ABSTRACT: Needless to say, an effective teaching approach plays a significant part in the dynamics of the educational process. Yet, there is not a ready made recipe that can be ideally suited to teach all courses. Thus, since the beginning of the educational process, many endeavors have been made to find that magic/optimal teaching method that suits everyone, everywhere at optimal time and cost.

The material presented in this paper is part of ongoing research and development on teaching and learning at undergraduate engineering courses. Hence, discussion is focused on salient practical aspects of teaching a 16-bit Intel 8086 microprocessor to novice engineering students. The outcome of this paper is an attempt to share experience and ideas concerning the teaching method at undergraduate engineering course.

Keyword: Virtual education, microprocessor, curricula

1. Introduction

Education is a dynamically interactive process within all aspects of life. With the fast march of the global market and the consequent technological advancement, there has been a growing concern about the present and the future of engineering educational process. A frightening statistic is that ‘in some fields’, 20% of an engineer’s knowledge becomes obsolete every year [1]. Despite the availability of information technology nowadays, the delivery of engineering, at tertiary education, depends largely on the traditional method [2]. An objective study [3] suggested that an urgent reform of the engineering tertiary educational system is needed, as this system is expected to provide the skilled engineering workforce for today’s manufacturing technology [4]. Somehow, this has put extra pressure on engineering educators to adopt new teaching approaches to keep abreast with the new technologies without affecting the engineering academic standard.

The academic engineering standard is always quantified based on the quality of both the engineering concepts and their validations throughout the undergraduate engineering courses. This can be achieved by a balanced scientific and hands-on approaches in the engineering curricula. Therefore, the acquisition of engineering skills, during engineering courses, depends widely on the understanding and the flexibility of the teaching methodology [5]. However, the real dilemma is the growing pressure on the standard third level engineering education courses to be as short as possible. Perhaps, this indicates the declination of student number in some engineering courses and hence gradual decline in engineering competencies.

The material presented in this paper is based on some of the author’s experience in teaching undergraduate engineering students at IT educational sector [6] in Ireland. It takes into account the course delivery tools, course structure and practical measures to introduce a 16-bit Intel 8086 microprocessor to novice engineering students. This is part of an effort to further the engineering academic standards and make the engineering courses more attractive at minimum time and least resources.

2. Course delivery tools

Often, it is not an easy task to choose the appropriate method and the relevant support tools to teach novice engineering students. However, in tangent with the modern market, a new form of course delivery mode with new tools is gradually replacing the traditional engineering educational method. Generally, this new method is based on the interactive approach using computer technologies. This includes the development of lectures, tutorials, assignments, practical studies and student support materials to dynamically create and solve problems and to provide a number of questions and detailed answers for students. The objective of this method is to help students at their learning activity locally or remotely through the web. There are a variety of computer-based tools available commercially for teachers/instructors to design the most effective interactive remote [7].

Recently, the author has been involved in developing micro-world for computer assisted learning of mathematics for engineering students using VBA Microsoft Excel for [5]. This is part on ongoing research to implement ubiquitous interactive web site to deliver automated dynamical problem creation and solution to students over the internet. This will provide an
integrated GUI driven computer environment where students can work in a virtual laboratory.

The course delivery tools used effectively in the present model are the most popular commercial computer-based tools available. These tools were used as follows:

(i) Class/practical presentation:
- Macromedia products (i.e. Authorware/Dreamweaver, Director MX, Flash and Breeze).
- Audio and video streaming
- MS Power Point.
- Programming tools (e.g. Java, C++, etc.)

(ii) Virtual laboratory:
- Matlab
- LabView
- MultiSim
- Simulators/emulator.
- Video and audio capturing and streaming

In general, these tools can be implemented to create a range of effective interactive/virtual engineering courses locally or remotely through the Web. A framework of the development of a virtual educational environment is shown in Figure 1.

Figure 1. Framework of the development of a virtual educational environment.

