A First Attempt of Problem-Based Learning (PBL) in Microelectronic Course (BKE 4423) for Computer Engineering Undergraduates at Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO).

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ABSTRACT

This paper discusses a review of a first attempt of Problem-Based Learning (PBL) in Microelectronic (BKE 4423) Course for Computer Engineering undergraduates at Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO). The target of this PBL is to design a 4-bit Carry Lookahead Adder (CLA) using both top-down and bottom-up approach. Ten undergraduates are working as a team to accomplish the task. The project is successfully completed in the given duration, which is two months. Throughout the duration, undergraduates are working independently to distribute the subtasks, learn new Computer-Aided Design (CAD) and Electronic Design Automation (EDA) tool, determine the most suitable methodology flow and prepare the presentation and the documentation of the project. Upon completion, a 4-bit CLA codes and a 4-bit CLA layout are available. Simulations on both end products are shown. Both simulations are then validated against initial specifications and verified among themselves. Besides, the designs from different groups are compared for the minimum area, fastest speed and least transistors.

KEYWORDS: Problem-Based Learning, Carry Lookahead Adder

INTRODUCTION

With all the rapid change and progress in the world, little has changed in the way engineering graduates are taught. Technology may have changed the chalk and talk method to include overhead projectors or computer (powerpoint) presentations; the delivery style, however, is still very much the same, if not worse. Dimmed lights during computer presentations makes it difficult for students to take notes and more convenient to doze off [1].

In Malaysia, students in general are highly examination-orientated. In schools, they are drilled on the correct way of answering examination questions rather than developing true understanding. In universities, with a large amount of content and didactic lectures being the predominant mode of instruction, engineering students resort to rote learning to commit lecture notes to their short-term memories before a test so that it can be reproduced.

Students also detest reading books and journals, preferring printed notes and handouts, which they religiously refer to as if there were no other sources of reference. For most, the retention of material is only until the final examinations. It is therefore not surprising that students can hardly recall the previous semester's material, much less in several semesters after they graduate.

Engineering educators are faced with demands from various sectors to produce graduates who can be effective in today's borderless k-economy [3]. To accommodate these demands and adapt to changes in the 21st century, Problem-Based Learning (PBL) is proposed as an alternative to traditional lectures in moulding engineering graduates to acquire the desired attributes.

Problem-based learning was introduced over 25 years ago, began at McMaster University Medical School [2]. It has been implemented in various undergraduate and graduate programs around the world. Additionally, elementary and secondary schools have adopted PBL. The PBL approach is now being used in a few community colleges as well. Those charged with educating professionals have found PBL to be effective in allowing learners to assume the role of problem-solver in areas relevant to their studies and to their future work.

PROBLEM-BASED LEARNING

What is Problem-Based Learning?

- Problem-based learning has some typical features as follow [1]:
- Problems are designed to emulate real-world problems.
- Problems used are complex and cover multiple objectives.
- The problem or task is introduced FIRST, before any learning occurs.
- Learning procedures, facts, and concepts occurs within the context of finding a solution to the problem.
- Specific procedures or algorithms are learned as needed.
- Additional structure for learning is proportional to the experience level of the learner.
- Much of the structure for learning is provided through in-depth questioning by the instructor.
- Students using this process usually work in cooperative or collaborative groups to gain multiple perspectives on possible solutions.

Objectives

- The objectives of PBL are to produce learners who will:
- Engage the problems they face in life and career with initiative and enthusiasm.
- Problem-solve effectively using an integrated, flexible and usable knowledge base.
- Employ effective self-directed learning skills to continue learning as a lifetime habit.
- Continuously monitor and assess the adequacy of their knowledge, problem-solving and self-directed learning skills.
- Collaborate effectively as a member of a group.

The PBL Process

Having examined the emotional reactions PBL might engender and the challenges of working in groups, it is important to consider about the process or steps to attack and solve a problem in PBL. Figure 1 provides a schema of a typical PBL process that has been applied in this mini project.

