Web of Scholars: Multidimensional Research Journal (MRJ)
Volume: 01 Issue: 08 | 2022 ISNN: (2751-7543)
http://innosci.org

Digital Electronics and Microcomputer Principle: Online Teaching and Assessment

U. M. Ubaydullaev, Sh. N. Narzullayev
Assosiate professor in Information processing and management systems department at Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan

Abstract: *In this paper, a novel teaching and assessment method for the subjects Digital electronics and microcomputer principle proposed. Because of academic dishonesty and low effectiveness of traditional assessment methods based on memorized material repetition problems were raised.*

Keywords: *knowledge assessment method, distance education, online education, online exam, gamified education, simulation, digital circuits design, microcomputer basics.*

Introduction

Due to the COVID-19 pandemic, the forced transition of the higher education system around the world to the form of distance education has caused a number of organizational, technical, pedagogical and psychological problems. In the organization of distance education, solving these problems and creating resources for teaching science was one problem, on the other hand, creating a method for assessing students' knowledge and skills was a more complicated issue.

In the spring of 2020, when the global pandemic forced the education system to "distance learning", it became clear to everyone that a full return to the traditional higher education system would not be possible. The idea that the distance education system should be used only during a pandemic is also not correct, because this system also has its own advantages. However, in order to organize distance education, it is necessary to develop the educational process in accordance with the distance format. Due to the rapid transition to the online format, there was no time to redevelop the full-time curriculum. Teachers had to master new educational resources, change work methods and methods, and introduce new forms of supervision. Because some traditional forms of teaching and supervision have become completely ineffective in the electronic format [1, c. 1].

Based on the experience of different countries during the quarantine period, new approaches to evaluating the educational results of students in distance education are being discussed [2]–[8]. Particular attention is paid to the revision and improvement of control-measurement materials, the need to use flexible assessment methods and increase the importance of constant control, as well as the introduction of alternative forms of assessment aimed at developing students' creative and critical thinking skills [9]–[14].

Many sociological surveys conducted in the press and by higher educational institutions show that the transition to distance education was difficult for both teachers and students, and a number of organizational, technical, pedagogical, faced with psychological and other problems [15]. In universities that actively introduced digital technologies into the educational process before the quarantine, teachers and students were able to adapt to the new educational format painlessly and quickly, and these universities passed with the least loss in quality. However, although it was

possible to organize the distance learning process, the organization of exams caused a number of serious difficulties [4], [6], [7], [16]–[18]. The main issues discussed during online exams were: 1) how teachers can check students' independent performance of tasks, 2) how to evaluate educational results in practical areas where it is difficult to demonstrate acquired knowledge remotely, 3) which forms of supervision can ensure accurate and objective assessment of student learning in an online format [4], [19]–[21]. The complexity of these questions and the lack of clear answers made it difficult for teachers in many universities to conduct the final certification at the end of the academic year. In Uzbekistan, a number of universities, including the Tashkent State Technical University, have replaced the defense of graduation qualifications with a final examination. In the conditions of the risk of a new stage of distance education, the issues of ensuring the quality of the educational process and using appropriate online tools for knowledge assessment remain relevant.

The purpose of this article is to analyze the main problems related to the organization and conduct of teaching and examinations in the engineering fields of universities in the conditions of distance education, as well as to address these problems with the aim of applying them in traditional and mixed educational formats. the solution is to contribute to the professional and personal development of students by offering suggestions. Articles of foreign and domestic scientists, publications of the Organization for Economic Cooperation and Development and UNESCO on the research topic were used as sources for the research.

2. Methodology

2.1. Choice of subjects

For the study, the authors chose the subjects "Digital circuit engineering" and "Microcomputer fundamentals", which are important subjects for computer engineering. Also, at the Tashkent State Technical University, "Information systems and technologies" and "Intelligent engineering systems" are taught in the second and third semesters, respectively. The list of subjects taught in these courses is presented in Tables 1 and 2.

