METHODS FOR EVALUATING THE EFFECTIVENESS OF A C PROGRAMMING TEACHING TOOL

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ABSTRACT. Programming has always been one of the subjects that are associated with high failure rates. The shortage of programmers is often cited by IT related industries as major problem in hindering growth. Improvisations are often done to teaching methods and tools to capture interest in programming. The method we introduce is to teach programming on an embedded kit. This paper describes the methodology used in evaluating the effectiveness of an embedded system teaching tool for C programming. An illustration of the testing process and evaluation method used are detailed. The results of the evaluation are also given.

Keywords: Teaching and Learning Programming, Embedded Systems, C Programming, Teaching Tool

INTRODUCTION

Introductory college computer science course has always been associated with high failure rates (Susan, et. al. 2004). In research published by Shukur et. al., (2005), programming was found to be among the subjects not favored by the students in IT and Computer Science stream. The research found that 33.33% students are getting grade D for computer programming course. According to a study conducted at Universiti Tenaga Nasional, 40.1% of students are not interested in learning Programming (Programming Task Force Report, 2009). This was evident by the statistic that shows that 41% of students do not want to learn other languages after learning the C Programming subject. In addition, the same study also found that students only allocate less than two hours per week to learn Programming subject while 74% do not do homework before class and 50% of the students admitted that they allocate more time to learn other subjects compared to programming. The lack of interest in programming was supported in the observations made by Ahdon, (Ahdon, 2010) who found that students' behavior during the process of teaching and learning programming demonstrated the lack of responses and interest in the question and answer sessions conducted.

Understanding the importance to teach programming from school to generate students' interest to programming, the Government of Malaysia, through the Ministry of Education, has introduced the Computer Programming course for Vocational Schools. This course teaches the Fundamental of Programming, and Programming and Development Tools subject that relates to programming. For non-vocational schools, student also can take the ICT subject where one of the modules in the subject introduced students to programming via Visual Basic. With early exposure in programming, the government hoped the aim to produce and increase number of programming experts in the future would be achieved. Until 2010, there are about 18 Vocational Schools that offer this subject. However, the number of students sitting for the subjects is still small. In 2009, only 316 students from overall 31166 or 1.01% of vocational students take Computer Programming course (KPM, 2010) and in 2010, this number goes to

300 students over 23411 or 1.28% of vocational students (KPM, 2011). In 2011, there are 416 students from overall 23246 or 1.77% of vocational student take the computer programming course (KPM, 2012).

In Japan for example, they use the Robotic methods to stimulate students' interest towards programming and this has given a positive impact because Japan is recognized as one of the nation with a large number of programmers as well as having the biggest number of embedded systems and robots (Dodds & Ogasawara, 1992). A common way is to use Lego Mindstorms®. Japanese students have been exposed to this method from the age of 6 or 7. They also teach languages and computer programming to high school students at some private schools (Fujioka at el, 2005). In India, they use embedded system to teach programming since childhood, from standard six to nine, and this has also been proven to be effective in producing a large number of skilled programmers (Kannan, 2010). Learning from these success stories, a module for teaching C programming was developed using embedded system. The teaching tools include a complete teaching module that teaches the fundamentals of C programming and relating every topic with examples that can be implemented on an embedded kit. A complete lab experiments and exercises for the students to try out were also included. The preliminary study at Malaysian schools done prior to the module development is discussed in (Hawari & Suliman, 2010; Suliman et. al., 2011). Other publications that discussed the teaching tool can be referred from (Nazeri et. al., 2013; Suliman et. al. 2012). This paper only touches on the methods of evaluation for the teaching tool. The paper is divided in sections that describe briefly the teaching modules, a more extensive elaboration of the evaluation process and the results before it concludes.

THE MODULE

As mentioned before the modules are developed based on the syllabus of Fundamentals of Programming Language (C Language) but with an introduction to Embedded Systems Programming (ESP) so the students may be able to use the accompanied training kit to test their programs. Table 1 shows a brief outline of the content of ESP teaching module.

