

PROGRAMMABLE INDUSTRIAL MOTOR CONTROL TRAINER

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Abstract - Learning is a continuous process gained by man through study and experiences in life. It is the key to success that provides a comfortable life to mankind. Learning opens the portal of advanced technology. It leads man to invent and develop devices that make life easier. Theory alone is not enough to develop skills among students. The lack of instructional devices becomes an obstacle for hands-on training of the learners.

Using technological devices in teaching had been proven to be an effective tool in conceptualizing ideas through demonstration of the actual process. Learning in school is more comparable with the real work situation but with the aid of instructional technology, the application and function become similar to the real world of work. With the introduction of this technological equipment, students' knowledge and skills could be enhanced. In response to the vision of the university and the lack of devices to be used in instruction, the researcher desired to assemble the Programmable Industrial Motor Control: An Instructional Device to enhance the skill competency of the students, thus improving quality of instruction in the workshop environment.

The study employed the pre-skill test and post-skill test experimental design. After the assembly of the devices, pre-skill test and post-skill test design were used in measuring the change of the outcome before and after an intervention was implemented. The researcher utilized an observation guide to be answered by experts in acquiring the necessary information on the performance level of the Programmable Industrial Motor Control.

The researcher has chosen twenty (20) technical experts to validate the performance level and to assess the acceptability level of the device. Thirty (30) BS Electrical Technology and BS Electrical Engineering students underwent the skill test; hence, these students have the basic knowledge of using PLC, to determine the level of effectiveness of the Programmable Industrial Motor Control Trainer. Based on the results of the study by using the trainer revealed that the students' performance rating was increased by 120.39%.

Based on the study's findings, the Programmable Industrial Motor Control: an Instructional Device is an effective tool for instruction in BS Electrical Technology and BS Electrical Engineering students. The device got a high rate in the effectiveness level and performed well the automation control system. It could enhance the skill competency of the students

and improve the quality of instruction in the workshop environment.

Key Words: programmable, trainer, technology, performance level, acceptability level

1. INTRODUCTION

Effective learning requires training in both theory and practice in doing and in thinking about doing. The theory of John Dewey's, "Learning by Doing", actual and practical approach will contribute much to the development of student's skills and ideas (Thompson, 2010). Learning is enhanced and memory retention is enriched with both physical and mental capacities are used. The said theory is further asserted by Johann Wolfgang von Goethe, a famous German dramatist who said, "Knowing is not enough, we must apply; willing is not enough, we must do" (Beilby, 2010).

In today's technology-enabled knowledge economy, many universities find themselves facing a new challenge not only to equip students with an adequate education in their field of study but also to arm them with the skills and knowledge required to leverage technology effectively in the workplace (Nacorda, 2014).

Bohol Island State University-Main Campus (BISU-MC), that is located in the province of Bohol, is one of the premier institutions in the country that mandates the formation of world-class professionals in the field of engineering and technology. It is committed to provide higher quality education to produce globally competitive graduates in the province of Bohol and in the country. BISU plays a vital role in advancing the frontiers of science and technology. In recent years, the key concern for policy-makers was to ensure that the wealth of knowledge generated within the university can be transferred to the industry so that society in general, and local businesses in particular, can benefit from the university's scientific and technological expertise.

PLC has evolved as an important controller in industries these days because of its simplicity and robustness. It was used for controlling many mechanical movements of the heavy machines or to control the voltage and frequency of the power supplies. The automation of many different processes, such as controlling machines, factory assembly lines, production line, conveyors and many more were PLC driven. The advancement of technology came the birth of the magnetic starters and contactors, switches, and relays that

were integrated as a motor controlling system. Motor control is a broad term that means anything from a simple toggle switch to a complex system with components such as relays, timers, and switches. It was a simple problem where motors are used to drive a common line shaft to which several machines were connected. It was necessary to start and stop the motor a few times a day (Herman, 2007).

