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Programmable Conveyor System with Product Counter

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Abstract: ***Programmable Logic Controller (PLC) plays an important role to the globally competitive industry because every movement of the processing machines were aided by PLC. With its advanced usage, it is increasingly becoming an important part in the industry and academe as well. Thus, it is essential that this knowledge is effectively delivered to students with practical applications. For this reason, the researcher was motivated to design, assemble and assess the performance of the Programmable Conveyor System with Product Counter and determine the level of effectiveness of the conveyor system as a tool for instruction. This study presents a series of programming experiments to automate the process of transporting the materials to its respective locations using sensors and PLC. Through this project, it can provide students a realistic learning experience by designing, troubleshooting and simulating the industrial application of PLC. The study was conducted at Bohol Island State University Main Campus, Tagbilaran City and in different learning institutions and private industries in the province of Bohol during the Academic Year 2017-2018 to propose a technology package for the improvement of instruction in electrical technology and engineering courses. The study employed the experimental methods of research and descriptive design in developing the conveyor system, particularly the one group pre-skill and post skill test design, and testing its effectiveness in enhancing the skills of the students. The respondents of the study who took the pre and post skill test were the third year Bachelor of Science in Electrical Technology and Engineering students while the respondents who evaluated the performance of the conveyor system were experts from the academe and industry. The results revealed that the students' performance rating was increased by 134.87%. The conveyor system is suitable for the electrical laboratory as an instructional tool. The use of the conveyor system as a tool for instruction in electrical technology and engineering laboratories is highly recommended due to its positive results in improving the performance of the students.***

Index Terms: ***Conveyor System, Effectiveness, Engineering and Technology, Product Counter, Programmable.***

I. INTRODUCTION

Technology has brought a number of positive effects to the different aspects of human life. In education, for instance, its incorporation to the curriculum built competitiveness in students that copes with the changing times. Thus, students are not only equipped with adequate education in their field of study but also armed with skills and the knowledge required to influence technology effectively in the workplace [1]. Integrating technology resulted to many favorable improvements in education. More importantly, the teachers' competence and ability to shape instructional technology activities to meet students' needs [2].

Bohol Island State University (BISU), as one of the top performing engineering and technology schools, intends to consistently produce and cultivate field professionals, with sufficient knowledge, skills, and values. Thus, the institution must become an effective training ground which can provide advanced technology to mirror reality.

Controllers were developed to play a vital role in an industry particularly in the processing stage [3]. Researcher found that Programmable Logic Controllers can be effectively used in education to emphasize its importance in light of globalization. The application of the programmable logic controller remains relevant to the globally competitive industry with every movement of the processing machine aided by a PLC [4]. Embracing the changes brought by technology, the researchers intended to develop a control system simulation of PLC functions. For this study, the researcher developed the Programmable Conveyor System with Product Counter.

Programmable Conveyor System with Product Counter is an instructional machinery system which incorporates a fundamental programmed language to have an operational output intended to provide students an experience identical to an actual workplace in the industry. This instructional tool operates such as transferring products from one place to another particularly useful for moving bulk or heavy materials and can automatically detect the object presence through sensor by detecting the events or changes in qualities and provides a corresponding output, generally as an electrical or optical signal and also the tool can monitored the number of objects counted using the binary coded decimal counter.

The researcher believes that developing the Programmable Conveyor System with Product Counter addresses the diverse needs of learning in the field of automation and industrial process control.

II. METHODOLOGY

This study focuses on developing the knowledge of the students in the Bohol Island State University through providing an actual and a practical experience that would prepare students in real world. The following phases are provided below for the achievement of the study.

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1. Permission Phase: Upon written approval from the thesis adviser and the Dean of the College of Advanced Studies, the researcher submitted letters to the different Campus Directors of Bohol Island State University, asking permission to conduct the study in their respective campuses and appointment of the thesis committee. Separate letters were also sent to the Deans and Heads of the Agency of the different academic institutions and private industries involved in the study.
2. Planning Phase: The researcher created a diagram and gathered supplies with quality guaranteed materials needed in making the Programmable Conveyor System with Product Counter
3. Assembly Phase: The projected layout plan was followed by the researcher in constructing the Programmable Conveyor System with Product Counter. The diagram was used for the interconnectivity of all the electrical and electronic devices.
4. Testing Phase: When the assembly was completed, the testing of the functionality of the conveyor system was done to check if the parts were installed properly and functioned according to its desired operation. Through the observation guide, the researcher recorded the phases of the assembly of the conveyor system and documented the results properly.
5. Experimentation Phase: The study employed the experimental method of research in developing the conveyor system. A one group pre skill test and post skill test was designed to test its effectiveness in enhancing the technology skills of the students.