Table 1. Topics contains in ESP module

Chapter	Topic
1	Introduction to Programming
2	Basic Problem Analysis and Design
3	Fundamentals of C programming
4	Selection Statements
5	Iterative Statements
6	Introduction to Embedded System
7	PIC16 Background
8	Embedded Programming

THE EVALUATION METHOD

A suitable teaching method for this module is a combination of lecturer oriented and student oriented method. The lecturer oriented is a method that needs the instructor to teach and explain the concept to students and students are required to understand the things that are taught by instructors to make teaching and learning is effective. Chapter suitable for this method is practiced Chapter 1, Chapter 2 and Chapter 6. Student oriented method is a method in which students were required to discuss among them to solve or learn something. Through this method, students will be given a problem or question and they have to answer

the question. This method is appropriate practice in chapter 3, 4, 5 and 8 as students need to produce a program and display the output through the embedded kit. They will discuss in their groups and then have to produce a program based on the questions given to them.

The Sample

In representing the population, which is the schools in Malaysia, a careful selection was made. Since the testing phase is not merely surveys or questionnaires but involved intensive trainings a large sample would not be possible. Due to time, money and work force constraints only a very small numbers of selected schools were chosen. However the demographic and grouping of the selected school is considered to be very well presented of the population. The syllabi of all schools in Malaysia are controlled by the Ministry of Education, as such any schools can be assumed to have the same level of education at a given point. In considering the urban and rural factor that might have effect on the students' performance, two schools are selected from Selangor which are nearer to Kuala Lumpur city and two schools are selected from the northern part of Malaysia as shown in Table 2.

Table 2. The Selected Schools

	GROUP 1	GROUP 2
Exposure to programming	8 months of basic programming	None. Only general ICT subjects taken.
Programming Languages learned	HTML, PHP and C Programming	None.
Name of schools	Sekolah Vokasional Balik Pulau, Penang Sekolah Vokasional Shah Alam, Selangor	Sekolah Kebangsaan Derma, Kangar, Perlis Sekolah Kebangsaan Bandar Baru Salak Tinggi, Selangor
Number of students	34	36

The Teaching

During the teaching process, students will be divided into groups of 2 to 4 persons. Each group is provided with one ESP module, one embedded kit and one set of answer booklet to enable students to write answers to each exercise session. The concept of TALK, where the instructor gives lecture and DO, where the students are involved in doing programming oriented tasks are incorporated in the teaching plan. Table 3 gives the details of the teaching plan. Due to the time constraints only Chapters 1, 2, 3, 4, 5 and 8 are covered. These chapters adequately covered the fundamental topics of C programming and a brief introduction to Embedded Programming where students are exposed to the basic concepts of programming on a PIC16F877 microcontroller. In the earlier part students used the kit in experimenting with their C programming concepts without the need to worry about the microcontroller programming as the will merely be called functions from a specially made libraries.

The Assessments

The students are assessed in three ways: exercises and quizzes, project and questionnaire. For every topics taught they are given quizzes and exercises do. The exercises and quizzes are graded and marks are collected and stored for every individual student. At the very end of the teaching session each group of students are required to do a Project. Project is to identify

either the students can apply what they are taught, to produce a program using the Embedded Kit. Each group was given time for 3 to 4 hours to write a program using the embedded kit that must have input and produce output. Scoring does not necessarily depend on the creativity of students in producing exciting programs but awarding marks are dependent on the amount subtopic that is included in the program. The more subtopics included in a program, the more marks are obtained. Each group is required to present their project.

Survey was done to get feedbacks and views from the students regarding the teaching sessions conducted, the module and the training kit used. A questionnaire contains a number of questions about interest, understanding and improvement that can be done are distributed and collected. This survey is done after the completion of the teaching and learning process.

