

# Preliminary Survey on MATLAB Learning among Power Electronics Students in Technical Education: A Case Study

Muhammad Mujtaba Asad, Razali Bin Hassan, Fahad Sherwani, Insaf Ali Siming

**Abstract**—This paper discusses about the findings of preliminary survey on MATLAB software learning among power electronics students. One of the main focuses of power electronics course is on DC to DC boost convertors, because boost convertors are generally used in different industrial and non industrial applications. Population samples of this study were randomly selected final year bachelor of electronics and electrical engineering students from University Tun Hussein Onn Malaysia (UTHM). As per the results from the survey questioner analysis, almost eighty percent students are facing problem and difficulties in Dc to Dc boost convertors experimental understanding without using MATLAB simulink package. As per finding of this study it is clear that MATLAB play an effective and efficient function for better understanding of boost convertors experimental work among power electronics learners.

**Keywords**—MATLAB, Simulation, Power Electronics, Experimental Work.

## I. INTRODUCTION

**P**OWER electronics is, by nature, a multi-disciplinary subject, and for any instructor a challenging course to teach. It is especially demanding course because of variety of topics, such as circuit analysis, signals and systems analysis, and control theory. It is a combination of hands-on experience and solid knowledge of theory provides an active learning environment that leads to successful learning and understanding process.

The use of simulation has always been a powerful tool for technology in all its various fields of application. Power Electronics course is essential for electrical and electronics engineers and it is included in the undergraduate and Postgraduate syllabus. An effective power electronics laboratory is expected to combine theoretical and experimental aspects of the topics by using state-of-the-art software/hardware tools. Sometime during experiment students face many problems in understanding of the procedure of experiment. For them simulation based demonstration of

experiment is very useful especially in power electronic and some relevant courses. Matlab is a numerical computing environment and fourth-generation programming language. Developed by Math Works, Matlab allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. The simulation results states that Matlab/Simulink is a suitable platform for control and regulation of the simulation processes, in addition to its dominant role in conducting research tasks.

## II. PROBLEM STATEMENT

Power electronics is one of the essential course in engineering (electrical and electronics), and the main focus of this course on diploma and degree level on DC-DC boost convertors. DC-DC boost convertors are widely used in industrial applications according to the requirement of project. Firstly, most of the power electronics final year degree students of Electrical engineering they are facing problems during working on hardware without testing on simulation based software, that's why they waste a lot of their money and time and sometimes they may damage expensive laboratory equipment's of university and Polytechnics because they are working on hardware without any precaution and proper handling [1].

Secondly most of the students have different learning styles like auditory, visual and hands-on. Sometimes student they cannot understand on first attempt and sometimes because of improper material used in class might be the reason why students can't perform well in exams. Students also might feel annoyed with the material used which will lead them to lose concentration and attention in the class. Many students they prefer visual and hands-on learning style rather than auditory or teacher center. For these type of students simulation based software's are very useful and especially in electrical and electronics engineering students with the help of this simulation based software they can repeat and redo their required experiment before working on hardware even the last year students of faculty of Electrical and Electronic, Universiti Tun Hussein Onn Malaysia are facing same problem in their experimental work.

Engr Muhammad Mujtaba Asad is from Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia (Phone: +60187600543; e-mail: mujtabaasad11@gmail.com).

Dr Razali Bin Hassan is from Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia (e-mail: razalih@uthm.edu.my).

Fahad Sherwani is from Faculty of Electrical and Electronics Engineering, Universiti Tun Hussein Onn Malaysia (e-mail: fahadsherwanis@gmail.com).

Insaf Ali Siming is PhD Student from Faculty of Science and Human Development, Universiti Tun Hussein Onn Malaysia (e-mail: justiceali\_1@yahoo.com).

### III. LITERATURE REVIEW

#### A. Simulation-Based Learning

Simulation based engineering experiments is a technique for practice and learning that can be applied to many different disciplines and types of trainees. It is a technique (not a technology) to replace and amplify real experiences with guided ones, often “immersive” in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. “Immersive” here implies that participants are immersed in a task or setting as if it was the real world. [2], [3].