The PBL Result

Students involved in problem-based learning acquire knowledge and become proficient in problem solving, self-directed learning, and team participation. Studies show that PBL prepares students as well as traditional methods. PBL students do as well as their counterparts from traditional classrooms on national exams, but are in fact better practitioners of their professions.

PBL IMPLEMENTATION IN MICROELECTRONIC COURSE

Formation of a Team

There are a total of ten undergraduates in a 4-bit CLA design team. Among the ten undergraduates, a group manager is selected as the tasks distributor, project progress keeper and coordinator. During the beginning stage of this project, lecturer guides the students in recognizing the project background, objectives and scopes. This guidance is then transferred into a five-page proposal to be submitted to the lecturer.

Defining the Problem

The given problem is defined as follow:

"*You are required to design, simulate, and verify a design of 4-bit carry lookahead adder. All the design should be implemented via bottom-up design (using L-Edit by Tanner) and top-down design (using either VHDL or Verilog with Altera platform).*

For bottom-up design, choose the nMOSFET's to have aspect ratios of $(W/L)_n = 8$ *and the pMOSFET's with aspect ratio of* $(W/L)_p = 12$"

Objectives of the Project

- To understand top-down and bottom-up design methodology
- To design the 4-bit CLA using VHDL and L-Edit.
- To simulate the functionality of the 4-bit CLA.
- To verify the result of simulation.
- To compare the result of VHDL and L-Edit design.

Scope of the Project

- Designing 4-bit CLA by using design entry method – schematic, VHDL code and layout design method.
- Simulation of those approaches will be done.
- Those simulation results will be compared to verify that those approaches achieve the specification of 4-bit CLA.

EXAMPLE OF PBL IMPLEMENTATION

Project Background

Adding is the most basic arithmetic operation. To add an addend to an augend, to product will produce sum and carry. This can be done by using an adder circuit. The adder circuit will depend on the number bits of addend and augend.

The carry-look-ahead adder solves the ripple carry adder's propagation delay issue by calculating the carry signals in advance, based on the input signals. It is based on the fact that a carry signal will be generated in two cases: (1) when both bits A_i and B_i are 1, or (2) when one of the two bits is 1 and the carry-in (carry of the previous stage) is 1.

Seeking Information

The reasons to use two kinds of approach are to compare and verify the result achieved from each approach. Beside that, the top-down approach is to compare those alternatives and choose the best solution for the problem. In seeking for information, various resources can be referred to get the different designs of the 4-bit CLA for the top-down approach.

Generating Options and Selecting a Solution

For the top-down approach, there are a few options for the 4-bit CLA design:

- Two 2-bit blocks CLA with ripple carry between blocks using schematic and VHDL code.
- Two 2-bit blocks CLA with ripple carry between blocks (alternative design) using schematic and VHDL code.
- 4 single bit block CLA using schematic and VHDL code.

Presenting the Solution

After each part is done, they were combined into level and then the two levels were combined into the whole layout that is requested by the problem. There are 221 transistors in this design. The length is 154λ and width is 590λ.

COMMENTS ON PBL APPROACH

Students Feedback

Appendix A provides a part of the comments from the students for this PBL implementation in this course.

Summary of the Comments

This is a good learning method whereby a designing problem and situation resembles a working environment. The students have to pick up the necessary skills independently. By this, the knowledge and skills can be equipped with the students for a longer period. In the process of learning, they apply what they have just learned. Through this immediate application, they would know the usage of the certain knowledge and skills better. Students will also be self-determining in problem solving. They have to find out the solution and methodology by themselves. In the real working environment, solution would not just come out by itself and it needs to be figured out by researching all related information and current issues. PBL also helps to build up the mentality for the students to be ready to involve in any real world problem or working environment. By this, student can always get ready to work and contribute to the society.

SUGGESTIONS ON PBL APPROACH

In the PBL, time is the major problem for the students. While doing other tasks, students have to consider the completion of the PBL project too. They need to do a lot of researching and solutions findings. At the end of the project, students need to come out with a report. So, the dateline for the project should consider other tasks and estimated time of completion.

