A Kick Start in Implementation of PBL in Computer Programming

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Abstract

This paper aims to provide ideas regarding implementation of Problem-Based Learning (PBL) in computer programming, where practical activities are included in order to generate interaction between software and hardware. The details regarding the experience, mode of delivering, obstacles and suggestion for future improvement are described in the paper. It presents the procedures involved in developing PBL cases for some basic electrical engineering problems. The approach begins with the students exploring the given problems and proposing the outcomes of their brainstorming session. They are then put into groups in order to encourage team working between team members, and cooperation between groups. To practice communication skills, each group is required to present their findings. With this initiative and approach, it is found that the students have the ability to present their own creative ideas, lending to a better understanding of the course.

Keywords: Problem-based learning

1. Background

In global engineering education, students are exposed to a variety of knowledge. This requires the university's academic staff to be creative in their teaching and learning process.

When KUKTEM shifted to Bandar MEC, Gambang, Kuantan, the university decided to set up the Academic Staff Development Centre (ASDC). The main objective for setting up this centre is to develop and improve the teaching and learning capabilities of KUKTEM's academic staff and students. This has led to the implementation of Student Centred Learning (SCL). Whilst this concept was not considered during the initial planning of the curriculum, but this concept was put to test in some courses by some lecturers. To demonstrate the university's seriousness in tackling the issues of engineering education, ASDC conducted a "Teaching & Learning Conference 2004: SCL – A Vehicle to Effective Teaching" on 11th December 2004. Several papers were presented by associates from every faculty in KUKTEM. Several outcomes have been achieved from the above conference, which include the following:

- To provide a platform where experience or ideas on teaching and learning can be shared among KUKTEM's academic associates.
- To disseminate the research findings to other academic associates on teaching and learning in KUKTEM.
- To address issues and challenges of teaching students in KUKTEM.
- To provide suggestions and discuss strategies for improving teaching and learning in KUKTEM.

As part of the effort to improve the teaching methodology, the Faculty of Electrical & Electronics Engineering (FKEE) has decided to implement Problem-Based Learning (PBL) in Computer Programming course.

The aim of Problem-Based Learning is to improve the students' ability to work in a team to solve new, complex and ill-structured real-life problems, showing their co-ordinated abilities to access information and turn it into viable knowledge [5].

2. Introduction

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Computer Programming is a 2 credit-hour course offered by FKEE as part of the undergraduate curriculum. It involves C language programming which is relevant to the study of electrical engineering, electronic engineering, computer engineering, applied computer science and applied information technology at diploma and bachelor's level. To enhance the learning process, faculty members responsible for the planning of the course decided to increase the face-to-face (F2F) component in the computer laboratory. The panel also decided to integrate hardware and software. In the implementation, one lecturer taught this course to three groups of students. This paper presents the experience gained during the process of teaching and learning of diploma students. All the three groups of students sat for the same tests, quizzes, assignments and project evaluations. The detailed breakdown of the marks for the whole course is shown in Table 1.

Table 1: Grading of the Computer Programming course.

Assignment	1 x 10% = 10%
Quiz	5 x 3% = 15%
Project	1 x 30% = 30%
Test	3 x 15% = 45%
Final Examination	None

The details on PBL concept will be elaborated later when discussing the project assessment. Although the implementation is still far from perfect, students - especially the first year students - have shown their appreciation over traditional lectures.

3. Implementation

During the first week of the semester, students were asked to form and manage their own group. Each group consisted of two to three students. This was a mistake as there was a tendency for the not-so-smart student to be left out of any group as the smarter students sometimes refused to partner with them. By selecting their own peers, the members of group have their own level of thinking, own creativity even their own strength [5].

After the first week, students were asked to sit in their respective groups. The groups are valid for the project assessment only; for other types of assessment, the students are evaluated individually.

3.1 Design of the project assessment

The idea began with the lecturer demonstrating his own prototype. After identifying the shortcomings of the prototype, the students and lecturer came up with a problem statement. The students were then asked to act upon the problem statement by developing prototypes that would improve the first prototype.