Motor control plays a vital role in the industry since, without it, the performance of the industry will not as productive as it is today. Yet, even though PLCs were heavily used by the industry, their use in teaching control theory concepts was uncommon in the electrical engineering and electrical technology programs in the university. Traditional control systems of the engineering courses focused on the theory of continuous-based control systems and rarely involve the use of PLCs. Recognizing the appropriate ways of how and when to use PLCs was a key factor in applying control theory effectively in an industrial or even in a research environment.

In the context of education, it was observed that it was not enough that one learns by giving a discussion theory, schematic diagram or just by project making. Education and training of students in relation to their field of study were one of the important aspects in order for them to perceive the actual job situation. If they were exposed to different kinds of assemblies, repairing and troubleshooting, the better they could interpret problems and solve them successfully. Therefore, it was imperative to provide Programmable Industrial Motor Control Trainer to help the learners understand the concept of developing a PLC-based motor controller.

Theory alone is not enough to develop skills among students. The lack of instructional devices becomes an obstacle for hands-on training of the learners. In view of this, the researcher believed that developing a Programmable Industrial Motor Control Trainer would be beneficial in developing the student's learning in the field of automation and control systems.

Programmable Industrial Motor Control Trainer is an instructional device that would help improve the teaching techniques of the instructors. This device could be used for instruction to deliver quality education, especially in the field of Electrical Engineering and Electrical Technology. This motivated the researcher to assemble this device in order to address the inadequacy of the learning of the students using PLC in the automation field.

2. METHOD/S

The study employed the pre-skill test and post-skill test experimental design. After the assembly of the devices, pre-skill test and post-skill test design were used in measuring the change of the outcome before and after an intervention was implemented. The purpose of a pre-skill test and post-

skill test experiment was to perceive if the treatment would improve the learning of the participants.

The study was conducted in Bohol Island State University Main Campus, Tagbilaran City, in the academic year 2015-2016 because this institution offered technical education whose learners have the comprehensive and realistic view of this research study.

BISU MC was chosen for the conduct of the research due to the fact that learning involves an actual demonstration and installation of the device. Programmable Industrial Motor Control Trainer was demonstrated to cater the effective delivery of the lessons in technology and engineering courses.

The researcher chose fifty (50) respondents, with ten (10) electrical and electronics instructors coming from the different campuses of BISU and also ten (10) experts from different private electrical institutions in Bohol, (Coca-cola Bottlers Incorporated, Bohol Light Companies Incorporated and Geresonic Electronics and Communication System), who were experts in the field. They answered the observation guide to validate the performance level of the device and to assess the acceptability level of the device. Fifteen (15) Bs Electrical Technology third year students and another fifteen (15) Bs Electrical Engineering third year students underwent the skill test; hence, these students have the basic knowledge of using PLC, to determine the level of effectiveness of the device by imposing the pre-skill test and post-skill test design. The level of effectiveness was determined by using this method.

The construction of the device was done at Bohol Island State University-Main Campus where the necessary materials were available.

3. RESULTS AND DISCUSSION

The construction of the Programmable Industrial Motor Control Trainer was based accordingly to its specified design. This design was the basis of the assembly of the trainer.

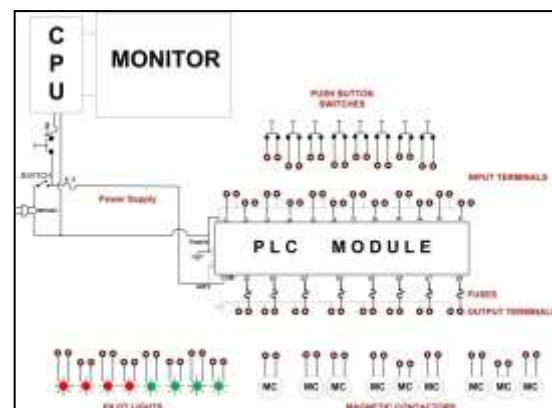


Figure 1. Schematic Diagram of the Programmable Industrial Motor Control Trainer

3.1 Ladder Diagram

The ladder diagram of the Programmable Industrial Motor Control Trainer could be seen as a set of connections between logical checkers (contacts) and actuators (coils).