The experimental design was used to measure change in outcomes before and after an intervention was implemented. The purpose of the pre skill test and post skill test experiment was to see if the treatment has caused a change in the respondents. Since all respondents were subjected to the same treatment, any changes happening across the group of respondents are likely to come from the treatment. Hence, an initial test was done with the respondents, then they were subjected to the experimental design. Another test was conducted to see if there were any changes. The effectiveness in imparting the knowledge and skills to the students was evaluated by this design.

A pre skill test was given to the students before any discussion. This evaluated the baseline skills requirement of the study in designing program construction. The test was composed of a set of instructions for installation, interfacing, and programming of the conveyor system. At this stage, students were not expected to know all the answers to the skill test situation problems given. However, students were expected to utilize previous knowledge to give sensible answers.

A discussion on the Programmable Conveyor System with Product Counter was conducted after the pre skill test was done. Respondents were allowed to experience hands-on application by programming the PLC with a given situation. A post skill test was employed after the discussion. The content of the discussion and the manner of conducting the post skill test were similar to the contents of the pre skill test. Students were expected to answer more problem situation given correctly based on an increase in knowledge and understanding.

The students' ratings in the post skill test were the basis for determining the degree of effectiveness of the conveyor system. The design will weigh the effectiveness and amount of learning a student has acquired through the use of the conveyor system.
6. Gathering Data Phase: Pre skill test and post skill test was administered to the students before and after the demonstration teaching respectively. After showing the device and conducting the lesson, the students applied new learning and ideas acquired through hands-on programming and installation of the conveyor system. After conducting the post skill test, the feedback on the questionnaires was recorded.
7. Analyzing and Interpreting Data Phase: The researcher gathered the data, tallied, and tabulated the results using appropriate statistical treatment to arrive at proper analysis and interpretation.
8. Conclusion and Recommendation Phase: Based on the data gathered, the researcher formulated the conclusions and recommendations.

III. RESULTS AND DISCUSSION

This presents the findings, analysis, interpretation and holistic project design of the study. It also presents the data gathered, collated, and tabulated in accordance to the appropriate statistical treatment. The construction of the Programmable Conveyor System with Product Counter was based accordingly to its specified design. This design was the basis of the assembly of the conveyor system.

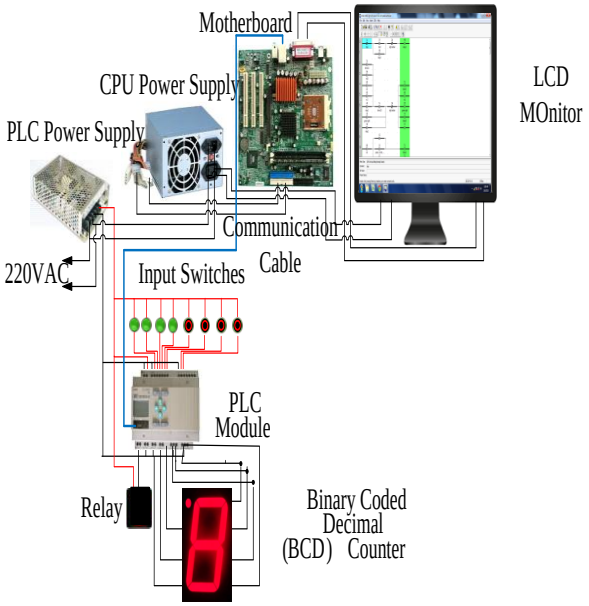

Fig 1: Pictorial Diagram of the Programmable Conveyor System with Product Counter

Table I
The Performance of the Programmable Conveyor System with Product Counter

Types of Product	Number of Input Products	Program-med Set Value	Number of Detected Product/s	Time Response to Display (second)	Time Response to Deactivate (second
Bond Paper	10	3	2	1	unable to deactivate
			3	2	1
			3	1	1
		6	6	1	1
			6	1	1
			6	1	1
		10	10	2	2
			10	1	1
			10	1	1
Glass Bottle	10	3	3	2	2
			3	1	1
			3	1	1
		6	6	1	1
			6	1	1
			6	1	1
		10	10	1	1
			10	1	1
			10	1	1
Plastic Bottle	10	3	3	1	1
			3	1	1
			3	1	1
		6	6	1	1
			6	1	1
			6	1	1
		10	10	1	1
			10	1	1
			10	1	1