Table 3. Teaching Plan

TIME (approx.)	CONTENTS	METHODS	RESOURCES
30 mins	Introduction of the Course	TALK	Embedded Kit
60 mins	Introduction	TALK	Module and PowerPoint Slides
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
60 mins	Problem Analysis & Design	TALK	Module and PowerPoint Slides
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
120 mins	Fundamentals of Embedded Programming	TALK Demonstration DO : Doing Experiment	Module, PowerPoint Slides and Embedded Kit
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
90 mins	Selection Statements	TALK Demonstration DO: Doing Experiment	Module, PowerPoint Slides and Embedded Kit
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
120 mins	Looping Statements	TALK Demonstration DO: Doing Experiment	Module, PowerPoint Slides and Embedded Kit
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
150 mins	Embedded Programming	TALK Demonstration DO: Doing Experiment	Module, PowerPoint Slides and Embedded Kit
30 mins	Quiz and Exercise	DO (Write answer in answer booklet)	Quiz/Exercise Question
120 mins	Project Preparation	DO: Developing a programming project	Embedded Kit and Module
30 mins	Project Presentation	DO: Group Presentation	Embedded Kit
960 mins	TOTAL		

THE RESULTS

All the marks accumulated by the students from the exercises, quizzes and projects are totaled and a common grading scale are used to give each of the student a grade. Detailed results can be referred to in (Nazeri et. al. 2013). In general it can be said that both group did equally good. There are no huge gaps observed in the results of the two groups though the

group who had done programming before did do on average better than the group who have not done programming. Figure 1 compares their achievements. In project works, the groups that have no basic programming seemed to be better at applying what they have learned. This group applied more programming techniques that are taught to them and incorporate more I/O devices on the embedded kit into their projects. Hence their projects showed more creativity and complexity. Figure 2 gives an estimate of the topics applied in their projects.