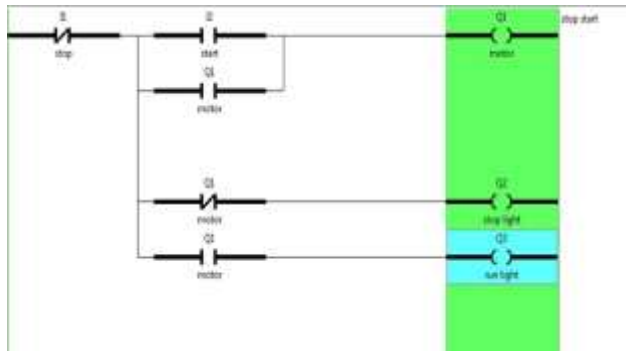


Figure 2. Ladder Diagram of a Stop Start Motor Control

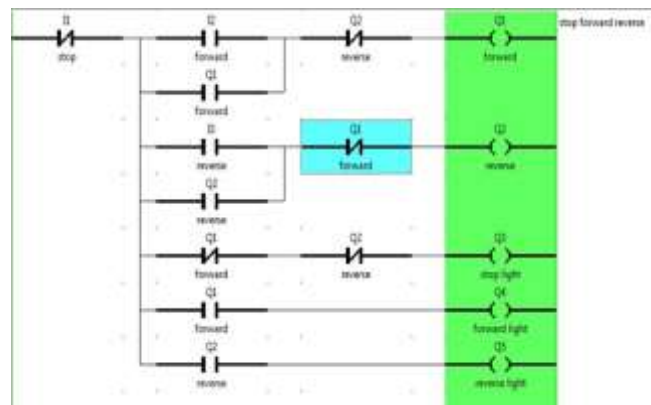


Figure 3. Ladder Diagram of a Stop Forward Reverse Control

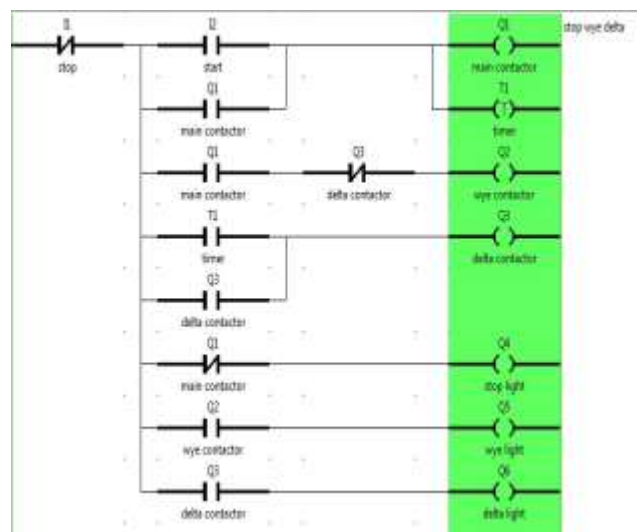
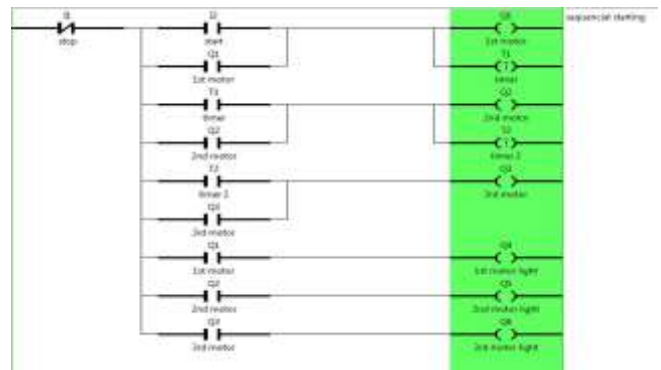


Figure 4. Ladder Diagram of a Stop Wye Delta Control

Figure 5. Ladder Diagram of a Sequential Starting Motor Control



3.2 Perspective



Figure 6. Perspective of the Programmable Industrial Motor Control Trainer

3.3 Parts

The major components and their corresponding functions in the Programmable Industrial Motor Control Trainer

