Acceptability of PIC16F877A-based Microcontroller Training Unit and Laboratory Manual as a Supplementary Learning Material for Microprocessor Systems

Keith Marlon R. Tabal
College of Engineering, Camarines Sur Polytechnic Colleges, Philippines
k.r.tabal@ieee.org

Date Received: June 8, 2015; Date Revised: September 15, 2015

Abstract – *This paper discusses the creation of a training unit and laboratory manual based on a PIC16F877A microcontroller which was evaluated by both students and instructors of Bachelor of Science in Electronics Engineering of the Camarines Sur Polytechnic Colleges in terms of its acceptability as a supplementary learning material for microprocessor systems. Based on the result of the evaluation, it was revealed that the training unit obtained an average weighted mean of 4.65 for the students and 5.00 for the instructors which both fall under the "Strongly Acceptable" criteria. On the other hand, the evaluation for the laboratory manual got an average weighted mean of 4.44 which is verbally interpreted as "Acceptable" and 4.84 for the instructors which is verbally interpreted as "Strongly Acceptable". Using t-test, it was also revealed that there is a significant difference between the level of acceptability of the students and instructors to the training unit and laboratory manual*

Keywords – *laboratory manual, learning material, microprocessor systems, pic16f877a, training unit,.*

INTRODUCTION

Jobs-skills mismatch has been associated to the rising unemployment rate in the Philippines, with about 30% of an estimated 2.5 million college graduates in 2007 still without work according to Former Commissioner on Higher Education (CHED) chairman Emmanuel Y. Angeles [1]. It is either these graduates were not provided appropriate skills or they did not learn the skills but were able to graduate.

Laboratory materials and exercises have been an important aspect in providing the needed skills of a student when they graduate. An article [2] mentioned that laboratory materials such as learning modules, kits and instructional manuals plays a significant role in engineering education and helps prepare students to practicing engineering. Moreover, it has been said that "Laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science".[3] Furthermore, it has also been proven that students who engage in laboratory activities develop problem-solving and critical-thinking skills and that hands-on experiences help inspire students to further their education and prepare them for high-technology careers by fostering skills sought by potential employers.[4] However, the laboratory activities should conform to the course curriculum and that it should meet the minimum requirement by CHED. This will make sure that the laboratory correlate closely with lectures and not be separate activities.[5]

The Camarines Sur Polytechnic Colleges (CSPC) is doing its best to provide its graduates the necessary skills needed in the outside world. However, due to insufficient laboratory manuals and training units in some of the laboratory subjects, providing these skills has become a major challenge both for the students and instructors. Among these subjects is Microprocessor Systems which is offered in the Ladder V of the degree, Bachelor of Science in Electronics Engineering (BSECE). In this subject, students should be taught not only to focus on theories; instead the students should be given equal time in applying these theories through simulations in laboratory activities where applications of the theories learned inside their classrooms are put to test.

It is for this reason that this study has been conceptualized. A Training Unit and Laboratory Manual for Microprocessor Systems course were created as supplementary materials to compensate for the insufficient learning materials in the laboratory. Moreover, the training unit and manual seek to provide additional practical support for the students taking up Electronics Engineering and also aim to equip them with competitive theoretical and technical knowledge thus encouraging them to get involved in the advancement in technology. The training unit and laboratory manual is based on the minimum requirements for laboratory by CHED. The training

P-ISSN 2362-8022 | E-ISSN 2362-8030

unit and laboratory manual will guide the students in learning the concepts of microprocessor systems operation and the actual programming of an embedded system. The training unit also uses locally available and affordable electronic components, thus making it possible for students to replicate the unit.

The supplementary material is evaluated in terms of the level of acceptability by the 4th year Electronics Engineering (ECE) students and ECE Instructors of the Camarines Sur Polytechnic Colleges. Further, the null hypothesis that there is no significant difference between the levels of acceptability by the respondents has been tested.

OBJECTIVES OF THE STUDY

This study aims to develop a supplementary learning material for learning microprocessor systems based on the CHED minimum requirements for laboratory for the course microprocessor systems. Further, this study also aims to determine the level of acceptability of the PIC16F877A-based training unit and laboratory manual; and to assess if there is a significant difference in the level of acceptability of the supplementary learning material among students and instructors.