Table 2: General guidelines for project assessment

Step 1	Basic Hardware identification	5%
	manually functioning amongst the buffer - (74LS244); i/p and o/p pin	(5 marks)
	o/p test – buffer and led / application	(5 marks)
Step 2	Interfacing hardware/software	10%
	software/hardware communication (program testing and hardware) Type 1: If ...else if ...else statement Type 2: switch statement Type 3: functions	(10 marks)
Step 3	Application & Documentation	15%
	Technical report: not more than 20 pages (excluding data sheet), neat and well presented in printed form (except for schematic drawing) • printed form must be in Times Roman with 1.5 spacing • front page (Project Title, Name & ID Number of Group Member, Name of Lecturer, Year of Study) • student creativity and implementation • progress report consists of three elements : a) hardware explanation: buffer, driver, applications b) software explanation: pseudo-code/flowchart c) full schematic drawing (CAD or manual) d) future work of the project	(30 marks)

The group members were asked to design the layout of the circuit, as in Step 1. They were then required to reconfirm the layout by briefing the lecturer. During this session, group members must present the detailed schematic drawing of the layout. Other than the layout, supplementary materials, such as basic data sheets, hardware layout, and computer programs were also shown and discussed. The group must consult and discuss with the lecturer before proceeding to the next step.

At every stage of the project, participation and discussions were not only encouraged but also required. Hence, the project work encourages students to learn by doing; it enhances their capability to learn and relearn; it enables them to recognize their fortes; and, most importantly, it imparts knowledge management skills [2].

3.2 Method of assessment

For each of the project assessed, an open-ended time frame was given until the dateline. The last one hour of every laboratory session was allocated for the students to demonstrate their work. The third test of overall course was the oral test, whereby each group member was required to explain the overall prototype to a panel of lecturers. Each student was given individual marks based on the performance during the oral test. As part of this process, students were encouraged to learn from other team members. It is hoped that the capability of life-long learning and continuing professional development is improved by returning the emphasis for learning to the students [2].

4. Results and discussion

4.1 Meeting the dateline

All the groups have successfully submitted the full report of the project on-time, and 80% of the projects functioned as expected. This reflects the high commitment of the students.

4.2 Prototype and selected project

Figure 1 shows the lecturer's prototype that was demonstrated to the students. The demonstration consists of the following:

- Setting Input/Output (I/O) pin configuration for a buffer.
- Downloading of C language to the buffer and activating the set of LED.
- Testing and configuring the parallel port using DB25.

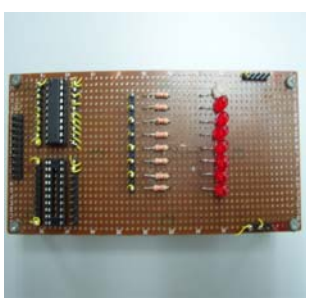

Figure 1. Top view of lecturer's prototype

In PBL concept, the main goal is to learn – learning by combining courses and engineering problem solving [4]. The prototype shown in Figure 1 is intended to challenge and motivate the students to understand the basic elements of the project.

The next task for the students is expanding the basic ideas shown in Figure 1. They were asked to display two 7-segments that will display a variety of numbers. Each group was nominated to use either coding Type 1, Type 2 or Type 3.

Figure 2 shows the final project by one of the groups of students. This group retained the basic elements or components of Figure 1 but added more circuitry. This group used Type 3 for coding the programme and the data was loaded through the buffer before displaying the number system from two units of 7-segments.

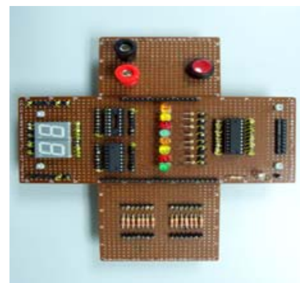

Figure 2. Top view of a project by the student.

4.3 Oral assessment

The objective of this oral assessment is to:

- Determine each student's capability and performance;
- Detect sleeping partners in the groups; and
- Verify the level of understanding about the course and the project.

The breakdown of the set of questions in the oral assessment is shown in Table 3. Each student was asked to answer any 2 questions from a set of questions. These set of questions will show whether or not the outcomes of the oral assessment have been achieved.