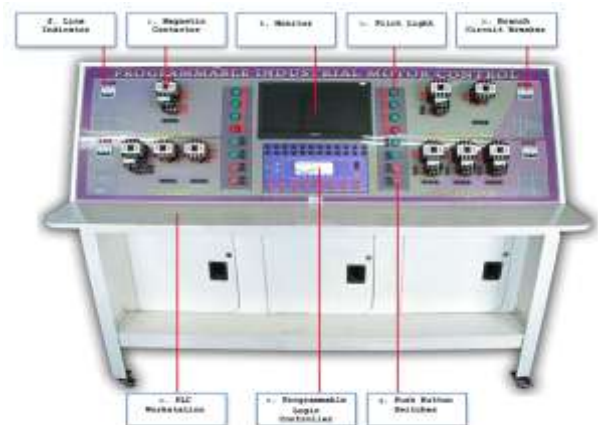


Figure 7. Programmable Industrial Motor Control Trainer External Parts

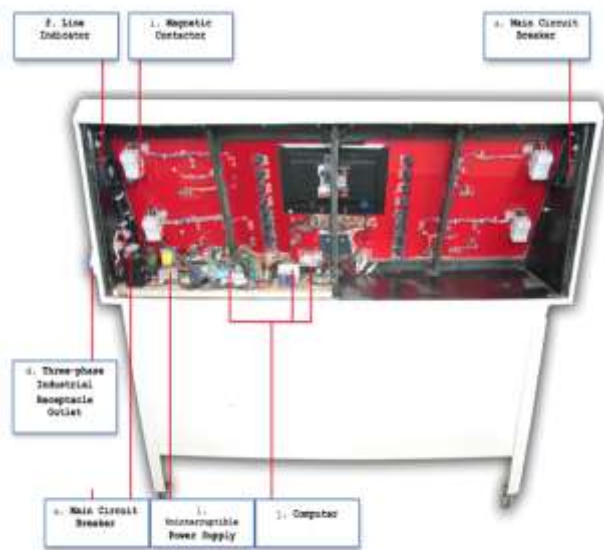


Figure 8. Programmable Industrial Motor Control Trainer Internal Parts

3.4 Functions

a. Main Circuit Breaker. An electrical switch mounted at the right side of the device designed to protect the circuit from overload or short circuit. It is where the current passes to give power supply to the UPS's control unit and power on the PLC and the computer of the Programmable Industrial Motor Control Trainer.

b. Branch Circuit Breaker. An electrical switch mounted in the front panel of the Programmable Industrial Motor Control Trainer used to switch on the individual motor control system.

c. Power Switch. An electronic control switch mounted at the left side of the Programmable Industrial Motor Control Trainer used to turn on the computer.

d. Three-phase Industrial Receptacle Outlet. An opening connected to a wired three-phase power source meant to power the Programmable Industrial Motor Control Trainer.

e. Programmable Logic Controller. It is an industrial computer control system used for automation of industrial processes. It continuously monitors the state of input devices and makes decisions based on a ladder program designed to control the state of output devices for the Programmable Industrial Motor Control Trainer.

f. Line Indicator. A visual indication whether the control system of the Programmable Industrial Motor Control Trainer is in an energized or de-energized state.

g. Push Button Switches. A momentary switch that causes a temporary change in the state of an electrical circuit while

the switch is physically actuated. It will give a signal to the PLC whether to start or stop a control system

h. Pilot Light. A small light located in the front panel of the Programmable Industrial Motor Control Trainer to indicate that there is a power source

i. Magnetic Contactor. An electrically controlled switch used for switching a power circuit of the electric motor in the Programmable Industrial Motor Control Trainer.

j. Computer. A programmable machine that exchange data from the Programmable Industrial Motor Control Trainer for the storing and processing of the ladder language diagram programmed to the PLC

k. Monitor. an electronic visual display for a computer. It will display the program created in the computer of the Programmable Industrial Motor Control Trainer.

l. Uninterruptible Power Supply. A device that allows the computer and the PLC of the Programmable Industrial Motor Control Trainer to keep on running for a short period of time when the primary power source is lost.

m. Exhaust Fan. A small fan mounted in both sides of the workstation used to expel warm air inside the Programmable Industrial Motor Control Trainer.

n. PLC Workstation. A customized laboratory furniture designed for the Programmable Industrial Motor Control Trainer consisting of a metal frame and durable components to ensure long term use and durability.