METHODOLOGY

In this paper, descriptive research method was used to evaluate the level of acceptability of the proposed supplimentary learning material for microprocessor systems. Moreover, this research used the process flow shown in Figure 1 as guide in conducting the study.

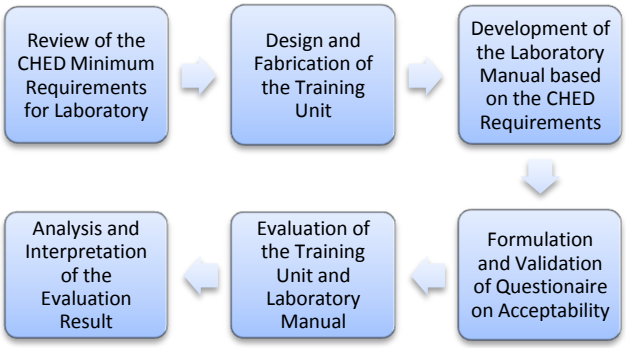

Figure 1. Process Flow

Review of the CHED Minimum Requirements for Laboratory

In a memorandum order [4] released by CHED, the minimum requirement for microprocessor systems laboratory is very broad. As shown in first column in Table 1, the requirements include activities such as familiarization with microprocessor system, LED matrix character generator, data transmission and reception through Input/Output (I/O) boards and stepper motor. Using these requirements by CHED, a more detailed training material for teaching microprocessor was conceptualized.

As shown in the second column in Table 1, a more detailed series of activities were included in the proposed training unit and laboratory manual in microprocessor systems. These include familiarization with the training unit, programming the PIC microcontroller, interfacing and programming basic output devices, interfacing input devices, liquid crystal display (LCD) interfacing, keypad interfacing, using timers and interrupts, analog-to-digital conversion, multiplexing output devices (2-digit seven-segment display and 5x7 LED Matrix), motor control (DC and Stepper Motor) and serial communications. These are intended to provide students a hands-on step-by-step approach in learning the subject.

Design and Fabrication of the Training Unit

A block diagram of the training unit is shown in Figure 2. The figure shows how the modules in the training unit are connected to the PIC16F877A microcontroller.

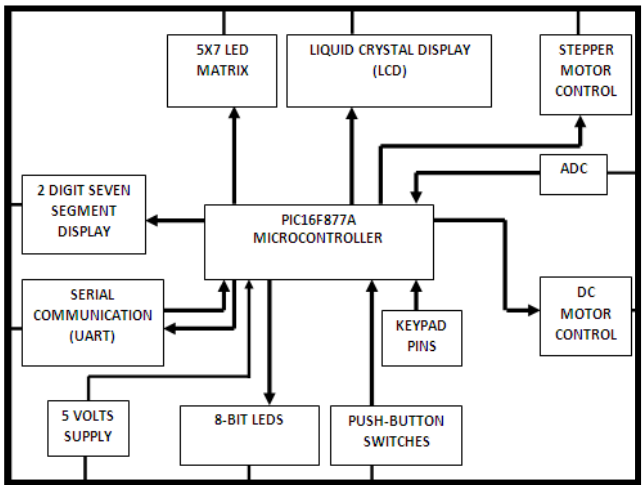

Figure 2. Conceptual Block Diagram of the Training Unit

The output devices in the block diagram are the 8-bit LEDs for basic output interfacing, 2-digit seven segment display for displaying numerical values, 5x7 led matrix for displaying characters, LCD for displaying alphanumeric, DC and Stepper motor

P-ISSN 2362-8022 | E-ISSN 2362-8030

controllers for driving motors. The input devices used are the push-button switches for reading inputs, analog to digital converter for reading analog signals such as varying voltages, and keypad for entering numerical values into the microcontroller. The serial communication is used both as an input and output since it is capable of exchanging serial data with a computer. Its main function is for computer interfacing. An external hardware programmer is used to upload or transfer the programs created in the computer to the training unit shown in Figure 3.

