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Centre for Excellence in Enquiry-Based Learning

Project Case Study

Preparation for Group Project Work – A Structured Approach

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Abstract

This case-study describes the introduction of a series of structured activities into the Second-Year Tutorials (SYT) scheme of an Electrical and Electronic Engineering degree programme. These tutorial activities are designed to prepare students for a team project in the following semester and take the form of a series of five linked problems, which simulate aspects of a practical team project, developing team working, project planning and group presentation skills. A Problem-Based Learning (PBL) approach was taken, which provided a model for problem solving in structured team meetings.

An integrative evaluation of the tutorial system was conducted using confidence logs, attitude surveys, questionnaires and a number of focus groups. It was found that the activity was appreciated by participating staff and students. However, there was a need to assign credit to this activity to improve engagement.

Introduction

The development of professional and personal skills in Engineering students is becoming increasingly important. A recent survey of employers, conducted by the Institution of Electrical Engineers (IEE) (2006), highlighted a mismatch in the skills required by Electronic Engineers, and the skills that graduates possessed. This finding is in line with similar studies and Engineering educational reviews in both America and Australia, reported by Mills and Treagust (2003). These studies emphasise a lack of teamwork and communication skills among graduates. There has been debate about the most appropriate method of embedding these skills into the curricula, whether PBL or project-based learning approaches are more suitable for engineering subjects (Mills and Treagust 2003) (Perrenet *et al.* 2000). This case-study describes a development where these approaches are used to complement each other. PBL is used to provide a structured approach and framework to prepare students for project-based learning.

Background

The School of Electrical and Electronic Engineering at the University of Manchester offers five related degree programmes: Electrical and Electronic Engineering (EEE); Electronic Systems Engineering (ESE); Mechatronic Engineering (MTE); Computing and Communications Systems Engineering (CCSE); and Computer Systems Engineering (CSE), as three-year BEng or four-year MEng degrees. These programmes have a common first year, specialised second year through core units, and further specialisation in the third and fourth years through core and optional units. The current second year consists of 132 students, divided into 24 tutorial groups of 5-6 students from a mix of degree programmes.

Rationale

The stimulus for the present exercise arose from experience gained in a practical team project that the school had recently introduced into the second year of its programmes. Known as the Embedded Systems Project

(ESP), this ran for the first time in the 2004-05 session, after having been piloted in the MTE programme in the previous year. The ESP represents a 10-credit unit of continually assessed project-based learning.

In the ESP students typically work in teams of 4-5 throughout Semester 2 on the design and implementation of a microcontroller-based product. Each programme has a different project, reflecting the specialities of that programme:

- EEE worked on a model of a 11kV ring circuit;
- MTE designed and constructed a robot buggy;
- CCSE looked at data transfer between two microcontroller boards, initially over wires then over a radio link;
- CSE and ESE implemented a weather recording station with pressure sensors, liquid crystal display and FPGA controller programmed in VHDL.

All of these projects have substantial hardware and software components.

Staff feedback suggested that the students had learnt a lot from the activity but were slow to engage with the project, taking time to understand the required amount of commitment and the shift from passive to active learning. Students' feedback suggested that they required more preparation in the skills of teamwork, project planning and group presentation prior to engaging on a full unit that demanded these skills for its success.

It was decided to use the SYT in Semester 1, to develop these skills in preparation for the ESP in Semester 2. This would provide an opportunity for students to develop and practise these skills through a structured series of problems, allowing the students to focus on a few of these skills at a time, in contrast with a full-scale project where competence in all of these skills would be required for a successful outcome.

It is anticipated that, with this preparation, students will be able to form functional teams with effective team processes much more quickly and

consequently begin to make constructive progress on the ESP at an earlier stage.

There were also a number of practical, electronics-based skills that would be useful for the students to acquire as preparation for the ESP. These included designing operational amplifier circuits, selecting electrical components, and planning the layout of a prototype circuit on stripboard. These requirements informed the design of the scenario and the problems that it contained.

Approach

Introduction

A series of linked problems were designed for students to work through during the semester. These problems simulate aspects of a real-life project. Tutors and students would meet fortnightly in timetabled sessions. Students would report on their solution of the previous problem, the tutor providing appropriate feedback. The next problem would then be presented and the tutor facilitated the students' initial discussions about the new problem.

The Scenario

An industrially-inspired scenario was developed to contain these problems, which provided an example of Electronic Engineering supporting another industry. An industry was chosen whose products would be tangible and familiar to the students, although the processes involved might not be fully understood.