Table I shows the performance of the Programmable Conveyor System with Product Counter in terms of detecting, counting and programming. The researcher identified first the types and quantities of products included during the testing of the performance of the conveyor system. During the test, the researcher set the values (3, 6, 10) to the different types of product wherein the values are equivalent to the number of product bypass to the sensor and after obtaining the set values the operation stopped automatically. In all the set values inputted, the researcher observed during testing the first product that there were some delays and sometimes failed in sensing the product, that causes the decimal counter to get also failed in counting the number of products passed and as the result the conveyor system would not able to deactivate the operation. So, to correct this technical error, the researcher adjusted the potentiometer to regulate the frequency for accurate and perfect in time in sensing the product as it passes. Since, the counting and deactivating the operation were just dependent in the sensor. After the adjustments, the sensing of the last two products was already good as well as the counting of product and deactivating the operation. It was repeated 3 times and it was all successfully done.

Table II
The Level of Effectiveness of the Programmable Conveyor System with Product Counter

Pre-skill Test and Post Skill Test Result of the Programmable Conveyor System with Product Counter
N = 30

Score	Description	Pre-skill Test			Post skill Test		
		F	%	Rank	F	%	Rank
3.25-4.00	Very Good	0	00.00%		28	93.33%	1
2.5-3.24	Good	0	00.00%		2	06.67%	2
1.75-2.49	Fair	6	20.00%	2	0	00.00%	
1.00-1.74	Poor	24	80.00%	1	0	00.00%	
Average Rating		1.52 Poor			3.57 Very Good		

Table II presents the lists of frequencies and percentages of the performance of the students before and after operating the conveyor system. The skill test would determine the level of effectiveness gained by students through the used programmable conveyor system with product counter. It revealed that 24 out of 30 or 80.00% of the students' pre skill test performance fell under "poor". Meanwhile, 6 out of 30 or 20.00% of respondents were described as "fair". No respondent was able to get "Good" and "Very Good". The average rating of this group was 1.52 which is described as "poor".

Meanwhile, the post skill test comparatively showed higher results to pre skill test. Twenty eight (28) out of 30 or 93.33% rated "Very Good". Two (2) out of 30 or 06.67% of respondents were described "Good". The students' total average rating of 3.57 was interpreted as "Very Good".

The post skill test became easy for the students and proves that the knowledge of the student was increased after exposing into programmable conveyor system with product counter. The result of the post skill test shows that there is a noticeable change in the knowledge gained by the students. This is connected with the Experiential Learning. Students showed that they learn best when they have meaningful practice and repetition [5].

Table III
The Significant Difference between the Pre Skill Test and Post Skill Test Results of the Students

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			
Pre-skill Test and Post skill Test	-25.24	±2.045	Significant	Reject Null Hypothesis

Table III presents the difference between the pre skill test

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and post skill test of the students. The computed t-value was -25.24 with an absolute tabular value of ± 2.045 at 0.05 level of significance. It indicates that there was a significant difference in the learners' performance after experiencing various methods of instruction. The above statement connect the Law of Exercise stated that; behavior is more strongly established through frequent connections of stimulus and response [6]. Thus, students gained knowledge and understanding about the subject though repetition of activities. Therefore, the null hypothesis was rejected.

IV. CONCLUSION

The Programmable Conveyor System with Product Counter was found to be an effective tool for instruction in electrical technology given that the performance of the device can deliver efficient and automated process of programming due to its soft wiring advantage. It improves the learning competencies of the students because the conveyor system provides real experience encountered in the workplace and it also provides relevant insights among instructors in the modern world of automation.

V. RECOMMENDATIONS

1. Researchers will introduce the Programmable Conveyor System with Product Counter to electrical technology and allied engineering courses as a tool for instruction.

- Improve the conveyor system with provisions for various types of PLC and programming language.
- Conduct trainings to teachers and instructors on PLC-based technology to broaden their competencies in control automation.
- Recommend the study to be patented for its protection.

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

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AUTHOR'S PROFILE

Jessie Nigparanon received the Bachelor of Science in Electrical Technology and Master of Science in Industrial Technology major in Electrical Technology from Bohol Island State University, Main Campus, Tagbilaran City, Bohol, Philippines in 2014 and 2016, respectively. Since 2015, he has been with the College of Technology and Allied Sciences and College of Engineering and Architecture of Bohol Island State University, where he is currently working as an Instructor.