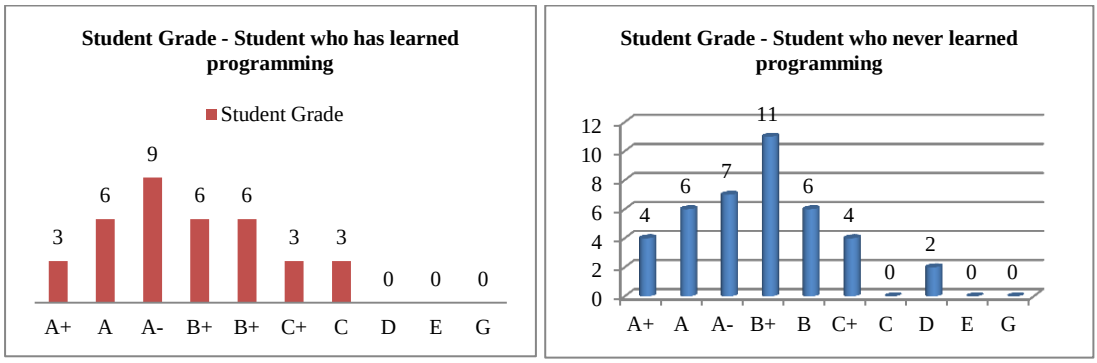

Figure 1: Grades comparisons of the two groups

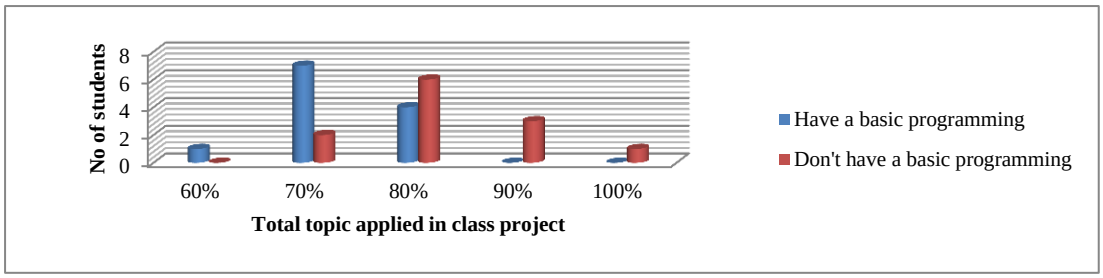

Figure 2. Percentage of topic applied in student's project

CONCLUSION

In general the teaching tool was developed and tested in accordance to steps prescribed in a research project. A preliminary study was done prior to the development in hopes of gathering ideas and requirements in order to go forward with the development. The teaching module, the experimental and training kit were then developed following the basic topics covered in many programming books. A teaching plan was devised and the module is taught to groups of students. Results are collected and analyzed and the findings are documented. The effectiveness of the teaching tool is measured through the performance of the students. In any teaching assignments, the success of the teaching methods, modules, and the instructor is commonly measured through the achievements of students in their exams and tests. Grades achieved will reflect that the teaching sessions have been effective in achieving its outcomes. As such, the results of this study have proven that the teaching tool is effective. We feel the use of embedded systems as a medium to run the C programs has proven to be effective in attracting student interest in learning programming as well as able to enhance the students' understanding. With interest and deep understanding of the concepts taught, the students would naturally excel in their tests and exams. The method of teaching C through embedded system should be considered as an alternative teaching method to the current method as its effectiveness has been proven.

REFERENCES

Ahdon M. F. (2010) *Penggunaan Robot Soccer Sebagai Alat Bantu Mengajar Bagi Kursus Pengaturcaraan C++*. PTSS Digest.

Dodds C. and Ogasawara T. (1992). *Robotics in Japan: From east to west and outer space to inner space*. The Queen's University of Belfast and Electrotechnical Laboratory, Japan.

Fujioka, T., Takada, H. & Kita, H. (2005). New Challenge of Information Science Education Based on PBL Using Squeak eToy: ISEC-SeT. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 14-21). Chesapeake, VA: AACE.

Kannan S. (March 22, 2010) Chennai school to teach robotics, *The Hindu*, Retrieved from http://www.thehindu.com/features/education/school/chennai-school-to-teach-robotics/article267516.ece.

Kementerian Pelajaran Malaysia (KPM). (2009). Bahagian Pendidikan Teknik dan Vokasional,. *Analisis Keputusan SPM 2009 Sekolah Menengah Teknik dan Sekolah Menengah Vokasional*.

Kementerian Pelajaran Malaysia (KPM). (2010). Bahagian Pendidikan Teknik dan Vokasional, *Analisis Keputusan SPM 2010 Sekolah Menengah Teknik dan Sekolah Menengah Vokasional*.

Kementerian Pelajaran Malaysia (KPM) (2011). Bahagian Pendidikan Teknik dan Vokasional, Analisis *Keputusan SPM 2011 Sekolah Menengah Teknik dan Sekolah Menengah Vokasional*.

Nazeri S., Suliman A., Yussof, S., & Mohd-Salleh N. (2013). Measuring the Effectiveness of Teaching and Learning Programming through Embedded Systems, *2nd International Conference on Teaching and Learning Education* (ICTLE2013), 21 - 22 May 2013, Melaka, Malaysia.

Programming Task Force Report. (2009). *Result of survey questionnaire and suggestions*, College of Information Technology, Universiti Tenaga Nasional.

Shukur Z., Alias M., Hanawi S. A., & Arsad A. (2004). Faktor-faktor Kegagalan: Pandangan Pelajar Yang Mengulang Kursus Pengaturcaraan C , *Technical Report*, Jabatan Sains Komputer, FTSM, UKM

Suliman A., & Nazeri S., (2012). The Effectiveness Of Teaching And Learning Programming Using Embedded Systems, Proceedings of ICIDT 2012, *8th International Conference on Information Science and Digital Content Technology* 1, pp. 32-36

Suliman A., Nazeri S., & Yussof S. (2011). A Study on Teaching and Learning of Programming Subjects at Vocational Schools in Malaysia, *1st International Conference on Teaching and Learning Education* (ICTLE2011), June, UNITEN Bangi, Malaysia.

Suliman A., Hawari R., & Othman M. (2011). Preliminary Study of Teaching Programming at a Malaysian School , *Proceedings of the 3rd International Conference on Computing and Informatics*, ICOCI 2011,8-9 June, Bandung, Indonesia.