3.5 The Performance Level of the Programmable Industrial Motor Control

Table 1 shows the performance level of the Programmable Logic Controller in terms of programmability.

PLC was programmed using application software on a computer. Item 1, 2 and 3 were tested to the PLC. As stated by Iqbal S. in Workhorse of Industrial Automation, the programming software allows entry and editing of the ladder-style logic. The researcher entered a set of instruction to the software and the program ran without a bug. The researcher managed to change the addresses and it was accepted. During the simulation, input and output status changed, which indicated the program was functional.

Table 1 The Performance Level of the Programmable Industrial Motor Control Trainer Programmability

Item	PLC	Operation	Trial	Response	Description
1	Input Logic Instructions	Design ladder logic diagram	1,2&3	Functional ladder logic simulation	100 % functional
2	Debug ladder logic diagram	Change input output addresses	1,2&3	Input and output addresses changed	100 % functional
3	Program Simulation	Run ladder logic diagram	1,2&3	Change of input and output status	100 % functional

Table 2 shows the performance level of the Programmable Industrial Motor Control Trainer in terms of reliability. The Law of Electromagnetic Induction states that when a conductor is placed in a changing magnetic field (or a conductor moving through a stationary magnetic field) causes the production of a voltage across the conductor that causes the motor to turn on or rotate (Galili,2006). The device was tested to function the desired operation the researcher provides. All outputs were described as 100 percent functional because, in digital programming, we can only say that the logic that we program to the PLC was functional or not.

Table 2

The Performance Level of the Programmable Industrial Motor Control Trainer

Reliability

Item	Program	Operation	Trial	Response	Description
1	Stop - Start Motor Control	Turning ON and OFF the electric motor	1, 2 & 3	Electric motor will turn on and off	100 % functional
2	Stop - Forward - Reverse Motor Control	Reversing the rotation of the electric motor	1, 2 & 3	Electric motor will turn clockwise and counter-clockwise	100 % functional
3	Stop - Wye - Delta	Changing wye starting	1, 2 & 3	Electric motor will change from wye to	100 % functional

	Motor Control	to delta connection	3	delta operation	onal
4	Sequential operation of 3 Motors Control	Electric motor operate in desired sequence	1, 2 & 3	Motor 1 starts, then motor 2, lastly motor 3 will turn on	100 % functional

The researcher designed Stop-Start Motor Control diagram and uploaded to the PLC. Wirings were done. All the input and output devices were connected in the PLC at their designated terminals used in the program. When the researcher pressed the start button, the motor started to run continuously and when the researcher pushed the stop button the motor stopped. The researcher did it thrice just to make sure the operation would not in trouble. During the three trials, all the operations were successful without any problem.

Another control system was performed by the researcher, the Stop-Forward-Reverse Control. After the program was uploaded to the PLC, the researcher did the same were steps like in the previous operation. After all the steps done, the researcher pressed the forward button. The electric motor started to rotate its shaft in a clockwise direction and when the researcher pressed the reverse button it also reversed the direction of the electric motor. This indicated that the operation was fully functional.

Stop-Wye-Delta motor control was also performed. After pressing the start button the motor ran's in wye operation. After several seconds, the wye contactor disconnected and turned to delta operation. The researcher designed and uploaded the sequential motor control. Motor 1 first turned on, the motor 2, then motor 3 turned on successively. All the electric motor design functioned properly from the first design up to the last design. That's why it was all rated 100% functional.