The scenario chosen was based on a fictitious decorative tile company, 'Baked Earth', which has become aware of inconsistencies in the quality of a new high temperature glaze. They are working in partnership with 'Euro-Tunnel Kilns' to find a solution to this problem. They need to measure the temperature profile of a kiln using portable temperature sensors. The Agency for Consultancy in Electronics (ACE) has been commissioned to design the electronics for this task; the students took the role of a team of consultant Engineers in this agency.

Problems

Five linked problems took the students through various stages of this project.

1) Design a Circuit

A senior consultant had recommended that a thermistor should be used for this project. The students were asked to design a circuit for a thermistor sensor to interface with a PIC control board.

2) Choose a Sensor

It was revealed that the thermistor would not measure the kiln temperatures required and they were asked to find another sensor that would.

3) Plan a Project

Noting that the earlier misdirection of the senior consultant had caused some slippage to the project, the students were asked to review the project plan and recommend a revision.

4) Practical Implementation

The students were asked to redesign their circuit for the new temperature sensor and plan how to lay out a prototype circuit on the stripboard.

5) Group Presentation

Finally, the students were asked to present their findings for the problems.

Lectures

A series of lectures supported this activity, providing timely advice:

- Introduction
- Searching Skills
- Working in Groups
- Project Planning
- Presentation Skills

Guides

In addition, a series of guides were written to reinforce the lectures:

- Second Year Tutorials
- Manchester Steps
- Small Group and Team Work
- Searching for Information
- Project Planning
- Group Presentations
- The Marking Scheme

The Manchester Steps takes the steps associated with PBL (Centre for Excellence in Enquiry-Based Learning 2006) and fitted them to the acronym of MANCHESTER:

- **M**ake the problem explicit;
- **A**ssess existing knowledge;
- **N**eed to know;
- **C**ourse of action;
- **H**ome in on resources;
- **E**nquiries and/or experiment;
- **S**hare results;
- **T**heorise;
- **E**valuate;
- **R**eport, repeat, refine, reflect.

Tutor Briefings

Tutors were supported through this activity via a series of tutor briefings. These were deliberately succinct, highlighting the key points of each session through trigger phrases.

Assessment

The tutorials were not formally assessed. However, formative assessment was conducted to indicate how the students would have performed on the ESP if they had made a similar level of contribution. Each week the tutor would grade individual contributions on a five-point scale. The group presentation was also marked against: preparation, delivery, contents and responses to questions, in equal measures. The contribution of each student to the presentation was also recorded.

The ESP employs a formula that weights a group product mark, based on combination of report and presentation marks, with the level of contribution of the individual student to the group. This allows the individual mark of the student to vary up to 50%, above or below the group product mark. The group product mark then becomes the average mark for that group. For the SYT it was intended to use the presentation mark as the group product mark; however, since not all of the students were involved in the final presentation, this was considered inappropriate. Consequently, an example group product mark of 60%, weighted against the students' contribution to the tutorials and presentation, was used to provide an indication of the level of achievement the student might make under the ESP model.

Evaluation

Method

Integrative evaluation was conducted, based on the process described by Draper *et al.* (1996), where the focus is on understanding the experience of the students engaged in the learning activity. A series of evaluation questionnaires were used.

Initial questionnaires were administered on-line, through links distributed via e-mail. The response rates were low; consequently later questionnaires were administered on paper, during the group presentation sessions.

Confidence Logs

These were used to record the confidence of the students on the learning objectives of the SYT (Draper *et al.* 1996) and were applied pre-and post-SYT.

Study Process Questionnaire

Developed by Biggs *et al.* (2001), this measures the students' approaches to learning, whether deep or surface. This was applied prior to the semester to give an indication of the types of learner engaged on the activity.

Learning Resource Questionnaire

Developed by Brown *et al.* (1996), this measures the frequency of use and usefulness of resources.

Perceptions of PBL Questionnaire

This gauges students' perceptions of PBL and conventional learning.

Post-Course Questionnaire

This open response was used to gather more general feedback.

Focus Groups

In addition three focus groups were conducted, one part-way through the semester and two at the end.

Outcomes

These results should be treated with caution, since the response rates were low (22%-28%) and there is likely to be an element of self-selection in those who responded. Those who completed the on-line questionnaire are possibly more motivated students, and those who filled in the paper questionnaires are those who gave a presentation. The focus groups were based on volunteer samples, so may have attracted students who had something to say about the tutorials, whether positive or negative.

Despite that, the results provide a useful indication of what was happening during the learning experience.

Confidence Logs

Table 1 (Appendix 1) shows the score against the intended learning outcomes of the SYT. There appear to be modest increases to all the learning outcomes, with the exception of presenting information.

Study Process Questionnaire

On average the cohort came out as having a Deep Learning Attitude of 28.3 and Surface Learning Attitude of 22.9, on a scale of 10 to 50. This is a very similar result to an independent group of third years on whom this questionnaire was applied, so are probably typical of the profile of our students.