The problem has to be designated according to the difficulties and considering the level of study. The purpose to do so is to make sure the students understand about the whole project and what they are going to learn. The task division in a group is important to make sure it is fair and the progress should be cleared by every member so that everyone can follow the knowledge that they are learning and to avoid any skill miss out.

The progress in a group should be always presented to the class to share any important information that the other group that might left out or to learn any new and more efficient skill. In the PBL project, the challenging parameters should be determined and the best solution would be produced if the parameters have been countered. Mean while, the lecturer should play a role as guidance provider, so, the students would sail on the right path and the solution can solve the actual problem.

CONCLUSION

Problem-based learning is another method of learning that is suitable in any level of education. It is an instructional method that uses real world cases or problems as the starting point of learning. It is also like an alternative that prepare the challenges for engineering graduates for 21st century. In other words, it gives the simulation for the undergraduate students before they facing any other real world challenges when they get into working environment. From the given example, PBL works effectively among the undergraduates in KUiTTHO.

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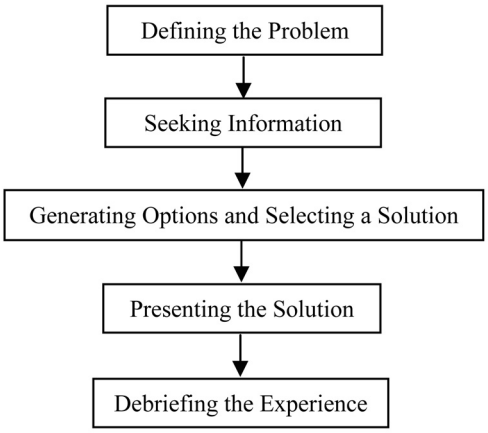

Figure 1: The PBL Process

APPENDIX A

From: KHAIRUL NIEZAM MOHAMMADIAH

To me PBL is interesting but I have to say that our group starts from nil with no ideas, reference or whatsoever. But from my personal point of view, PBL helps the students to immediately and directly apply the learnt subject. However, it proves to be quite burdening since it is a time consuming effort and should be judge with accordingly. It would be better if the mini project could be extended until the fabrication level since the design could be tested.

From: MOHD ZEID BIN ABU BAKAR, 830810145539

To me, the initiated Problem Based Learning or PBL is one good learning method since it encourages the students to think and 'learn to learn'. Besides, the PBL had actually gives the students a little bit of something on the real world (industry) problems. The given problem excites the students' curiosity to

know more. However, i have to agree with my friends about the limited and packed time frame for us to actually go through everything. About the passenger or 'hantu' thing, it is avoidable but it's hard to do so. Like I said before, the PBL let the students to experience the real thing... and in this case, the 'hantu' is real. You will keep on finding this sort of people in the future too. After all, this is how it looks like in the real world. But what the hell, the learning process sure is a success and a nice experience to remember. Thanks Mr. Afandi

From: KOK SENG, TEO

It is a good project since it really applies the knowledge that students have learnt in the class. We have explored the L-Edit software independently by ourselves with guidance from lecturer. It's a good way of learning since it enables the students to really master on the software without relying too much on the lecturer. We also learnt a lot in progress report presentation which has never been applied on other subjects' project before, is a good thing since it makes the students realize and keep on working on their projects without delay.

From: KAMALUDIN, ASRUL NAZIF

The implementation of the PBL leaves huge implications in education and teaching technique. It can be described as a double edged sword which presses more on indirect learning methods and informal education. In my opinion, PBL should be implemented on the 1st, 2nd or in 3rd year students so that it will gives them a direct exposure of what to expect during the final year project or PSM. PBL can be made more interesting by keeping abreast with the latest development and technology used in industrial sector today. Members of the group should consist of students with different academic background (weak, average and good) so that nobody felt to be left behind and resulting in greater outcomes.