
AC 2012-5460: TEACHING FRESHMEN ENGINEERING DESIGN VIA HYBRID MODE: A CASE STUDY IN THE MIDDLE EAST

Dr. Jaby Mohammed, Petroleum Institute

Jaby Mohammed is a faculty at the Petroleum Institute, Abu Dhabi, UAE. He received his Ph.D. in Industrial engineering from University of Louisville (2006), master's in industrial engineering from University of Louisville (2003), and also a master's in business administration from Indira Gandhi National Open University (2001). His research interests include advanced manufacturing, design methodologies, Six Sigma, lean manufacturing, and enterprise resource planning. He previously taught at Indiana University-Purdue University, Fort Wayne in Indiana and at Morehead State University in Kentucky. He is a member of IIE, SME, ASQ, ASEE, and informs.

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Introduction

The mission of The Petroleum Institute is to provide world-class education in engineering and applied sciences in order to support and advance the petroleum and energy industries. The Institute is committed to academic excellence, and to fostering an intellectual environment that leads to the development of graduates as whole persons and as the future leaders in their respective fields of expertise in the oil and gas sector of the United Arab Emirates and beyond. One of the goals to achieve in a graduating student is that he/she should acknowledge that technologies, economies and societies are in a continuous state of evolution, and should therefore have the flexibility to manage a career path that changes over time, and that is supported by life-long learning, critical thinking, teamwork, leadership and the ability to span several disciplines.

Hybrid programs have expanded well beyond the liberal arts program. Many engineering schools have adopted hybrid programs for many reasons some might be into cost benefits and for some it would be for better academic experience for students^{1,2}. Most of the online education or hybrid course offering had been at the master's and certificate level. Limited activity has been noted at the Ph.D. and pre-engineering level^{3,4} this case study had been directed towards the freshmen engineering design course. In this paper authors would discuss how they used the hybrid program to work on one of the sub goals set by the institution.

The course that is chosen for the hybrid program is the freshmen engineering design course. Since many engineering educators have recognized project based learning, service learning, and freshmen engineering projects have lasting impact on students learning compared to the traditional classroom set up. In this paper authors would discuss about the project based course, its objectives, transforming the project based course to hybrid course, and also the different content areas of the hybrid course.

Background

The Petroleum Institute

The Petroleum Institute (PI) was created in 2001 with the goal of establishing itself as a world-class institution in engineering education and research in areas of significance to the oil and gas and the broader energy industries. The PI's sponsors and affiliates include Abu Dhabi National Oil Company (ADNOC) and four major international oil companies. Currently the PI offers Bachelor degrees in Chemical, Electrical, Mechanical and Petroleum Engineering, Metallurgical and Polymer Science & Engineering and Petroleum Geosciences; Master of Engineering degrees in Chemical, Electrical, Mechanical and Petroleum Engineering and Master of Science degrees in Chemical, Electrical, Mechanical and Petroleum Engineering and Petroleum Geosciences. These programs are open to both male and female students, with an annual enrollment of 1000 students with a 70/30 split between male / female engineering students. The student population consists of 70% local students and 30% expat students from other countries in the Middle East and Asia. The medium of instruction is English.

The STEPS Program

Strategies for Team Based Engineering Problem Solving Program (STEPS) is freshmen engineering program at The Petroleum Institute. There are two levels of STEPS courses, in the first level of the STEPS course is more real life problems and in the second level of the course is more of a theoretical approach with computer simulation and analysis. Both the course level is core courses to be taken in succession.

The aim of the STEPS program is to introduce and expose students to the engineering design process and integrate a range of skills and competencies that will simulate project management and real-world design activities in a professional engineering environment.

This program requires teams of students to respond to client specifications by designing, managing and presenting technically feasible solutions to real-world problems. The program aims to facilitate good engineering practices with a strong focus on behavioral competencies and communication skills. Teamwork, organization, planning, research skills, and problem solving are essential for success. All students are actively engaged in teamwork and solving open-ended problems using methodical approaches and state-of-the-art design and communications tools.

During the semester, students also regularly present the results of their project work using oral, written and graphical communications skills. The progress and development of each team project and each student's contribution is closely monitored and evaluated by experienced PhD qualified engineering design experts and qualified English communication specialists for the purpose of providing helpful feedback and advice to improve project work, communication skills and presentation skills.

Development of practical skills

Primarily the STEPS courses help the students develop life-long learning habits, independent learning, ethics, project management (cost, risk, time, and even conflict management), and research. STEPS courses tend to achieve both through the experiment as well as through training, which would be useful in the workplace and in future careers in engineering. Some of the new specific skills that students develop in the STEPS program are:

- Identifying, clarifying and defining problems and specific needs of 'the client'
- Defining specific objectives, constraints, functions, requirements and metrics
- Generating and analyzing several different alternative solutions or means without bias, then selecting or forming the best possible solutions in a methodical and objective manner so that all project objectives, constraints and requirements are satisfied. i.e. Using divergent (creative) and convergent (analytical) thinking and analysis skills to select, develop, design and refine an effective, feasible and efficient solution based on specific metrics and successful design practices.
- Working productively and efficiently as team members, developing good rapport and trust, effective leadership, communicating effectively to achieve desired results, assigning tasks fairly, resolving conflicts and achieving win-win outcomes.
- Project management tools and techniques

- Reverse engineering
- Conceptual design sketching
- Computer modeling
- Integration and application of engineering design, analysis and problem-solving skills from several different subjects to solve project-related problems.
- Creating, presenting and delivering high quality seminars, posters and websites to showcase and summarize the team's work or progress.