3. Course structure

The 16-bit Intel 8086 microprocessor is a second-year module in an overall add-on degree in computing engineering. The 8086 microprocessor course was designed for students who successfully completed a basic course in digital electronic. The aim of this course is to teach students the first principles of internal functions of a 16-bit 8086 microprocessor. This is to enable students to learn the programming, interfacing and control techniques and prepare them for higher relative studies. This course was credited for 30 lecturing hours and 45 practical hours per semester. This means that students will be scheduled for 2 lecturing hours and 3 practical hours every week per semester.

The practical Lab work covers practical assignments and tutorials. These assignments consist of sessions on Intel 8086 family of microprocessors, code written and cross compiler using a PC IBM computer and a training kit. Each practical session is marked and weighted based on the accuracy of the completed assigned practical activity and the time spent to complete the entire practical activities. In general, there will be 7-9 labs for this module. Some of these practicals are introduced in a form of tutorial questions or in a form of mini projects. The overall practical works per semester is termed as the student Continuous Assessment. Therefore, students are urged to submit their lab work/tutorial questions at the end of each lab session. Final exam is weighed 70% and the final Continuous Assessment is weighed 30%. These two components will be added together and a student should score 40% in order to just pass the module. Having completed this module successfully, students can progress to take more advanced digital modules and
hands-on projects in the subsequent years in the degree programme.

Subsequently, students will study embedded systems, hardware/software co-design systems, computer architecture, digital signal processing and other relevant modules.

3. Delivery method

Experience shows that students in general tend to shy away from the subject of a microprocessor at the beginning of the course. This indicates that students require more detail about internal works/functions of the microprocessor. Thus, material should be presented in such a way that students meet the outcome, but also understand and built upon the material they have learned [8]. This suggests that an objective detailed delivery method for microprocessor needs to be more attractive and up-market. Consequently, a range of classes, lecture notes and a number of interactive questions and answers were designed/arranged carefully using a combination of quality MS Power Point, Macromedia Authorware, and Director MX including animation and video/audio streaming.

In the last number of years, students were exposed to a number of practical tools to support their learning of microprocessor. Initially the relevant laboratory was proposed with a microprocessor training system. This consisted of an 8086 16-bit microprocessor trainer board with a comprehensive range of accessories and application board [9]. In conjunction with the 8086 training system, there were laboratory manuals and tutorial questions and answers. Students were asked to submit a completed standard report with a detailed account of the task designed for every practical session. This training facility was more than enough resource for students to learn the basic 8086 principles to programming, interfacing and control techniques. However, it was felt that this training facility was not enough to give students the knowledge needed to validate/understand the internal work/design of an 8086 Intel microprocessor. Thus, the 8086 training board was replaced with a Target 188EB Development board with the relevant accessories and relevant programming tools [10]. With this facility, students learnt how to write an assembly code using Borland C compiler for a particular application and embed the code onto Target 188EB. This was to investigate the internal works/design of the 8088/86 microprocessor though the debugging process. The outcome of this practical mode was very satisfactory in terms of building and validating the concept of 8086 microprocessor. However, it was time consuming and required a substantial technical back up support to maintain smooth running of the laboratory. Consequently, an appropriate 8086 visual microprocessor emulator with a new method of laboratory investigation were suggested for the practical mode of delivering this course.

4. 8086 Visual Microprocessor emulator

There are a number of tools available on the web to develop an assembly code and hence to simulate the executable function of a microprocessor. As some of these tools are beyond the capability/level of novice students, choosing the most appropriate simulator is a constant challenge [8]. Thus an 8086 Visual Microprocessor emulator [11] was chosen to fulfill the needs for students of this course.