Table 3

The Performance Level of the Programmable Industrial Motor Control Trainer

Efficiency

Item	Program	Operation	Trial	Response	Description
1	Stop - Start Motor Control	Turning ON and OFF the electric	1,2 & 3	Programmable controller works	100 % funct

	1	motor		without failure	ional
2	Stop – Forward-Reversible Motor Control	Reversing the rotation of the electric motor	1,2 &3	Programmable controller works without failure	100 % functional
3	Stop – Wye – Delta Motor Control	Changing wye starting to delta connection	1,2 &3	Programmable controller works without failure	100 % functional
4	Sequential operation of 3 Motors Control	Motor 1, motor 2, then motor 3 turn on successively	1,2 &3	Programmable controller works without failure	100 % functional

Table 3 shows the performance level of the Programmable Logic Controller in terms of efficiency. In connection to the previous law, Ohm's law states that whenever a potential difference or voltage is applied across a resistor of a closed circuit, current starts flowing through it. When the magnetic contactor was energized it would connect the motor to the power supply that made the motor energized.

All the four kinds of motor control were performed by the device for three trials. Each was all successful and did not have any trouble during each operation. That's why it was all rated 100% functional.

3.6. The Level of Effectiveness of the Programmable Industrial Motor Control Trainer

To determine the degree of effectiveness of the Programmable Industrial Motor Control Trainer, a pre-skill test and post skill test were administered to thirty (30) students.

A rubric is simply a scoring tool that identifies the various criteria relevant to an assignment or a learning outcome and explicitly states the possible levels of achievement along with a continuum. A rubric was used by the researcher to identify the learning outcome of the respondents and to explicitly

state the possible level of achievement from poor to very good.

Table 4

Pre-skill Test and Post Skill Test Result of the students using Programmable Industrial Motor Control Trainer

N = 30

Score	Description	Pre skill Test			Post Skill Test		
		f	%	Rank	f	%	Rank
3.25 - 4.00	Very Good	0	00.00 %		19	63.33 %	1
2.50 - 3.24	Good	0	00.00 %		11	36.67 %	2
1.75 - 2.49	Fair	7	23.33 %	2	0	00.00 %	
1.00 - 1.74	Poor	23	76.67 %	1	0	00.00 %	
Average Rating		1.52 Poor			3.35 Very Good		

The training environment is the working environment itself or a replica of the working environment" (Colley, 2003). The table above shows the improvement in the average rating of the students using the device. This will address the inadequacy of the learning of the students using Programmable Industrial Motor Control Trainer.

Table 4 shows the frequency and percentage of the performance of the students before and after the manipulation of the Programmable Industrial Motor Control Trainer. It shows that 23 out of 30 or 76.67% of the student's pre-skill test performance were described as "poor". Seven(7) students or 23.33% of the total respondents were described as "fair". Likewise, none were described "Very Good" and "Good". The average rating of this group is 1.52, which was described as "poor".

After the treatment was employed, the post skill tests were performed. The respondents got higher results compared to pre-skill test. Nineteen (19) out of thirty(30) or 63.33% of the respondents performance were rated "Very Good" and were ranked first in the group. Eleven (11) out of

thirty (30) or 36.67% of the respondent's were described "Good". The students got a total average rating of 3.35, which was interpreted as "Very Good". Clearly, it was found out that the post skill test of the students who used the Programmable Industrial Motor Control Trainer got higher scores and was shown to be effective for the improvement of learning competencies of students through actual and hands-on demonstration.

3.7 The Significant Difference between the Pre-Skill Test and Post-Skill Test Result of the Students

Table 5

Difference between the Performance of the students under Pre skill test and Post skill test

N = 30

Difference	t computed value	t tabular value	Description	Interpretation
	at 0.05 level of significance, df 29			
Pretest and Posttest	-8.21	±2.045	Significant	Reject Null Hypothesis

Table 5 presents the difference between the pre skill test and post skill test of the students. The computed t-value was -8.21, an absolute tabular value of ± 2.045 at 0.05 level of significance. It shows that there is a significant difference between the performance of the students taking pre skill test and post skill test, thus the null hypothesis was rejected. The use of the Programmable Industrial Motor Control Trainer proved that it has greatly enhanced the student's retention of knowledge and facilitates effective learning acquisition in electrical technology.