In the 1980s, during the time when personal computers became less expensive and more simulation software became available, independent groups began to develop simulator systems. Much of this was utilized in the areas of engineering sciences, aviation, military training, medical, nuclear power generation, and space flights.

Simulation-based learning itself is not new. It has been applied widely in the aviation industry (also known as CRM or crew resource management), anesthesiology, as well as in the military and engineering sciences. It helps to mitigate errors and maintain a culture of safety, especially in these industries where there is zero tolerance for any deviation from set standards. [1], [3].

The simulated environment allows learning and re-learning as often as required to correct mistakes, allowing the trainee to perfect steps and fine-tune skills to optimize technical and industrial outcomes. [5], [6].

Many also believe that simulation-based learning enhances efficiency of the learning process in a controlled and safe environment. The skills requirements which can be enhanced with the use of simulation include:

- 1- Technical and functional expertise training.
- 2- Problem-solving and decision-making skills.
- 3- Interpersonal and communications skills or team-based competencies.

#### B. Pedagogical Philosophy

Power electronics is a multi-disciplinary subject, and represents for any instructor a challenging topic to teach. It is an especially demanding course as it requires assimilation of a broad variety of topics, such as circuit analysis, signals and systems analysis, and control theory.

It is widely accepted that hands-on experience in combination with a solid knowledge of theory provides an active learning environment that leads to successful learning in engineering topics [7], [8].

An effective power electronics simulation is expected to combine theoretical and experimental aspects of the topics by using state-of-the-art software/hardware tools.

#### C. Pedagogical Approach

The pedagogical approach by using Kolb learning theory of Experiential Learning Cycle and ADDIE model of instructional design seeks to combine industrial-grade technology with interactive learning strategies to reinforce the basic concepts of the power electronics course in the context

of the innovative power electronics simulation based laboratory. The tools used in the simulation based laboratory are compatible with industrial-grade platforms and encompass both theoretical aspects of power electronics circuits and practical applications. The simulation based laboratory is built upon prior knowledge and background of the students, and is interdisciplinary with respect to the tools and skills required. For example, it combines knowledge in Digital Signal Processor micro-controller hardware/software platforms with power electronics to design and control the power electronic circuits. This signature aspect of the laboratory is intended to create threads among the related subjects to power electronics and retain the students' knowledge across multiple disciplines for the enhancement of student learning. This pedagogical strategy goes beyond the “divide and conquer” strategy wherein each subject is relegated to its own course and then reduced and analyzed. Engineering education has traditionally followed such a strategy so that upon completion of the course, students find it unnecessary to draw upon the information learned from other courses, with the exception of more advanced courses on the same subject. This has been described as a “filtering” or non-retaining mode of education [4].

#### D. MATLAB Simulation Based Learning

Matlab is a numerical computing environment and fourth-generation programming language. Developed by Math Works, Matlab allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. The simulation results states that Matlab/Simulink is a suitable platform for control and regulation of the simulation processes; in addition to its dominant role in conducting research tasks [6].

Although Matlab is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation for dynamic and embedded systems [3],[7].

In 2004, Matlab had around one million users across industry. Matlab users come from various backgrounds of engineering, science, and economics. Matlab is widely used in academic research institutions as well as industrial enterprises.

Simulink, developed by Math Works, is a data flow graphical programming language tool for modeling, simulating and analyzing multi domain dynamic systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive Matlab or be scripted from it. Simulink is widely used in control theory and digital signal processing for multi domain simulation and Model-Based Design.

### E. Matlab Simulink for Power Electronics

The following section will look at how the modeling and simulation of a power electronic converter can be carried out using Matlab simulink software.

The blocks which are used to achieve the modeling as follow:

1. Repeating Sequence: this block will be used to generate a number of pulses in terms of time.
2. Sine wave: is used to generate a sinusoidal input with amplitude, frequency and phase.
3. Switch Function (Thy): is used to switch between the sine wave form and the firing pulse which is generated from the repeating sequence.
4. OR Logic: is used to turn the thruster off when current reaches zero.