Table 1. Lecture topics on digital circuit engineering

#	Subject	Hours
1	Number systems used in digital devices	2
2	Logical elements	2
3	Basic laws of logical algebra	2
4	Encryptors and decryptors	2
5	Multiplexers and demultiplexers	2
6	Binary adder.	2
7	Digital comparator	2
8	Digital-analog and analog-digital converters	2
9	RS - triggers	2
10	JK - triggers	2
11	D - triggers	2
12	T - triggers. Forward and reverse counting and reverse counting devices	2
13	Registers. Shifting and reversing registers	2
14	The structure and principle of operation of memory devices	2
15	Arithmetic-logical devices	2
	Total	30

Table 2. Microcomputer Basics

#	Subject	Hours
1	General concepts of computer structure	4
2	General concepts of digital circuits	2
3	Design of finite automata	4
4	Interveys	4
5	Tire design	4
6	Design of memory devices	4
7	Assembler programming language	4
8	Internet technologies	4
	Total	30

To teach these topics, a special simulator program for computers and mobile devices will be developed. Students will need to use computers or smartphones to master these courses.

2.2. Teaching digital circuits course

To study this course a student registers by installing the simulator application on their computer or mobile device. At first, the student is allowed to work only with transistors from the elements in the application library. To activate elements in the library or create another desired element that does not exist, the student creates the desired logic element using transistors or active elements in the library. Figure 1 shows transistor-based schematics of Negation (a), two-input NAND (b) and NOR (c) elements, as well as the instrument panel (d) showing the activation of these elements as a result of creating and saving the circuits in the library.

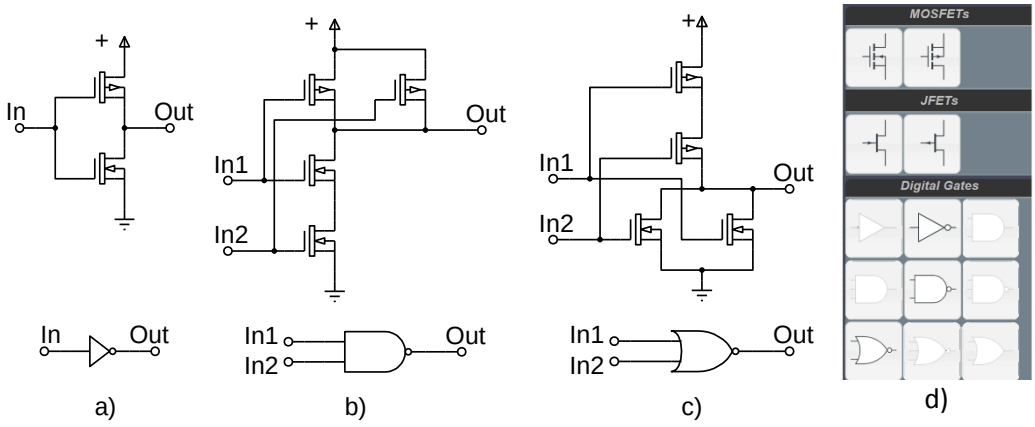

Figure 1. The structure of logical elements based on transistors, their conditional designations: a - Negation, b - NAND, c - NOR, d - display of active and passive elements in the library on the instrument panel

Can be used the schemes created in the previous topics or created by the user to create combination or sequential digital schemes related to the next topics in the science program. For example, a multiplexer or demultiplexer circuit can be drawn using the logic elements themselves, but the circuit will look simpler if a decoder is also used. In order to assemble the scheme of the element in each subject, it is required that he has mastered the previous subjects, otherwise the assembly of the scheme will be complicated.

3. Conclusion

This simulator helps students understand and learn to build digital circuits. It also allows them to better visualize the principles of designing digital circuit components. It should be noted that it is

difficult to say that students will learn all the subjects independently using this simulator. Students should be given theoretical knowledge and assignments by the teacher.

In general, the simulator has the ability to create and simulate small microprocessors and microcontrollers. The main thing is that the student is less likely to get bored due to the step-by-step process. In addition, it is possible to organize a competition among students to reach a step faster.

Currently, the structure of the simulator has been developed to help students learn the courses "Microcomputer Fundamentals" and "Digital Circuit Engineering" and evaluate their knowledge gained in these courses. The simulator is intended for use on Windows and Linux desktop computers, and on Android and IOS operating systems for mobile devices.

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