Global Scientific JOURNALS
GSJ: Volume 11, Issue 2, February 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

ENHANCING STUDENTS' INTEREST IN ENGINEERNIG EDUCATION BY TEACHING LEYBOLD-BASED PROJECTS

Yslam Orazov Kiyasovich[1], Nurjemal Bayramova[2]

[1] - *Lecturer of Cyberphysical systems department of Oguzhan engineering and technology university of Turkmenistan. Bachelor of Engineering in the field of Electronic and Information Engineering from Osaka University, Japan. Master of Engineering in the field of Electrical engineering and Information systems from the University of Tokyo, Japan.*

oguzhantech22@gmail. com

[2]- *Second year student of Oguzhan Engineering and Technology University of Turkmenistan majoring in Physics of Modern Technologies.*

bibijanbayramova@gmail.com

Keywords

Teaching methodology, Leybold COM3LAB Multimedia, Logic gates

Abstract-Laboratory practice plays an essential role in engineering and technology education. However, with diminishing resources, teaching and learning of engineering courses become harder and it is progressively becoming difficult to teach basic engineering courses effectively. Moreover, studying only theoretical part is not enough for understanding. As a result, students cannot fully comprehend the topic. To overcome these challenges, a Leybold based teaching approach has been developed to enhance students' learning outcomes. In this work, we work with Digital Technology 1 board by Leybold company for conducting laboratory assignments. It was designed for training in various fields of electrical engineering and electronics in order to learn a fundamental concept of digital technologies. The proposed laboratory assignments prepared in easy to hard order and they aim at learning the working principles of logic gates, half adder and full adder. In doing so, both enhancement of students' interest and pedagogical aspects of Leybold based teaching were taken into account.

1.Introduction

Successful engineers must have a knowledge of nature that goes beyond mere theory—knowledge that is traditionally gained in laboratories. In this paper, we involve COM3LAB Multimedia course with Digital Technology 1 board by Leybold company in our lab project in order to learn fundamentals of logic gate concept [1].

In many universities, logic gate concept is one of the fundamental concepts in digital electronics course for undergraduate Physics, Computer science, and Engineering students. This course consists of the theoretical contents that are linked to the practical understanding of how computers operate physically. Generally, students were taught the operation of logic gate by lectures however it is not enough for having a complete idea of what they are learning. The absence of the laboratory class made students difficult to grasp completely the ideas. Moreover, it may cause the diminishment of students' interest to the science and its applications. As Rickel [2] introduced the "learning by doing" method as students retain 25% of what they hear and 45% of what they hear and see, but students can get 70% of learning if they do what they hear and

see. As a result, students cannot achieve effective learning outcomes.

Therefore, lecturers of these areas have to advance multifaceted teaching strategies, introduce innovative technologies, and let students see real world hands-on laboratory practices. These challenges can be overcome by encouraging students to make Leybold based lab projects. Moreover, students can directly observe the output of the logic gate through LED when they select the desired input in Digital Technology 1 board by using switches and compare it with their predictions. By doing so, we get active learning environment and positive learning outcome. The main goal of this paper is to implement innovative educational methods in teaching through Leybold based laboratory assignments and increasing students` interest by giving them hands-on lab projects.

2.Literature review

Laboratory practices have been crucial part of engineering curricula from the earliest days of engineering education to prepare students to practice engineering thereby creating benefit for humankind. However the emphasis on laboratory practices has varies over the years as much attention has been put on curriculum and teaching methods and relatively little effort has been put on laboratory practices as noted by Fiesel and Rose [3], Alam et al. [4, 5].Many research studies have been conducted to investigate the educational effectiveness of laboratory work in science education in facilitating the attainment of the cognitive, affective, and practical goals. These studies have been critically and extensively reviewed in the literature [6]. From these reviews it is clear that in general, although the science laboratory has been given a distinctive role in science education, research has failed to show simple relationships between experiences in the laboratory and student learning. Authors of paper [7] underlines that relating computational reasoning skills to real-world problems using embedded systems may result in broader participation of students in computer science and engineering.

Nowadays, teaching engineering courses using Arduino is becoming more popular. One of the first papers highlighting the importance of Arduino systems applications in education [8] appeared in 2011. The paper emphasizes the interest shown by the students using Arduino systems, their achievements but also the difficulties of assessing the students' original achievements, given the large number of open-source applications. Moreover, authors of paper [9] conducted "open- project" student labs in which they tried to teach physics courses using Arduino- based projects and obtained positive results. According to them, students were more active during the labs. In addition, authors of the article [10] developed a compact, robust, and portable Arduino based logic gate training kit. It was designed for an electronic engineering undergraduate university course in order to learn a fundamental concept of logic gates operation through six logic gates; AND, NAND, OR, NOR, XOR, and XNOR. An ATmega 2560 Arduino board was used to develop the training kit. Authors of above-mentioned articles work with Arduino based projects on the contrast, we intend to work with Digital Technology 1 board which was designed by Leybold company as a demonstration tool for learning fundamentals of digital technologies.