Table 6

Acceptability Level of the Programmable Industrial Motor Control Trainer

Acceptability Level	WM	Description	Rank
Performance			
As a gadget			

1. Design program based on the desired operation	3.90	VH	4
2. Upload saved programmed files from computers to PLC.	3.90	VH	
3. Can edit, save and restore ladder program.	3.60	VH	
4. Ladder diagram can be corrected from errors during programming	3.70	VH	
5. Able to back-up important programs to PC	3.85	VH	
6. PLC program is compatible with other PLC unit with the same brand, model and version	3.95	VH	
Average	3.79	VH	
As Instructional Device			
7. Provides additional activities for students to develop skills in ladder logic programming	3.70	VH	
8. Students were able to increase the performance of the experimental group from pre test to post test	3.75	VH	
9. The post test rating of the students gains a very good performance	3.85	VH	1
Average	3.77	VH	
Average in performance			
5.2 Durability			
1. Wiring connections are properly insulated.	3.85	VH	
2. The component of the device is properly mounted.	3.95	VH	
3. Conductors are being insulated.	3.90	VH	
4. Installation follows the approved design.	3.85	VH	
5. Uses of fuse as a protective device.	3.90	VH	

Average	3.89	VH	
5.3 Safeness			
1. Wiring connections are properly insulated.	3.80	VH	2
2. Conductors are being insulated.	3.95	VH	
3. Usage of fuse and breaker as a protective device.	3.85	VH	
4. All wires are properly harness and fixed	3.75	VH	
Average	3.84	VH	
5.4 Cost			
1. The Programmable Industrial Motor Control Trainer costs of <u>Php. ₱</u> 59,776.50	3.7	VH	5
5.5 Convenience			
1. Accessible ports/terminals.	3.95	VH	3
2. Less hard wiring	3.90	VH	
3. Parts are replaceable when damaged	3.80	VH	
4. Less maintenance is required	3.85	VH	
5. Movable gadget from one place to another.	3.75	VH	
Average	3.85	VH	
Average WM	3.81	VH	

Table 6 illustrates the summary of the acceptability level of the Programmable Industrial Motor Control Trainer in terms of its performance, durability, safeness, cost, and convenience.

Using the weighted arithmetic mean, Programmable Industrial Motor Control Trainer as a gadget gained an average rating of 3.79 and was interpreted as “very high” which means that the gadget was successfully functional to its maximum motor control operation. On the other hand, the Programmable Industrial Motor Control Trainer as an instructional device gained an average weighted mean of 3.77 and was interpreted as “very high”. This device increased the knowledge of the students on the industrial motor control system. To sum up, the average rating of the Programmable

Industrial Motor Control Trainer as a gadget and as an instructional device under performance has the fourth in the rank with the average weighted mean of 3.78 and described as “very high”. The performance got the second to the lowest rating because the respondents coming from different outside institutions used other automation systems in their work, that is more advanced than using PLC but it is too much expensive.

The durability of the instructional device gained an average weighted mean of 3.89 and rank as first because the researcher used high-quality materials and assembled the device precisely according to the designed layout. All the devices used were properly mounted and well insulated to avoid the user from being electrocuted. The device got a very high description.

Every time an accident may occur. Safeness is very important as always. It was ranked second as it has an average weighted mean of 3.84 which means that the instructional device was properly assembled that offers a guaranteed safety to both the device and the students. The safety of the instructional device garnered an average weighted mean of 3.84 which was interpreted as highly acceptable by the respondents. The statement further means that the students were convinced by the safety that the instructional device can guarantee.

According to the Commercial Industry Conference, the price of supplies and materials are solely based on their qualities and the substance used to produce it. The total cost of the instructional device ranked fifth and garnered a weighted mean of 3.70, which was interpreted as “very high”. Since the materials used in building the instructional device were from of a guaranteed quality, it was expected to cost high also.