4.4 Student's Marks

Figure 3 illustrates the distribution of the overall grades of students in Section 1. The passing mark is 40%. No students from this section failed the course, and this is very encouraging as this is the first time the course was offered.

Table 3. The set of questions for oral assessment

	Software Explanation (10 marks)	Hardware Explanation (10 marks)
Questions 1	Explain the coding	Identify the pin of buffer that shows HIGH and LOW logic level
Questions 2	What is the function for pre-processor directive?	What is the function of the pin number?
Questions 3	Show the format of Type1, Type 2 or Type 3	What is the function of the buffer?
Questions 4	What is the function of Type 1, Type 2 or Type 3	Identify the types of 7-segments that are used in this project and why?

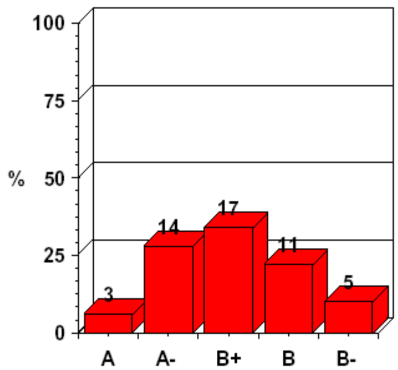

Figure 3. Distribution of overall marks for Section 1

Figures 4 and 5 show the overall grades for students in Section 2 and Section 3, respectively. Sections 2 and 3 consist of Year 1 and Year 2 diploma students, respectively. Only one student from each section failed the course. From studies done, it was found that the root-cause of the students' failure were due to poor attendance, poor team-working and lack of discussion with lecturers.

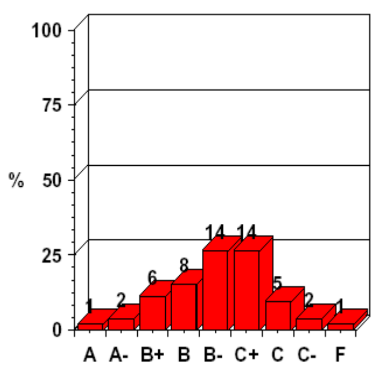

Figure 4.
Distribution of overall grades for Section 2

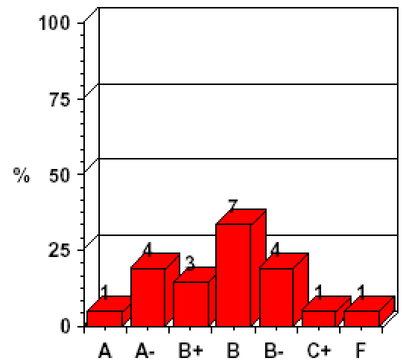

Figure 5. Distribution of overall grades for Section 3

5. Obstacles and suggestion.

There were some obstacles faced during the implementation of PBL in this course. The obstacles were:

- The implementation of PBL was based on trial and error. Lecturers did not have proper guidance and training, and so did not have a proper understanding of the concept;
- Preparation of teaching material. Lack of experience in teaching tertiary level courses, or having to teach a new course resulted in a heavy load for a new lecturer. In this situation, the lecturer is more interested in completing the syllabus rather than delivering the lectures using best practices.
- The issue of spoon feeding. The students expect the lecturer to deliver all the knowledge that they require. To a certain degree, this is not their fault since they have been "trained" throughout their primary and secondary school education.

Although the percentage of failure is less than 1%, there is still room for improvement. Some suggestions for improvement are:

- Encourage new lecturers to read more materials on engineering education.
- Cultivate a culture that engineers and lecturers are also responsible for engineering education, and not just the responsibility of educationists.
- Send new lecturers to attend courses that teach them to be more creative in teaching and learning.
- Have a more systematic and structured training on engineering education, focusing mainly on SCL, PBL, cooperative learning, etc.

6. Conclusion

It is observed that the students in this project attained different levels of positive development in the understanding of the course and project matter. In addition, Year 1 students were able to produce better than expected results. The confidence of the students during oral assessment was visible, and this was equally reflected in the project assessment. Students also acquired other related soft skills, such as creativity in making decision, communication and social skills, as well as team working.

Although much improvement need to be made, the positive outcomes and experience gained in kick-starting the implementation of PBL made the effort worthwhile.

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