3.Description of the proposed laboratory assignments

The teaching and learning of engineering courses are always challenging due to its complex and abstract nature, and the mathematics involved. Therefore, engineers have to know theory and application of science.

Moreover, as they are mainly dealing with the PLCs, they must to know working principle of logic gates. In order to reach these goals and keep up with demands of modern world, they must be taught working principles of basic electronic devices through Leybold based laboratory assignments. This will lead to comprehension of the topics and enhancement of students understanding at the same time. Therefore, in this proposed laboratory assignments the main goal is to foster Leybold based learning using COM3LAB Multimedia course with Digital Technology 1 board.

COM3LAB Multimedia combines interactive learning software with real hardware and is used in schools, universities and industrial companies for training in various fields of electrical engineering and electronics. Likewise, the COM3LAB courses on instrumentation and control faithfully implement the modern methods of blended learning. They offer flexible application in the classroom since they are suitable for demonstration, hands-on self-study, or for project work in teams. List of proposed laboratory assignments and required materials are shown in Table 1.

These laboratory assignments could further be increased in number considering that a completely new subject area can be accessed by simply changing the course PCB in the master unit. When it comes to realization of the proposed Leybold based laboratory projects or assignments in classes, following steps should be followed:

i. Clear explanation of laboratory goals, tasks and objectives;
ii. Dividing class into groups of 3-4 students;
iii. Providing each group with necessary materials and literatures such as booklets or lab-brochures;
iv. Directing students to build circuit diagram of the laboratory assignment;
v. Guiding students how to calculate output of logic gates;
vi. Observing the outputs via the board;
vii. Taking laboratory quizzes and lab reports;
viii. Grading students according to their reports and results.

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The most important part of the above- mentioned steps are fourth, fifth and sixth steps in which students are expected to reach the intended goals of the assignment. Therefore, if necessary, they can repeat these steps twice with instructor for full comprehension of the assignment.

Table1. Proposed Leybold based laboratory assignments for engineering students

N	Name of the assignment	Objectives of the assignment	Required materials
1.	Logic gate	To learn a fundamental concept of logic gates operation regarding to six logic gates; AND, NAND, OR, NOR, XOR, and NOT	Digital technology 1 board, jumpers, computer.
2.	Half adder	To learn working principles of half adder	Digital technology 1 board, jumpers, computer.
3.	Full adder	To learn working principle of full adder	Digital technology 1 board, jumpers, computer.

4. Performing the lab experiments

Digital Technology 1 board was chosen because of its abundance of digital inputs and output pins that enough for demonstrate the operation of 2-input of AND, NAND, OR, NOR, XOR, and NOT logic gates. Firstly, among the proposed laboratory assignments in the Table 1, the first one which is "logic gates" was conducted. Students were given clear instruction on how to calculate output of gates. Instead of teaching them the truth table of the basic logic gates operation as it was done in the typical classes, the students were asked to make a prediction of the basic logic gates (AND, NAND, OR, NOR, XOR, NOT) operation before doing the experiment with the Digital Technology 1 board. Moreover, students can directly observe the output of the logic gate through the LED when they select the desired input logic 1 (HIGH) or 0 (LOW). Students then compared their prediction and observation. The Leybold-based logic gate board can be used by students themselves or lecturer as a demonstration tool to learn the operations of the basic logic gates; AND, NAND, OR, NOR, XOR, and NOT.