One of the most credential things about this design course is that it is team-taught, which means there are two faculties who teach the class. One faculty would be communication faculty and second faculty would be engineering faculty. Students are given to solve the problem using design process; students solve problems in teams and communicate results to both clients and professors. Each project and the communication experience are designed to build the independent learning skills to improve the problem solving, team, and communication skills of each student. STPS 201 which is the first course in a two-course sequence introduces students to engineering design and problem solving in a project-based learning environment. Solutions to engineering problems are developed through a process that has a number of phases beginning with conceptual design and culminating in detailed design. During the conceptual design phase the focus is on understanding the nature of the problem and the client needs, exploring possible solutions of the problem and deciding on a solution that is worthy of follow up analysis. This solution, in the form of an abstract idea is called a “conceptual design”. In the following design stages an embodiment of the abstract design idea takes place. This involves transforming the abstract ideas into physical components, subsystems and systems, analyzing and testing the embodied design ensure that the solution will provide the desired outcomes. As you may expect, designers often iterate between conceptual design and embodiment design before settling down on a final design. The final design is specified in technical terms that allow it to be manufactured.

There are numerous tools and techniques that students would use in generating conceptual design. Students would work in teams to manage project and complete the required tasks and finally communicate the understanding to the client through written documentation, graphics design and oral presentations. The skills you learn by doing are useful throughout the student life and career.

Course Structure

The course is modular in organization, with a five-week introductory module to familiarize the students with the elements of the engineering design process and how to apply these in a guided project.

In the second module the student will work in teams to solve a real-world engineering design problem. Instructors would assign final deadlines so that the students are provided with the necessary information. Students then provide the instructors and clients with the documentation and presentations to show the quality of the understanding of the project and the approach used

in developing an effective design. The table below shows the assignments the students would do and deliver to the instructors, throughout the course. Some of the deliverables are individual and some of them are team based (mentioned as Type in the table), and weightage on the course is also provided in the table 1.

Student assignment	Type (I / T)	Weight
Project Proposal	T	8
Project reviews – 2	T	10
Poster	T	5
Final Presentation	T	5
Final report	T	20
DRS	T	5
Learning assessment / Journals	I	16
CAD Labs	I	5
Graphics assessments	I	15
Team work evaluations	I	4
Research	I	7
TOTAL		100

Table 1: Points allocation

This class is taught in a mix of traditional lecture format and studio format. The lectures are mainly used in the graphics lab and at the beginning of the first module where the design process is taught. For the rest of the class, students are expected to actively participate in classroom discussions, team design activities, and team presentations. The faculty will act as coaches or mentors who will lead and supervise the discussions. Students will learn by observing the results of others and by sharing contributions with team members. However, what students learn will depend directly on their willingness to participate and your preparedness for the class through reading the required material and research.

Traditional to hybrid

There are various skills that are developed throughout the course. Project management skills, use of technology skills, communication skills are some of the skills that are developed throughout the course. The freshmen design course is a course that is done in a team and often instructors find it difficult to identify students who are hidden within the team with out doing any work since often times peer assessment doesn't work as efficiently as it should. In order to solve this many of the topics are monitored through blackboard. As discussed earlier the courses focus on problem solving, report writing, presentation skills, project management, teamwork and independent learning. The intention of developing a hybrid course was neither cost reduction, nor for the convenience of adult working students, rather trying to teach students to be independent learners and be proficient with the technology and also to make sure that the students contribute to the project.

Teaching the hybrid course can be a little challenge for the first year since it requires different teaching skills, redesign the course, managing the contents of the course for both online as well as for face to face, and also to prepare students to work in the hybrid format, assist students with the use of technology and also making sure that the students work on time and keep track of the activities.