Figure 3. The Actual Training Unit

Development of the Laboratory Manual

The laboratory manual created was based on the training unit developed and the course syllabus. ECE faculty members also contributed ideas in the formulation of the manual's content. The manual contains eleven (11) chapters that include laboratory activities at the end of each chapter. The chapters were arranged in a manner that students start with the basic principles of microprocessor systems before continuing to the next chapters as recommended by the course syllabus. Each chapter in the laboratory manual is composed of the chapter title, the objectives that show the learning outcome expected after they finished the chapter, the references so that student will know what materials to look for in case they want to explore the topic more, the discussion that explains the topic for the student to understand the concepts, and the review question/s to test them on what they learned in each chapter. The laboratory activity has its title, specific objectives that show the learning outcome expected after they finished the activity, materials/software needed for them to know what software and which part of the training unit will be used, procedures that will guide them in the conduct of the activity, questions to test whether they achieved the objectives and conclusion to see what they had learned in the activity.

Formulation and Validation of the Questionnaire on Acceptability

A questionnaire was formulated to evaluate the level of acceptability of the training and laboratory manual. A dry run was performed by some of the engineering instructors to test the validity of the questions in the questionnaire. Further, the internal consistency of the questionnaire was validated using Cronbach's Alpha.

Evaluation of the Training Unit and Laboratory Manual

To determine the level of acceptability of the training unit and laboratory manual, an evaluation copy of the material and training unit was provided to the respondents who are instructors and students of CSPC. The total number of respondents who evaluated the training unit and laboratory manual were forty-three (43) students and five (5) instructors selected through a total enumeration. The training unit was evaluated in terms of usage convenience, how it contributes to the students' learning process and how it improves the students' level of understanding of the concepts. On the other hand, the laboratory manual was evaluated based on its content and the clarity of the objectives in the laboratory activities at the end of each chapter in the manual. The rating scale used has the following range of values and interpretations as as shown in the table below.

Table 1. The Five-point Likert Scale

Scale	Range	Verbal Interpretation
5	4.60 – 5.00	Strongly Acceptable
4	3.70 – 4.50	Acceptable
3	2.80 – 3.60	Moderately Acceptable
2	1.90 – 2.70	Fairly Acceptable
1	1.00 – 1.80	Not Acceptable

Analysis and Interpretation of the Evaluation Result

T-test was used in this study to determine the significant difference between the level of acceptability of the students and instructors of the training unit and laboratory manual in microprocessor systems among the students and instructor.

P-ISSN 2362-8022 | E-ISSN 2362-8030

RESULTS AND DISCUSSION

Table 2 shows the evaluation of the training unit by the students and instructors.

Each item is interpreted verbally according to the value of the arithmetic mean obtained. The evaluation ratings of the training unit in terms of ease of usage (4.50), contributes to the students' learning process (4.77) and improves the students' level of understanding of the concepts (4.79) were all verbally interpreted as strongly acceptable. The overall mean of 4.69 shows that the combined result of the students and instructors in the level of acceptability of the training unit is verbally interpreted as strongly acceptable.

Table 2. Evaluation on the Level of Acceptability of the Training Unit

ITEM	students		Instructors		OVERALL	
	Mean	Verbal Interpretation	Mean	Verbal Interpretation	Mean	Verbal Interpretation
The Training Unit:						
1. Is easy to use	**4.44**	Acceptable	**5.00**	Strongly Acceptable	**4.50**	Acceptable
2. Contributes to the students' learning process	**4.74**	Strongly Acceptable	**5.00**	Strongly Acceptable	**4.77**	Strongly Acceptable
3. Improves the students' Level of understanding of the concepts	**4.77**	Strongly Acceptable	**5.00**	Strongly Acceptable	**4.79**	Strongly Acceptable
Average Weighted Mean	**4.65**	**Strongly Acceptable**	**5.00**	**Strongly Acceptable**	**4.69**	**Strongly Acceptable**

