Journal of Engineering Education Transformations,
Volume 30, No. 3, January 2017, ISSN 2349-2473, eISSN 2394-1707

Personalized assignments to address skills in a heterogeneous classroom: A case study of a course on 'Smart grid technologies '

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Abstract: Engineering colleges in India, today are moving towards Outcome Based Education. One of the aims of OBE is to create a learning-centric environment for the students. A major challenge in Indian institutions is the wide variety of students who enrol to engineering colleges, with varying skills, interests and backgrounds. The general concept in traditional environments is to have common tests and assignments for all the students. This often leads to frustration in the students as they may not have the necessary skill set or interest to do the assignment. This paper presents the concept of creating personalized assignments in a course on Smart Grid Technologies and allow the students to choose what they want to do, based on their interest. Having different kinds of assignments, also helps in achieving more program outcomes than would be possible with homogeneous assignments. The feedback from the students is indicative of the need for and success of the experiment on personalized assignments.

Keywords: personalised assignments, OBE, heterogeneous class room, graduate attributes

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1. Introduction

In undergraduate engineering courses, we rarely give a thought to the diversity of student interests [1]. In school, students have a mixture of subjects including social sciences, physical sciences, biological sciences, mathematics and languages. Therefore a student, has avenues to channelize different interests and creative instincts. We find some excel in science, some in language,and some in mathematics and so on. When it comes to higher education in India, the choices and diversity are narrowed down. In typical Indian curriculum for undergraduate engineering program, across the country, we rarely find opportunities in the curriculum for students to showcase diverse interests. Most often, they are forced into the engineering stream by parental or peer pressure. Added to this, the monotonous nature of the subjects, it is not surprising that students exhibit lot of boredom and their learning experience is limited to their placement opportunities.

In this scenario, it is possible to introduce different assignments in engineering subjects [2], [3], so that students have an option to choose one of their choice.In a theory course in most of the engineering disciplines, a typical assignment would normally consist of one of the following:

(i) A set of numerical a student has to answer

(ii) A presentation to be made in a topic related to the subject

(iii) A set of questions to be answered by the student

The first option is normally exercised when teaching subjects which have a mathematical orientation, such as Signals & Systems, Electromagnetic Field Theory, Digital Signal Processing, Control Systems, etc. [4], [5], [6]. In these subjects, the students often fail to relate the mathematics to the physical system. It has been observed that while, the students can deftly solve a problem, and they are unable to give a physical interpretation to the numbers. This type of assignment does not appeal to students who do not have a flair for mathematics. In the second option, the students often end up browsing through the internet, collecting some information and presenting them [7], [8]. This is disliked by students who are not good in communication and are not adept at presentations. In the third type of assignment, typically a student has to answer a set of question and answers. Most often, a few students do it, and the rest of the class end up making copies of these answers [9].

Thus, the biggest challenge for a teacher, is to plan assignments to address the interests of all the students in a heterogeneous environment and motivate them towards learning [10]. It is more difficult to meet multi-faceted interests of students in technical subjects. This paper presents an experiment in letting students opt for different kinds of assignments, based on their interests in a course on "Smart grid technologies", at the undergraduate level. The paper discusses the major challenge faced in developing an evaluation structure when the assignments are different and also the end result of the experiment in motivating the students and creating an interest in the subject [11]. The paper is also intended as a guide to new teachers to try out innovative methods to hold student interest and motivate them.

2. Challenges faced in a heterogeneous environment

Teachers encounter a number of problems when teaching in mixed interest and heterogeneous environments. In India, the student spectrum in any class is spread over a widely varying range. There is diversity in the geographical regions from which the students come, urban and rural backgrounds, students who have studied upto higher secondary in vernacular languages as opposed to ones who have an English background from primary schooling, students who come from diploma background and may be slightly older than others, students who have excelled in the entrance tests as opposed to students who may enter through management seats and so on [12]. Such a diversity, brings a lot of challenges as discussed below.

· Discipline is bound to be a challenge on campus, more so in the class room. Discipline becomes an issue when the learners feel frustrated, they lack concentration or simply do not relate to the teacher. Handling such classes is a nightmare for young teachers. If the teacher tries to address the learning needs of the weaker section, the advanced learners get bored. If the teacher tries to address the needs of the quick learners, the slow learners are frustrated. Either way, there is bound to be disruption of classroom discipline.

- The second challenge is to hold the interest of all the students. Teachers handling courses with a wide spectrum of student abilities will find it difficult to provide content and create activities to motivate and create interest in all the students. In short, it requires great deal of skill to provide effective learning to all the students.
- The rigidity of the curriculum and evaluation procedures may not offer teachers many options or flexibility.
- It would not be possible to track the learning levels of all the students and ensure enthusiastic participation of all students in the activities.
- With increasing student strength, the teacher is often overwhelmed with valuation and marking and may find it easier to devise common assignments and evaluation structures for the whole class, rather than create different assignments based on individual student interest.