## IV. METHODOLOGY

### A. Sampling

Sample for this study will be mostly last year undergraduates from Electrical and Electronic Faculty UTHM which are taking Power Electronic course. Populations for this study are 85 students from last year of Electrical engineering degree. From this 80 students, only 30 will select randomly to become respondent for this study.

### B. Study Instruments

The instruments which will use in this study is a research questionnaire which is used for identifying the students problem in the understanding of DC-DC boost converters using fuzzy logic controller without using Matlab simulation software among power electronic students.

### C. Research Instrument

The research questionnaire form is divided into three sections which is section I, section II, and section III.

#### a) Section I

This section includes respondent information and educational background. Item that asked in this are the likes of Sex, Department, Year of study.

#### b) Section II

This section is about the prior knowledge and understanding of power electronic course. Item that asked in this are the like:

- 1- Do you prefer to work on DC to DC open loop boost converters by using simulation software?
- 2- Do you prefer to do experimental work on DC to DC PID boost converters by using Matlab simulink?
- 3- Did you work on Analog and digital controllers in your Power electronics Lab?
- 4- Did you work on fuzzy logic controller in your Power electronics Lab?
- 5- Can you implement the Matlab simulation before hardware assembly in your course projects?
- 6- Do you prefer to use Matlab simulation for boost converters before Hardware implementation?

- 7- Did you feel difficulty in understanding of DC to DC boost converters during working on fuzzy logic controllers without Matlab Simulink?

#### c) Section III

In this section respondent can write his/her suggestions about the Simulation based learning in Power Electronics.

## V. RESULTS AND FINDINGS

The respondents to these items of research questioner were coded and analyzed by using SPSS version 20.0 software to determine percentage of two (yes and no) categories of scale. Descriptive method percentages (%) of every item will use for analysis for justification of problem statement.

### A. Respondents Based on Gender

Number of respondents in this study is 30 students. Respondent are final year students from FKEE, they are currently studying power electronic course. The collected data is analyzed by using Statistical Packages for Social Sciences (SPSS). In Table I, it shows the number of respondents and percentage based on respondent's gender. For this study, 17 respondents are male which carrying 57.3%. Meanwhile, there only 13 female respondents involved in this study which is equal to 43.33%.

TABLE I  
RESPONDENTS BASED ON GENDER

Sex	Respondent	Percentage (%)
Male	17	57
Female	13	43
<b>Total</b>	<b>30</b>	<b>100</b>

### B. Students Response on Questions of Research Instrument

Question one of the questionnaire was about, "Do you prefer to work on DC to DC open loop boost converters by using simulation software"? Eighty three percent of the students already study the course of Digital electronics (shown in Table II).

TABLE II  
QUESTION ONE RESPONSE

Response	Frequency	Percent
Yes	25	83.3
No	5	16.7
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question two was about "Do you prefer to do experimental work on DC to DC PID boost converters by using Matlab simulink?" Seventy three percent of the students already performed experimental and practical work on DC DC boost converters in course of Digital electronics (shown in Table III).

TABLE III  
QUESTION TWO RESPONSE

Response	Frequency	Percent
Yes	22	73.3
No	8	26.7
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question three was about "Did you work on Analog and

digital controllers in your Power electronics Lab?" Sixty percent of the students already work on Analog and digital controllers (shown in Table IV)

TABLE IV  
QUESTION THREE RESPONSE

Response	Frequency	Percent
Yes	18	60.0
No	12	40.0
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question four of the questionnaire was "Did you work on fuzzy logic controller in your Power electronics lab?" Seventy three percent of the students already work on fuzzy logic controller (shown in Table V)

TABLE V  
QUESTION FOUR RESPONSE

Response	Frequency	Percent
Yes	23	76.7
No	7	23.3
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question five was about "Can you implement the Matlab simulation before hardware assembly in your course projects?" Twenty three percent of the students favor the Matlab simulation before hardware assembly in your course projects (shown in Table VI)

