DOES THE INTRODUCTION OF PROJECT-BASED LEARNING TO THE TEACHING OF ENGINEERING DESIGN INCREASE STUDENT ENGAGEMENT?

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ABSTRACT

The purpose of this project was to investigate whether the introduction of elements of active learning and teaching methods (Project-Based Learning) in a second year engineering design unit increased students' engagement with the material being covered.

This paper focuses on the experience and feedback resulting from the introduction of a poster presentation as one of the two assessment elements for the unit. Two cohorts of students, comprising a total of 21, took part in the study and completed a questionnaire directly after their poster presentation. The questionnaire included 10 questions, requiring students to grade their response between Yes and No (5 options) as well as explaining their views.

The data was analysed quantitatively and qualitatively to reveal that the majority of the students had found that this novel (to them) approach to assessment had had a positive impact on their learning. The major difference, when compared with traditional lecture and report combination, was the fact that students had begun work on their assignment early on in the semester rather than leaving it to the last minute.

In addition, being able to resolve a particular aspect of their assignment brief in each of the sessions helped students focus their attention and engage to a greater extent with the material included in the syllabus. A further beneficial side-effect was the increase in their confidence in presenting their own ideas to their peers, and being able to benchmark them against the rest of the cohort.

1   INTRODUCTION

Engineering courses have traditionally been taught and assessed using passive learning and teaching approaches, such as lectures and exams. In some cases, practical laboratory sessions or tutorials were available as well. This passive approach leads to superficial learning on the part of the students, who tend to rote memorise the contents of the unit for the exam and then forget them immediately after [1].

Active learning methods, on the other hand, encourage deep learning by allowing students to take responsibility for their learning, to participate actively in the learning process and to become independent learners [1].

Although current literature shows there is a move towards using active learning methods in teaching engineering subjects [2], they are still regarded with suspicion amongst certain academics. The application of these methods requires a change in teaching style

and involves a great deal of effort on the part of the academic in terms of preparation and delivery. Furthermore, it will also entail a certain amount of re-training of the students, who will most likely be accustomed to a passive style of teaching and learning [1, 3].

2   PROJECT-BASED LEARNING

Project-Based Learning (PjBL) is an active, student-centred teaching and learning methodology. The basis of the pedagogical activity is a real life project (or problem) that the students must address (solve). The academic acts as a facilitator, but it is the students who decide what and how they need to learn [2]. Since the students undertaking the unit included in the study were used to a passive learning style, it was thought that a complete change over in teaching style in a single semester would be too drastic for them. Therefore, the syllabus for a particular level 2 unit was modified to introduce a number of PjBL elements, alongside the lectures covering the theoretical material [4].

The syllabus for the unit covers Design Methodologies for engineering design problems, and is loosely based on Pugh's Total Design methodology [5]. One aspect of the Design Process was introduced during the thirteen sessions in the semester. Each of the sessions also allowed time to apply the material covered in the session to a real-world problem, which in this case formed the basis for the assignment.

The problem was the failure of a number of 1st generation iPod nanos, where the screens became detached or scratched shortly after purchase. The brief for the students was to propose three different designs for protective cases for the nanos, with the unique selling point of providing storage for the headphones and the cables. Since apple launched a new line of iPod devices recently, the brief was modified to allow for the 3rd generation nano, the iTouch and the iPhone to be included in the assignment.

Students were required to make a poster presentation with their initial design concepts during week 7, alongside a project report to be submitted at the end of the semester. The first 6 weeks of the semester were spent covering the problem definition, product design and concept generation phases of the design process. The session prior to the presentations was devoted to the compilation of the posters.

On the day of the presentations, all the posters were pinned to the walls and we then moved around the room to listen to each student describe their concept designs for 10 minutes.

iPod case concepts by Ahmad Dabche (2nd Year BEng Mechanical Engineering)

3 METHODOLOGY

Feedback from the students was collected by means of a questionnaire, completed directly after the poster presentations had concluded. The purpose of the questionnaire was to explore whether the introduction of the poster presentation increased student engagement with engineering design. The average completion time was 10 minutes

A total of 21 students, comprising a cohort of 6 second-year Computer Aided Design students and another cohort of 15 second-year Mechanical Engineering students, took part in the study. The questionnaire included 10 questions, requiring students to grade their response between Yes and No (5 options) and giving them the opportunity to explain their views [6] (Please refer to Table 1 for details of the questions).

The questionnaire was designed to start with fairly neutral [2] questions such as 1, 2 [6] and 3. Questions 4, 5 and 6 explored student preferences in terms of assessment methods. Questions 7 and 8 were designed to find out whether this assessment method was more conducive to the understanding of the material, and the practical application of the knowledge acquired. Questions 8 and 9 focused on the change in their perception of their own confidence (increased) and ability. Finally, question 10 provided respondents with an opportunity to explain what they would do differently next time.

4 RESULTS AND ANALYSIS

The results for both cohorts have been combined in the table below.

Table 1 Results from questionnaire

	Question	Yes				No
1	Did the introduction of the poster as part of the assessment process encourage you to think about the assignment early on in the semester?	17	2	1	1	
2	Did the introduction of a poster as part of the assignment help you apply the material covered in the lectures to a practical problem?	12	4	3	1	1
3	Was the introduction of a poster as part of the assessment a good way of encouraging you to focus your ideas?	15	4	2		
4	Did you enjoy the experience of preparing the poster?	12	3	2	2	2
5	Did you enjoy presenting the poster?	12	2	5		2
6	Do you prefer this method of assessment to reports or exams?	13	2	3	1	2
7	Do you feel you have learnt about the "Specification" and "Concept Generation" phases of the Design Process?	12	5	4		
8	Has the preparation of the poster increased your confidence in your ability to solve design problems applying the material covered in the lectures?	11	5	4	1	
9	Has the preparation of the poster increased your confidence in presenting your ideas graphically?	12	5	3		1
10	What would you do differently next time?					