3. Advantages of a heterogeneous class

Notwithstanding the challenges quoted above, mixed class rooms with a wide spectrum of students offers certain advantages.

· Such classes provide a rich and varied pool of human resources and talents.

· Students come with different experiences, backgrounds, skills, ideas and interests to enable teacher to provide innovative student-centric assignments.

- Creativity of both teacher and students can be addressed.

- Greater learning autonomy is possible as the teacher may not be able to attend to individual learning skills, thus promoting students to form self-help groups amongst those who have similar interests.

- They provide an excellent opportunity for the teacher to grow professionally in trying to create content to suit different interest groups and providing a platform for everybody to learn the subject and at the same time do tasks as per their individual interests.

4. Strategies for teaching heterogeneous groups

From the above discussions we can see that it is indeed a challenge to teach students who have diverse backgrounds and interests. Some strategies which the teacher can adopt in such cases are discussed here.

a) Provide a supportive learning environment to infuse confidence and enable students to perform to the best of their ability.

b) Involve all students in activities to suit their varied interests

c) Provide a platform for students to showcase their work to others

d) Provide variety of topics, materials and activities. This will help accommodate different learning levels, abilities and styles.

e) Change the concept of having all students take up same assignments and tests. While different assignments and tests, may be difficult to evaluate, it is possible to frame fair evaluation procedures with some thought.

f) Give group assignments to permit learners of different levels to mingle and help each other.

g) Personalize assignments and project works to suit learner's interest. It is not necessary for all students to do the same task all the time.

h) Provide opportunities for students to work at their own pace.

i) Create assignments that would challenge the higher order thinking skills by providing problem-solving and analytic tasks rather than only comprehension tasks.

j) Give compulsory plus optional tasks. The compulsory tasks can be given to the whole class, while the optional tasks are left to the students. While no penalty is imposed for students who do not take up the optional tasks, incentives can be provided to encourage them to do so.

5. Personalized assignments in course on "Smart grid technologies"

The course on smart grid technologies is offered as an elective course at the third year of the undergraduate program of Electrical & Electronics Engineering. The course is one of current interest and an inter disciplinary area, requiring integration of power systems, renewable energy sources, communication technologies, IoT , data analytics and advanced instrumentation. Non availability of books which would cover all these areas was one of the major challenges faced. The sheer diversity of the skills required was another major challenge. The next challenge was to create personalized assignments to suit different interests of students. A few assignments that were given, the skills addressed by them and the program outcomes they met are discussed. As a trial to test the efficacy of personalized assignments, the students were given the option to choose an assignment as per their individual skill and interest. Students were also given the option to take up the task individually or in groups of two or three. The strength of the class is 35 students.

5.1 Programming tasks: In this a set of programming assignments were given in the areas of load flow and contingency analysis, wherein the student had to code programs in MATLAB or C to integrate renewable energy sources with conventional sources for load flow studies and contingency analysis. Six students interested in programming opted for this assignment.

5.2 Survey and case study: In this assignment the students were asked to take up a commercial establishment like a mall, or a hospital, survey the stake holders on energy usage, survey the establishment personally to assess energy usage patterns and then provide a solution for demand side management to reduce energy consumption.

Four students who were interested in human interactions and management opted for this assignment.

5.3 Creation of charts: Students were asked to make charts compactly to illustrate the Indian grid Code, NERC reliability criterion and Power system control centre operations. Six students who had a creative inclination towards aesthetic content opted for this.

5.4 Develop mathematical models: In this task the students were required to build mathematical models to assess the impact of solar roof top penetration. This task posed a challenge to students who were interested in mathematics and they opted for it. Four students opted for this assignment.

5.5 Data analytics: In this task, students were asked to collect data from a solar farm and develop predictive tools to predict day ahead solar power. Six students who were interested in data analytics and looking for job opportunities in that field, opted for this.

5.6 IoT application: In this task students were asked to develop a simple sensor based monitoring system for monitoring a solar panel performance. Four students interested in IoT opted for this.

5.7 Village survey: Here, the students were asked to survey a nearby village, study the resources available and suggest ways of creating alternate energy sources for the village. Five students interested in societal issues opted for this.

At the end of the course the students were asked to present their work to the whole class and initiate an open discussion on the task.

6. Course Outcomes met

The COS are defined based on the levels of learning they address. For the Smart Grid course the COs are as follows.

CO1: Define smart grids and assess feasible associated capabilities in a given environment

CO2: Analyze the needs of the grid in terms of data acquisition and analysis

CO3: Propose options for microgrids, grid integration and AMI in a given environment

CO4: Design and implement demand side management techniques.