Table 3. Evaluation on the Level of Acceptability of the Laboratory Manual

ITEM	students		Instructors		OVERALL	
	Mean	Verbal Interpretation	Mean	Verbal Interpretation	Mean	Verbal Interpretation
I. Content						
1. The topic is reflected in the course syllabus.	**4.86**	Strongly Acceptable	**5.00**	Strongly Acceptable	**4.87**	Strongly Acceptable
2. The terms used match the students' level of understanding.	**4.25**	Acceptable	**4.40**	Acceptable	**4.27**	Acceptable
3. The discussion of the topic is:	**4.29**	Acceptable	**4.79**	Strongly Acceptable	**4.34**	Strongly Acceptable
a. Clear	4.26		4.78		4.31	
b. Specific	4.47		4.93		4.52	
c. Comprehensible	4.14		4.67		4.20	
4. The illustrative examples given are:	**4.26**	Acceptable	**4.75**	Strongly Acceptable	**4.31**	Strongly Acceptable
a. Clearly presented	4.41		4.76		4.45	
b. Adequate to understand the concept	4.11		4.73		4.17	
5. The procedure is:	**4.34**	Acceptable	**4.88**	Strongly Acceptable	**4.40**	Strongly Acceptable
a. Brief	4.52		4.78		4.55	
b. Simple	4.43		4.89		4.48	
c. Easy to interpret	4.08		4.96		4.17	
II. Objectives						
1. Clear	4.63	Strongly Acceptable	4.98	Strongly Acceptable	4.67	Strongly Acceptable
2. Specific	4.54	Acceptable	4.96	Strongly Acceptable	4.58	Acceptable
3. Observable	4.42	Acceptable	4.98	Strongly Acceptable	4.48	Acceptable
4. Attainable	4.35	Acceptable	4.80	Strongly Acceptable	4.40	Acceptable
Average Weighted Mean	**4.44**	**Acceptable**	**4.84**	**Strongly Acceptable**	**4.48**	**Acceptable**

P-ISSN 2362-8022 | E-ISSN 2362-8030

Further, Table 3 shows the evaluation of the students and instructors of the laboratory manual. The average weighted mean of 4.44 which is verbally interpreted as "Acceptable" proves that the use of the laboratory material was accepted by the students and could contribute to the students' learning process, while the average weighted mean of 4.84 which is verbally interpreted as "Strongly Acceptable" proves that the use of the laboratory material was accepted by the instructors. The overall mean of 4.48 shows the combined result of the evaluation by the students and instructors in the acceptability of the laboratory manual which is verbally interpreted as acceptable.

Using the result of the evaluation, the significant difference between the level of acceptability of the students and instructors in electronics engineering to the training unit and laboratory manual was determined using t-test. For the training unit, the result of the computed value is 4.1351 which is higher than the table of critical ***t*** values at 0.05 which is 2.7764. For the laboratory manual, the result of the computed value is 4.6766 which is also higher than the table of critical t values at 0.05 which is 2.1199.

CONCLUSION

A training unit and laboratory manual based on the CHED minimum requirement is proposed as a supplementary learning material for learning microprocessor systems. Based on the evaluation on the instructional material, the students and instructors agree that the learning material is accepted and strongly accepted, respectively as a supplementary learning material for microprocessor systems.

However, the result of the evaluation of the null hypothesis showed that there is a significant difference in the level of acceptability of the training unit and laboratory manual between the students and instructors. One factor that might have influenced the result is due to the fact that instructors had more experience in the subject matter compared with the students. The students may need more reinforcement in order to appreciate the subject more.

REFERENCES

[1] Alluigan, B. U. Refocused curriculum to address jobs-skills mismatch – CHED, http://www.gmanews.tv/story/130514/Refocused-curriculum-to-address-jobs-skills-mismatch---CHED

[2] Feisel, L. D. & Rosa, A. J. (2005). The Role of Laboratory in Engineering Undergraduate Education, Journal of Engineering Education, Thomas J. Watson School of Engineering and Applied Science State University of New York at Binghamton

[3] Tobin, K. G., (1990). Research on science laboratory activities; in pursuit of better questions and answers to improve learning, School Science and Mathematics, 90, 403-418

[4] ACS Chemistry for Life, Importance of Hands-On Laboratory Science, Public Policy Statement, 2014-2017

[5] The Integral Role of Laboratory Investigations in Science Instruction. National Science Teachers Association. http://www.nsta.org/about/positions/laboratory.aspx

[6] CHED Memorandum Order No. 24. Policies and Standards for the Degree of Bachelor of Science in Electronics Engineering (BSECE) Program, series of 2008. Annex III Course Specification for the BSECE

P-ISSN 2362-8022 | E-ISSN 2362-8030