In the laboratory, the source code is assembled and then executed by the emulator in step by step mode. Students are asked to investigate, calculate, map the registers, flags and memory while the program is running. It is possible to load any executable (*.exe * .com *.bin etc) and use Ema8086 for reverse engineering. Visually, this emulator shows the internal work of the CPU including a few virtual devices to play and experiment with. These devices include an LCD display, a simple traffic lights system, a robot which moves around, a stepper motor and printer emulation. Students can even design their own virtual devices to practice device controlling. Stack and memory values can be viewed by just double clicking on them and the screen can be used to output data. Also, the emulator includes an expression evaluator that can be used to make mathematical and logical operations with hexadecimal, octal, binary and decimal values.

Laboratory assignments are designed to make use of the full capability of the emulator. Also, this is to aid the students to maximize their understanding of the internal works and control of the 16-bit 8086 microprocessor in palatable alternative fashion. The students can get access to the lecture notes, lab assignments, tutorial and emulator through the student drive on the local network on the campus. Equally, students can get access, to LabView, Multisim, and digital electronic material and other CAE tools in conjunction with the material for microprocessor. To this extend, students can remotely solve and submit their completed tutorials and laboratory assignment at minimum use of the physical resources. Figure 2 shows a conceptual model of the delivery mode of an 8086 microprocessor course.
5. Practical consideration and future plan

The current approach to date is to write software that is capable of creating problems which typically involve random quiz, and detailing associated solutions. Ultimately, this is to develop an interactive web site capable of delivering the theoretical and experimental material for the microprocessor. This should also provide a function to continuously create quizzes/problems and solutions to students. The module should contain a set of problems/miniprojects underlying microprocessor applications. Students should be introduced to the basic concepts of these problems based on a 16-bit microprocessor. They are encouraged to solve the assigned problems/miniprojects through group work and, at intervals, make a presentation on their work. Based on the experimental and theoretical investigation of each mini project, each student has a different related problem to solve through the virtual system. This is intended to reduce the possibility of direct “cogging” by students, and enhances the sense of personal “ownership” of their particular problem. Students who get stuck can simply look at the answer provided, and unlike a book or a problem database that has limited numbers of questions, the system can then create a brand new problem and try again. They can also experiment by creating different types of problems (sometimes specifiable within the application) and looking at the solutions to see how the solution varies with the problem. The system can be equipped with webCam/satellite connection for on-line video conferencing/presentation.

6. Results and discussion

Given the different delivery methods presented in this paper, the virtual delivery was met with high expectation and enthusiasm by students but interestingly, it did not have a major impact on the final grades. A year later, with the same number of students, after implementing this virtual delivery method, a mean final results of students showed an increase of about 2.5% in the practical works and about 3.5% in the final written exam. This may suggest that some of the students feel that the material is always available on the local network and hence, this could give them an apathetic attitude towards working on these materials. Perhaps, this could be due to the nature of the computer learning activities and relevant virtual learning environment. Although this environment is opened to students to practice time after time until they reach the competency needed, it requires a very high self motivation and discipline. Thus, this goes without saying that the impact of motivation in this form of education on students grades/performance needs to be substantiated seriously.

Certainly the remote/virtual approach for completing educational tasks is offering a flexible engineering education using less resources. This would alleviate laboratory’s occupation [12] and reduce the class contact hours. Consequently, this could shorten the length of the overall engineering courses and hence make these courses more attractive in the modern market. However, so far, it is felt that weighing and forecasting the students performance is not possibly accurate, as this method is still relying on the traditional educational quality framework which is centuries old.
The author came across an interesting study in engineering training presented in a pyramid shape graphic [13]. This showed that the average retention rate was 20% for the audio-visual and 75% for practice by doing in the engineering training process. According to this study, the audio-visual training came third from the top of the pyramid, and practice by doing came second from the base of pyramid. This is definitely some inspirational message to all of us as educators.

7. Conclusion

A package of virtual educational method at engineering undergraduate level has been presented. Provided measures for new educational quality framework and benchmarked feasibility studies are made available, this new form of engineering education will make engineering courses more effectively attractive. However, time will tell if this new form of education is going to create a balance between engineering academia and industrial training.

8. References