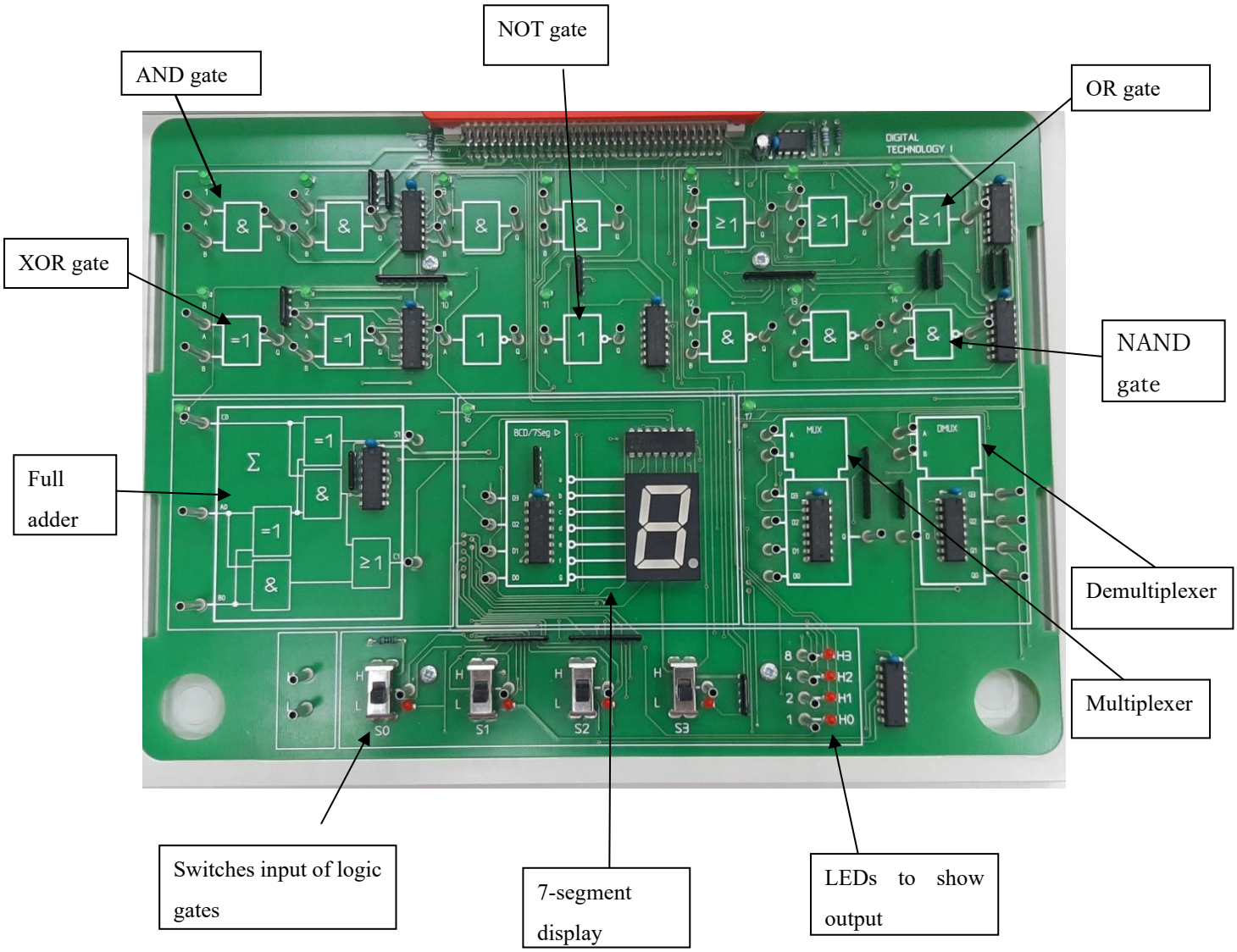

Figure1. Digital Technology 1 board by Leybold company

Second lab assignment was the half adder. The fundamental circuit for binary addition consists of half adder.

Its input receives two single digit binary values while its output supplies a binary value with a maximum of two digits: sum and carryover. Combining an XOR operator and an AND operator results in a half adder. Two single digit binary values A and B are to added. Switches S0, S1 are used for inputting the values A and B. The sum is indicated by LED H0 while the carryover is indicated by LED H1.

Alternatively, if two multi digit binary values need to be added, the half adder can be only used for the least significant digit. A full adder needs to be used for the other digits as they are dependent on three input values: A, B and C. This circuit on the Digital Technology 1 board (Figure1) shows how to two half adders are combined to form one full adder. To add two multi digit binary values, a full adder is required for each. Two single digit binary values A and B are to added, with C as the resulting carryover. Switches S0 to S2 are used for inputting the values A, B, and C. the sum is indicated by LED H0 while the carryover is indicated by LED H1. For example, (Figure 2) if A, B and C input values are 1 or HIGH then the output is 11 which means the sum and carryover are equal to 1. After learning operation of basic logic gates, it is easier for students to calculate outputs of half and full adders however students can take time for brainstorming with their group about output of adders. Then students compare their calculations with achieved results.