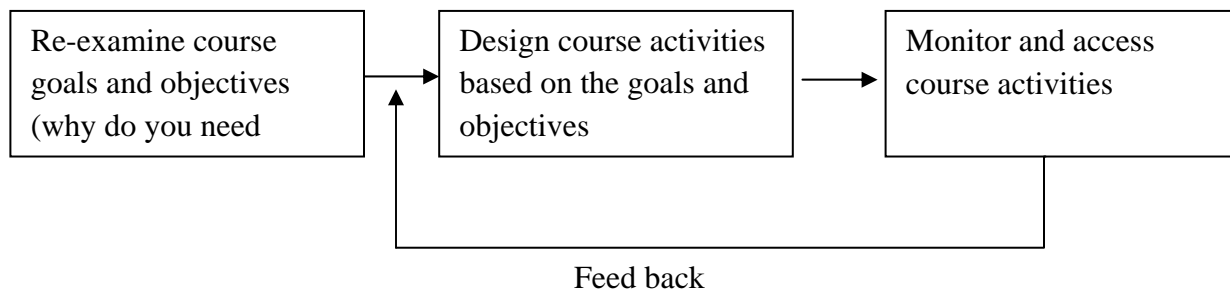


Figure 1: Designing hybrid courses

Managing the dual learning environment

To be successful in the hybrid course, the first thing that was set was to re-examine the course goal and objectives. Then the activities for the learning environment was designed based on the goals and objectives. Figure 1, shows the flow chart for involved in designing hybrid courses. To be successful in teaching hybrid courses the online activities must be effectively integrated to face to face meetings and the lecture and presentation slides should be made more students centered.

Revisiting course goals and activities planned on blackboard

The first and the foremost activity that was looked were the course goals. Independent learning, ethics, project management, and technical communication are some of the areas that were looked on while revisiting the course goals. For instructor blackboard was a medium of communication to the students and also a place to store the student work.

Journal entries on the blackboard

As discussed earlier in the first module students are taught about the design process, guided through a design project, they are also taught how to use blackboard as a tool for this course. In the first five weeks students are required to enter journal entries on the blackboard so that they get to use the technology and should be confident enough to progress after the five week. The students are required to keep an e-journal in the STEPS course, which they have to update every week. That means students have to write a short description/explanation each week of the main points that have been covered in the class for the first five weeks, this will show the instructors how well they have understood the key concepts being presented in the first module of the course. It will also act as a diagnosis of their writing and help in identifying any problems that

they may have. You will write one entry a week; dated and titled. This will be checked each week by the instructor and formative feedback will be given. Topics for the entries will be the main ones covered in the class that week. Specific guidance are be given by the instructors. Sometimes students are also advised to go to the writing center or to schedule a meeting with a faculty member. In order to produce an effective journal, students are advised to take notes in class. At the end of each week you will be given class time to write a short journal entry which you will submit to the instructors. You will receive formative feedback on this.

An instrumental value of the e-journal is that goes together with class input and out-of-class reading to help develop student understanding of key concepts in the engineering design process. In turn this will help students produce a better project and increase the likelihood of a better performance in the written assessment at the end of the module. The journal entries helped the student to be focused every week during the semester and also helped them improve their technical writing skills.

Discussion

After the end of the first module, students are divided into different team. Each team would have their own space on blackboard exclusively for them; they can use the same for discussion, file sharing, project management activities, chat, email etc. Both the instructors are also listed in the team so that they can view what happens within each team. The common rule in the discussion is that each student has to comment at least twice for the thread that is initiated in the discussion, which makes student to participate in the discussion. So in an online classroom, there is no place to hide so the students become more responsible than in a face-to-face discussion, instructors also felt that they are more connected with their students and are able to know them better since they communicate with them both by online and face-to-face, there were more integration of in class activities to activities that was done outside the class room.

Project management

Another skill that was developed and monitored through the blackboard was the project management skills. The individual management skills as well as the team management skills were efficiently accessed through the hybrid medium. The submission of assignments and deliverables are all monitored so that all the required materials are submitted before the deadline. There is a lot of independent learning that happens along with the project. Students were expected to independently extend their learning of the project by means of research related to the project through a virtual learning environment. A wide collection of eBooks, book chapters, journal articles, conference proceeding were also made available to students which enhanced there independent learning skills. The student activity in the blackboard was also monitored to see how much work they have done.

Knowledge and skills acquired

The goal behind developing the hybrid course is to increase the skill set. The hybrid course helps in the critical thinking, independent thinking, and better project management skills to manage complex projects and assignments. The students were able to achieve the following:

- Identify the areas needed for research and report the same in their journal entry
- More team interaction and students were found to be more responsible in their work
- Submission of assignments through blackboard are run through Turnitin plagiarism software, which makes them aware of ethics requirements
- Students learn to value what they know will be assessed. The online format class made it easier to focus students on material of importance and priority. For each assigned task, students prioritized their work and for team assignments they divided their tasks and all the information was available for the instructor on the blackboard.
- Meeting the deadlines for deliverables
- Appropriate use of technology

Conclusion

The globalization has changed how things are done in rapidly evolving technologies which requires future engineers to be prepared to process more technical knowledge in a shorter time with the use of technology. This paper has presented a case study of using hybrid teaching in a project-based course for freshmen engineering students at The Petroleum Institute, Abu Dhabi, UAE. It provided an in-depth view of the course information and various learning approaches that happen in a hybrid medium as compared to the traditional approach. Traditional engineering education classes make students play more of a passive role than taking more active participation. The utilization of resources available through blackboard clearly shows the strengthening of student awareness. The hybrid approach has clearly helped to improve students' approach to project goals, tasks, communication, observation learning, and learning from peers, and also means to overcome the challenges.

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