Convenience was rated third in the rank with very high in the description. It has an average weighted mean of 3.85. This means that Programmable Industrial Motor Control Trainer was easy to use as an instructional device and easy to operate as perceived by the expert respondents.

To sum up, the researcher got a total weighted mean of 3.81 in the acceptability level of the Programmable Industrial Motor Control Trainer. Thus, it was highly accepted by the respondents as their learning tool in their quest for knowledge.

4. FINDINGS

The following are the findings based on the result of the data obtained:

1. On the description of the Programmable Industrial Motor Control Trainer in terms of its preparation, design, tools, materials, cost, procedure, parts and function.

The Programmable Industrial Motor Control Trainer was used to increase the learning of the students in the automation control system to meet the required basic skill of an industrial working environment. The total cost in assembling the Programmable Industrial Motor Control Trainer is fifty-nine thousand seven hundred seventy-six and fifty centavos (₱ 59,776.50).

2. On the Performance Level of the Programmable Industrial Motor Control Trainer in terms of programmability, reliability, and efficiency.

Inputting, debugging and simulation of the program was done to test the programmability of the instructional device. All tests were functional and corresponded to the command of the researcher. The device also performed the four basic industrial motor control namely stop-start, forward-reverse, wye-delta and sequential starting. All the four operations were successful for three successive trials. During the operation of the device, the programmable controller worked without failure. That's why the researcher could say that the device was efficient to perform the motor control operation.

3. On the Level of Effectiveness of the Programmable Industrial Motor Control Trainer.

The average rating of the student having skill test first without the discussion of the device was rated poor. The average rating of the students taking the pre-skill test was only 1.52. On the other hand, the researcher discussed first the operation and functionality of the device to the students before taking the skill test. The average rating of the students became 3.35 which was interpreted "very good". It simply indicated that with the help of the Programmable Industrial Motor Control Trainer the learning of the students was improved.

4. The significant difference between the pre-skill test and post-skill test result.

In the pre and post skill test, the t-computed value was 8.21 and the t-tabular value was ± 2.045 . Therefore, the researcher rejected the null hypothesis which means that there is a significant difference in the pre skill test and post skill test of the students rating in performing the device.

5. The acceptability level of the Programmable Industrial Motor Control Trainer.

The level of acceptability of the Programmable Industrial Motor Control Trainer gained an average weighted mean of 3.81 with the description "very high". This means that the device was highly acceptable by the instructors and students in terms of performance, durability, safeness, cost, and convenience.

The durability of the device got the highest rank because the researcher carefully chose the materials needed to make

the device. The assembly followed the approved design. While cost got the lowest rank with an average weighted mean of 3.70 since the materials used in building the instructional device were from a guaranteed quality. It was expected to cost much.

5. CONCLUSION

Based on the study's findings, the following conclusions were drawn:

The Programmable Industrial Motor Control Trainer is an effective tool for instruction in BS Electrical Technology and BS Electrical Engineering students. The device got a high rate in the effectiveness level and performed well the automation control system. It could enhance the skill competency of the students and improve the quality of instruction in the workshop environment.

6. RECOMMENDATIONS

Based on the data and findings, the researcher offers the following recommendations:

1. The researcher shall provide a single phase to a three-phase inverter that will be added to the device so that the small learning institutions without the three-phase power system could still use the instructional device for the learning of the students.

- Recommends the study to be patented for its protection.

2. The shop instructors shall use the Programmable Industrial Motor Control Trainer for BS Electrical Engineering and BS Electrical Technology courses to assist the learning of the students. It will be used particularly in curriculum-related to industrial system automation.

- The instructor and learners must not focus only by using the built-in Schneider PLC. The device is able to interface different types of PLC operating at 220 volts.

- Electrical teachers and instructors shall undergo training on PLC-based technology to broaden their competencies in control automation.

3. School administrators shall encourage their instructors to construct instructional devices that can replicate the actual functions of the machines or devices found in the industry.

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BIOGRAPHY



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