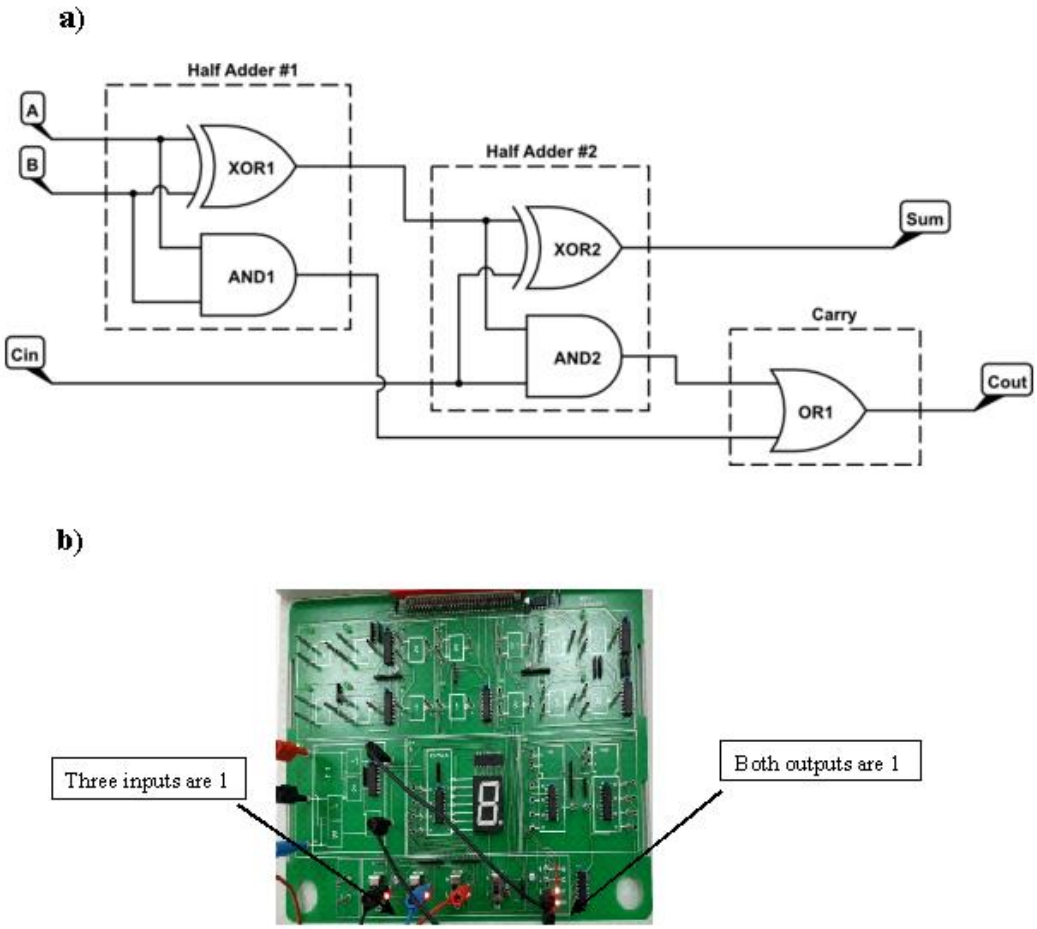

Figure 2. a) Schematic diagram of full adder. b) Example of set up of full adder in Leybold board

5. Achieved outcomes

At the end, students were interviewed about the benefit of the Leybold based laboratory assignment. Students responded that Leybold based laboratory assignments help them to learn operation of logic gates and also, they mentioned that they can directly observe by testing with output from Digital Technology 1 board practically by themselves.

By interviewing them we noticed that they were interested in laboratory assignments and how their interests were increased by including Leybold based projects in our laboratory assignments. The results showed that Leybold based laboratory projects were helpful for students to learn about logic gates operation. Interestingly, as the result of game type of quizzes and reports, it was noticed that students learn operations gates and majority of them were involved in learning. In this sense, we can easily say that our aims to implementing technologies in laboratories and enhancing students' interest were accomplished by Leybold based projects.

6. Conclusion

The main aims of the above-proposed laboratory assignments were to encourage students to become more digitally literate engineers, to implement innovative technologies in laboratory activities and to enhance students` interest by Leybold based laboratory assignments. To sum up, Leybold based laboratory assignments for students were proposed and tested for reliability which can be implemented during experimental hours of engineering courses in order to access two goals at once: comprehension of the topic and enhancement of students' interest to the topic. Therefore, the research could be further continued by finding out more laboratory assignments and conducting these experiments by using other experimental boards of Leybold.

The developed Leybold based teaching and learning approach can be applied to any engineering courses.

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