It is anticipated that, by correlating these results with other measures, it will be possible to discern if there are differences in behaviour between students with deep or surface attitudes to learning. This analysis will be the subject of further work.

Learning Resource Questionnaire

Table 2 shows the frequency of use of resources and Table 3 their usefulness. Clearly a wide range of resources was used, with the internet being used as a primary resource. Encouragingly, the discussion with other students and tutors registered highly, indicating that the students found the group work, both facilitated and unfacilitated, useful. Students who indicated other resources mentioned: the library, the intranet, company data sheets and catalogues, magazines and the results of previous project research.

Perceptions of PBL Questionnaire

Table 4 shows the responses of the students to this questionnaire. The results come out positively towards PBL. Despite recognising the increase in time and responsibility that PBL entails, the students seem happy with

the support they got and would be prepared to learn this way again. Their enjoyment of group work is of particular note. There is a preference for lectures, which may not be surprising since this is the mode of teaching in which they have predominantly been taught.

Post-Course Questionnaire

The questionnaire consisted of three value-neutral, open questions and an opportunity for further comments:

What did you learn from the SYT?

Most mentioned team working, though some suggested negative experiences. Project, presentation, problem solving and research skills were also mentioned.

What did you not like about the SYT?

Most complained that it was not marked, others complained of competing workloads from other units, and some mentioned dysfunctional teams.

What would you like to see changed about the SYT?

Suggestions included adding marks, reducing workload and better teamwork.

Other Comments

Some were supportive of the initiative but reiterated credit and workload issues. There were a few who did not value the initiative and would prefer using the tutorials in other ways.

Focus Groups

The focus groups reiterated the need for credit and the balance of workload. The team work and problem solving aspects were generally appreciated, though some commented that getting the full team to participate was difficult. Some felt that the project planning was not well enough supported. The introduction of example circuits into Problem 4 confused some students. Some thought that the problems were very difficult to subdivide into six different tasks.

Attendance

The attendance dropped off for this activity, beginning at 92% and falling to 45%. This seems to reinforce the idea that the lack of credit associated with the activity made it appear optional and easy to ignore, especially as competing workloads increased over the semester.

Tutor Feedback

Tutors expressed the view that it was a worthwhile activity, but considered that it required credit to maintain motivation throughout the semester.

Further Evaluation

During Semester 2, ESP supervisors will monitor the progress of the groups and further focus groups will be conducted to evaluate whether exposure to the SYT has improved their performance.

Further Development

The SYT will be run again in 2006-07. An appropriate amount of credit will be borrowed from related units to enhance student motivation and provide a clear signal that the activity is valued and compulsory. The problems will be fine-tuned, based on the feedback from the focus groups, with more structure and guidance on how the problems can be divided into tasks. Additional support will be provided for the project planning aspect.

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Appendix 1

TABLE 1 – Confidence Logs

Learning Outcome	Pre PBL	Post PBL
selecting components	3.2	3.4
designing circuits	2.9	3.5
team working	4.0	4.1
defining problems	3.7	3.9
problem solving	3.6	3.8
project planning	3.3	3.4
project managing	3.4	3.5
self-directed learning	3.5	3.6
communicating ideas	3.5	3.7
searching for information	3.9	4.0
presenting information	3.5	3.4
giving feedback	3.3	3.4
Number of Responses	*32*	*37*

1 – No Confidence, 5 – Very Confident

TABLE 2 – Frequency of Resource Use

Resource	Frequency of Use
textbooks	3.0
own notes lectures or labs	3.4
borrowed notes	2.2
discussion with tutors	3.0
discussion with students	3.5
Internet	3.8
other	2.7
Number of Responses	*30*

1 – Did not use, 4 – Used Regularly

TABLE 3 – Usefulness of Resource

Resource	Usefulness
lectures	3.1
textbooks	3.1
own notes lectures or labs	3.2
borrowed notes	2.4
discussion with tutors	3.3
discussion with students	3.1
Internet	3.5
other	2.7
Number of Responses	*30*

1 – Useless, 4 – Vital

TABLE 4 – Perceptions of PBL

Statement	Score
I like PBL	3.6
I learn more from PBL	3.2
PBL takes more time	3.5
more responsibility for learning	3.6
I enjoy group work	3.9
I understood the problem	3.7
I understood what was required	3.6
I was happy with staff support	3.7
I prefer to learn through lectures	3.1
would like to learn this way again	3.6
PBL has made me better at … finding and using information	3.6
Number of Responses	*30*

1 – Disagree Strongly, 5 – Agree Strongly