4.1 Quantitative Analysis

Overall the results indicate that the students perceived the experience as a positive one. The poster presentation half way through the semester helped them to stay focused on their assignment, and to tackle it earlier on than they would have normally done (17 out of 21).

In terms of practical application of the material covered, or learning by doing, 12 out of 21 thought the poster helped them out. It also helped the students focus their ideas on the possible design solutions to the problem in their assignment (15 out of 21).

Regarding the experience of preparing and presenting the poster itself, the overall perception was positive (12 of 21).

There was a strong preference for this type of assessment combined with a technical report over an exam, as it favours different strengths and learning styles (13 out of 21).

The majority (12 out of 21) felt they had learnt about the two phases of the design process covered in the lectures to date.

Questions 8 and 9 were designed to measure the change (increase) in confidence in terms of presentation, sketching and explaining their ideas in the students. Most of them (11 out of 21) thought that it had, despite having expressed some apprehension initially, not only in terms of public speaking, but also having to present heir ideas graphically, which was new to most of them.

4.2 Qualitative Analysis

A qualitative analysis of the responses to the questionnaires showed that the students had found the introduction of a poster as a form of assignment a positive experience. They were particularly enthused by doing something different: "It was a good idea to do something that differs from the traditional 'write a report' technique. Reports become boring and technical, whereas the poster still allowed us to be free and be more creative" Tom. "This was more interesting and different (from exams and reports)- it is nice to have a change" Laura. "The poster allowed me to think visually, which is a bonus in a design unit" Mzee.

However, they were aware that there are other areas within an engineering course that are better suited to an exam method of assessment. "A report allows you to do research and gives you a fuller view of the subject" Anonymous.

For most of these students, the poster presentation was the first time they had ever presented their ideas orally and, in many cases, English was not their first language. These two factors contributed to their initial reticence since they were being asked to move outside their comfort zones. Fortunately, their fears were not confirmed and their comments regarding the preparation and presentation of the poster were positive: "I am not used to drawing or sketching. It was a way to find out how good at sketching I can be. I was not too bad!" Anonymous, or "I was very nervous but when I was giving the presentation it felt good" Anonymous.

In other cases students were aware of the benefits of the experience even if they did not enjoy the oral presentation: "I don't really like talking in front of groups of people, but it helps me develop my concepts and my presenting skills" Jamie.

The students showed they had become more engaged with their learning and were aware of how far they had progressed since the beginning of the semester. In relation to question 7 one student stated: "Concept Generation was a main feature in my poster, but I missed some key issues from the Specification". In addition, they showed a sense of ownership and pride over their designs: "The poster allowed me to present my own

opinion on the concepts which had I generated. It allowed me to present and speak about something which I thought could potentially be a marketable product" Joel.

A surprising outcome was their awareness of the benefits of acquiring soft and communications skills for their future professional careers: "Yes, It is a good idea because when you go to work for a company, you might have to do presentations, so it prepares you for that" Muhammed.

Finally, in terms of what they would do differently next time, they mentioned taking more time to prepare the poster, practising their presentation and explaining their three concepts in greater detail.

4.3 Assessment results

The posters were assessed in terms of the originality of the concepts, the quality of the posters (graphics, colours, etc) and on their presentation. The results are shown in Table 2.

Table 2 Assessment results

Marks	CAD cohort (% of students)	Mech Eng cohort (% of students)
>70%	38	35
>60%	25	15
>50%	25	10
>40%	0	25
<40%	12	15

5   CONCLUSION

The data was analysed to find that the majority of the students had found this novel (to them) approach to assessment had had a positive impact on their learning. The major difference, when compared with traditional lecture and report combination, was the fact that students had begun work on their assignment early on in the semester rather than leaving it to the last minute. Furthermore, being able to resolve a particular aspect of their assignment brief in each of the sessions helped students focus their attention on and engage to a greater extent with the material included in the syllabus.

Despite initial reservations, they were enthused by presenting their ideas to their colleagues and being able to benchmark their ideas against those of others.

A further beneficial side-effect was the increase in their confidence in presenting their own ideas to their peers, and being able to benchmark them against the rest of the cohort.

I believe the general feeling of the students can be summarised by the comment the most disengaged student made at the end of the semester: "I come to class because I like the way the teacher teaches".

6   FUTURE WORK

A longitudinal study will be carried out to include two additional cohorts the second semester of the 2007-2008 academic year and a further four cohorts during 2008-2009.

In total approximately 100 students will complete the questionnaire.
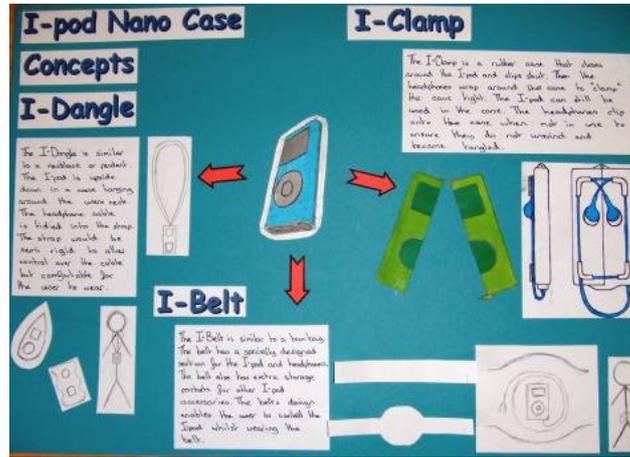
Jamie Willers (2nd year BSc Computer Aided Design)

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