In computing the course attainment the following components are considered

(i) Continuous Internal Evaluation – The components in this are Tests with quizzes and Assignment. For any test, for every question, the corresponding CO addressed and its maximum marks are marked. For each student the CO attainment is calculated. This is the sum of marks obtained by a student in all questions addressing a particular CO divided by the sum of maximum marks of all the questions addressing that CO. Once the CO attainment is calculated for all the students, the class average attainment for each CO is computed.

(ii) Assignment component- This is assigned 50% of the CIE marks in the course. The assignment has to address all the four COs since the student has to first understand the topic, then evaluate different strategies available, apply concepts of the course studied and finally actually implement or present idea for implementation. The evaluation of assignment is conducted in two phases – In the first phase the first two COs are normally addressed and in the second phase the other two COs are addressed.

(iii) Course end survey- After the completion of the course the students are given a questionnaire which finds out the extent to which the course outcomes have been achieved. A sample survey for Smart Grid course is shown below in Table 1

Once the course attainment has been calculated based on CIE and Course-End survey, the final attainment is given by giving due weightage to each of them. The weightage given is as follows: 50% to CIE, since it is a continuous evaluation, 40% for assignment and 10% for Course End survey. The final calculation is shown in Table 2

7. Program outcomes met

A major challenge in any course is to meet and address as many program outcomes as possible to effectively improve program attainment levels. Designing individual assignments helps in attaining

multiple outcomes since almost all dimensions of a student are addressed. In this case study the program outcomes met are tabulated in Table 3 for the different tasks discussed in sections 5.1 to 5.7.

Table 1. Course End Survey
Rating Excellent-4, Very Good-3, Good-2, Poor-1

Sl No	Outcomes	Student 1	Student 2
1	Were you able to define smart grids?		
2	Are you in a position to propose a microgrid for a given environment?		
3	Do you know the importance and role of data analytics in a smart grid?		
4	Can you assess the energy usage pattern and propose DSM techniques?		
5	Do you know the challenges of grid integration and the Indian grid code for the same?		
6	Do you think doing assignment of your choice improved your learning?		

Table 2 Attainment of Course Outcome

SUBJECT WITH SUB CODES	Course Outcomes	CIE Attainment (%)	Assignment Attainment	Attainment through Survey(%)	Final Attaiment= 0.5*CIE+0.4*SEE +0.1*Survey
Emerging Technologies 12EEE65	CO1: Define smart grids and assess feasible associated capabilities in a given environment	74	78.53	75	75.912
	CO2: Analyze the needs of the grid in terms of data acquisition and analysis	70	76.8	79	73.62
	CO3: Propose options for microgrids, grid integration and AMI in a given environment	69	79.6	78	74.14
	CO4: Design and implement demand side management techniques.	72	78.3	77	75.02

PO\T ask	Progra-mming Task	Survey and case study	Creation of charts	Develop mathematical models	Data Analytics	IoT Application	Village survey
Engineering knowledge	✓			✓			
Problem analysis	✓	✓		✓			✓
Design of solutions	✓	✓					✓
Investigation of complex problems					✓	✓	
Modern tool usage	✓		✓	✓	✓	✓	
Engineer and society		✓					✓
Sustain-ability and environment		✓					✓
Ethics							
Individual and team work		✓	✓			✓	
Commu nication	✓	✓	✓	✓	✓	✓	✓
Project management		✓					✓
Life long learning				✓		✓	✓

It can be observed that all the program outcomes are met to varying degrees. It would have been impossible to address all the program outcomes with a single type of assignment.

7. Feedback from students

At the end of the course the students were asked to give their feedback on having personalized assignments. A whopping 99% of the students responded that they were very happy with it, the learning experience was very good and there was no reluctance in doing the assignments. The students also got an overall exposure to different aspects of smart grid technologies, while working in the area of their interest. There was unanimous agreement on the fact that only mathematical assignments, survey assignments etc, would not appeal to all of them and would not have provided such a rich learning experience. 98% of the students were happy with being able to exercise option and choose their assignment, while 100% of them wanted this flexibility to be provided in their assignments in all the courses.

8. Conclusion

This paper presents the challenges of teaching in a heterogeneous environment with a wide spread of student spectrum, in terms of intellect, capabilities, background etc. The paper presents the concept of designing personalized assignments to suit the interests and skills of the students. As the interests and skills of students vary widely in a heterogeneous class, assignments of a single type, create frustration and at times erode the confidence of the student, if it does not fit their skill set. From the case study, it was observed that personalized assignments not only improved students motivation to learn and perform, but also helped to achieve all the program outcomes of the undergraduate program. They expressed a desire to continue with the activity in the next semester. The work on development of mathematical model to evaluate impact of roof top solar panels, resulted in publication of the work in an international conference. The work onIoT so motivated the students, that they took it up as a major project and the work resulted in two international conference papers. This observation is important for it is indicative of a progressive enhancement of the ability of the students toself learningif they are given the flexibility to choose to work based on their learning styles and personal interests, within the broad framework of the curriculum.

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