Alsayyed, students are the most valuable element in the education process; their needs have to be addressed in any continuous improvement discussion of the education process. Integration of academia and industry goals and activities are paramount. Sensing the industry needs and prepare future engineers to meet the challenges is an important dimension of Dr. Alsayyed's activities. Dr. Alsayyed research interests are in the areas of advanced manufacturing, quality & reliability, renewable energy, engineering education and knowledge management.