TABLE VI  
QUESTION FIVE RESPONSE

Response	Frequency	Percent
Yes	7	23.3
No	23	76.7
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question six of was about "Do you prefer to use simulation before Hardware implementation?" Sixty percent of the students prefer to use simulation before Hardware implementation (shown in Table VII)

TABLE VII  
QUESTION SIX RESPONSE

Response	Frequency	Percent
Yes	18	60.0
No	12	40.0
<b>Total</b>	<b>30</b>	<b>100.0</b>

Question seven was about "Did you feel difficulty in understanding of DC to DC boost convertors during your experimental work on controllers?" Eighty percent of the students feel difficulty in understanding of DC to DC boost convertors during your experimental work on controllers (shown in Table VIII)

TABLE VIII  
QUESTION SEVEN RESPONSE

Response	Frequency	Percent
Yes	24	80.0
No	6	20.0
<b>Total</b>	<b>30</b>	<b>100.0</b>

### C. Analysis Results of Pre-Research Questioner

From the results analysis of the research questioner says that students of FKEE have difficulty in understanding of DC -DC boost convertors during experimental work without Matlab Simulink. Eighty percent of them feel difficulty in understanding of DC to DC boost convertors during experimental work as shown in Fig. 1.

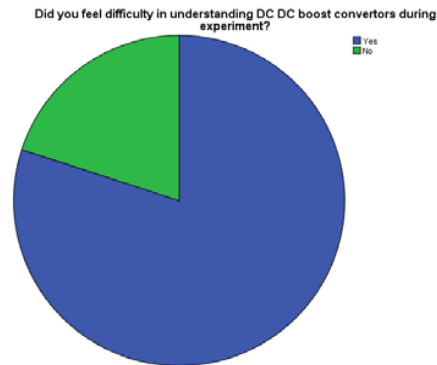


Fig. 1 Pie Chart for Percentage of Student feels difficulty

## VI. CONCLUSION

The conclusion can be made for Preliminary Survey on MATLAB Learning among Power Electronics Students in Technical Education. From the results analysis of the research questioner says that students of Universiti Tun Hussein Onn Malaysia have difficulty in understanding of DC -DC boost convertors during experimental work without Matlab simulink. Eighty percent of them feel difficulty in understanding of DC to DC boost convertors in power electronics course during experimental work. According to the results and finding of this research it shows that Matlab understanding and learning plays an important role for power electronics students for their experimental work.

## REFERENCES

- [1] W.M.Utomo, A. B. (April 2011). *Online Learning Neural Network Control of Buck-Boost Converter*. Eighth International Conference on Information Technology: New Generations (ITNG).
- [2] Adel E. El-kholy and A. M. Dabroom, (2006): *Adaptive Fuzzy Logic Controllers for DC Drives: A Survey of the State of the art*, Journal of Electrical Systems, pp. 116-145.
- [3] Collofello, J.S., et al. Using Software Process Simulation to Assist Software Development Organizations in Making Good Enough Quality Decisions. Summer Computer Simulation Conference, 1998 (SCSC98).
- [4] Asad, E. M. M., Hassan, R. B., Sherwani, E. F., (2014) FPTV, U. T. H. O. M., & Malaysia, P. R. B. P. J. Implementation And Qualities Of Multimedia Technologies In Technical and Vocational Education. Academ Arena, Marsland Press USA.
- [5] H. Pinheiro, A. Martins, and J. Pinheiro, "Single-phase voltage inverters controlled by sliding mode", *Proc. Brazilian Automatic Control Conf. (CBA'94)*, pp.1177-1182
- [6] L. Malesani, L. Rossetto, G. Spiazzi, and P. Tenti, "Performance optimization of Cuk converter by sliding mode control", *Proc. Applications Power Electronic Conf. (APEC'92)*, pp.395-402
- [7] Asad, E. M. M., Hassan, R. B., & Sherwani, E. F. Instructional Models For Enhancing The Performance Of Students And Workforce During Educational Training. Marsland Press USA.

- [8] Hagiwara M, Akagi H, 2008. "PWM Control and Experiment of Modular Multilevel Converters", IEEE Power Electronics Specialists Conference (PESC), Rhodes, Greece.