The Effect of a Virtual Learning Environment on Developing Computer Circuit Design Skills AMONG Computers and Information Students

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ABSTRACT
The aim of the current research was to develop students' skills in designing computer circuits among computers and information students through the development of an integrated virtual educational environment represented in (Moodle platform - virtual lab - educational software - YouTube channel). The researcher used the descriptive method and the experimental research method by applying the model of "Abdul Latif Al-Jazzar" (2014). The research sample consisted of two groups, a control group and an experimental group, numbering (60) students, 30 students for one group on first-year computer students. After applying the research procedures on the experimental and control sample, and using statistical treatments, the results showed that there were statistically significant differences at the significance level (0.01) between the mean scores of the students in the post-application of the achievement test. And the observation card in favor of the post application between the two groups in favor of the experimental group One of the most important recommendations of the research is to create virtual environments in the scientific fields in general and in the field of computers and engineering.

Keywords
Virtual learning environments- virtual lab- computer circuits.

1. INTRODUCTION
With the integration of computer science into the field of education, there have been many advancements in providing solutions to traditional educational challenges. Electronic environments, digital tools, and communication methods have all been developed to improve the teaching and learning process. One of the most impactful environments is the virtual learning environment, which operates on different systems and requires limited storage space on personal computers. Due to the high cost of infrastructure, designing these environments has relied on various virtual platforms, including educational platforms, virtual labs, and interactive sites, all of which are related to cloud computing. This allows learners of all levels and backgrounds to access educational environments based on cloud computing applications through any computer, regardless of its specifications, at any time and from anywhere. [1]

Virtual learning environments are based on multimedia programs, which allow for various implications and capabilities in different fields. For example, they can be used to train students to use complex and sensitive equipment in professional work, prepare them to face potential dangers and teach them how to deal with such conditions, provide opportunities to practice skills that may be difficult to practice on the ground, provide students with all necessary courses, documents, and references, and improve motivation, attention, and positive attitudes towards virtual learning and self-learning for lifelong learning. [2]

Several studies have explored the relationship between virtual environments mixed with blended learning and the development of computer circuit design skills among undergraduate students. For example, studies have shown that integration of face-to-face teaching with synchronous and asynchronous communication in virtual learning environments, the exchange of scientific materials, interactive dynamic simulations, and the process of self-assessment and group work in a media-rich environment can facilitate the exchange of scientific materials. [3] Additionally, research has confirmed that the use of a blended learning strategy based on the virtual lab effectively contributes to the success of students in learning computer circuit design skills. [4]

1.1 Motivation and Rationale
The motivation and rationale for this research stemmed from the researcher's experience teaching the content of logical design in the laboratory to first-year computer science students. It became apparent that many students struggled with connecting computer circuits and lacked knowledge of certain devices and electronics in the laboratory. To confirm these observations, an exploratory experience was conducted with an achievement test on a sample of 43 first-year computer science students. The results showed that 85% of the students had a low level of understanding in the cognitive aspect of the logical design course. Additionally, a note card was applied to an experiment carried out by the same exploratory sample, which showed that 93% of students had a low level of performance in the logical design course. These findings highlight the need for innovative teaching methods to improve computer circuit design skills and logical thinking among computer science students, which led to the development of a virtual blended learning environment in this study.

Previous studies have demonstrated the importance of virtual environments and virtual laboratories as a basis for a virtual environment in the educational process. These studies include [5], [6], [7], [8], and [9]. The findings of these studies support the use of virtual environments and virtual laboratories as effective tools in developing students' skills in various fields.

In light of the low and deficient level of first-year computer science students in designing computer circuits, as demonstrated by the exploratory experience conducted by the researcher, this study aimed to utilize a virtual learning

environment to improve students' skills in this area. The researcher was motivated to conduct this study based on the need for innovative teaching methods to improve computer circuit design skills and logical thinking among computer science students. paper organization.

1.2 Research problems and statements

Identifying the research problem in the presence of low and deficient level of first-year computer students in computer circuit design skills to address this problem, the following main question was formulated:

What is the impact of a virtual learning environment on developing computer circuit design skills for computer and information students?

The following sub-questions emerged from this main question:

1. What is the impact of a virtual learning environment on developing the cognitive aspect of computer circuit design skills for computer and information students?
2. What is the impact of a virtual learning environment on developing the performance aspect of computer circuit design skills for computer and information students?

Research Objectives

- Verify the impact of a virtual learning environment in the development of the cognitive side of computer circuit design skills among computer and information students.
- Investigating the impact of a virtual learning environment in the development of the performance aspect of computer circuit design skills among computer and information students.

Importance of research

- The research increases students' competence in the field of computer circuit design.
- Contribute to spreading the culture of virtual education through websites among faculty members.

Research hypotheses

After reviewing the results of previous studies and research, the research hypotheses were formulated as follows:

- There is a statistically significant difference at the level of significance ($0.05 \geq \alpha$) between the average scores of the students of the control and experimental groups in the dimensional measurement of the cognitive test of computer circuit design skills , in favor of the dimensional measurement of the experimental group.
- There is a statistically significant difference at the level of significance ($0.05 \geq \alpha$) between the average scores of the students of the control and experimental groups in the telemetry of the card to note the performance side of the computer circuit design skills , in favor of the telemetry of the experimental group.

Research Limitations:

The current research was limited to:

1. Human limits: a sample of first-year students, Computer Department, Higher Institute of Engineering and Technology in Kafr El-Sheikh.
2. Spatial boundaries: Department of Computers at the Higher Institute of Engineering and Technology in Kafr El-Sheikh.
3. Time limits: the second term of the academic year 2021-2022.
4. Virtual learning environment (website – educational platform – virtual lab -software program- YouTube channel).
5. Literature review

2. LITERATURE REVIEW

Based on the information provided, it appears that the research study aimed to investigate the effectiveness of game-based learning on logic gate material in improving student learning outcomes. The study used a one group pretest and posttest design, which means that the participants' performance was measured before and after the intervention (the application of game-based learning). The treatment given was the use of a game called "Circuit Scramble.apk" to teach the logic gate material The research was conducted at the Physics Education Study Program at Lambung Mangkurat University, and the research subjects were Physics education students taking digital electronics courses in 2019. Data was collected using pre-test and post-test about logic gate, and the results were analyzed using the N-gain test The N-gain test measures the improvement in learning outcomes between the pre-test and post-test. The results showed an N-gain value of 0.703, which indicates a high level of effectiveness of the application of game-based learning on logic gate material In conclusion, the study suggests that the use of game-based learning can be an effective method to improve student learning outcomes in the area of logic gate material. However, it is important to note that the study has limitations, such as the small sample size and the use of only one game as the intervention. Further research is needed to confirm the findings and explore the potential of other game-based learning approaches.[10]

This study describes an initial prototype of an Interactive Learning Environment (ILE) that uses a narrative-based framework to engage and motivate first-year undergraduate students studying a Computer Engineering unit at Manchester Metropolitan University. The primary goal of ILE is to increase students' interest and learning outcomes in the subject area of learning. A preliminary evaluation of ILE effectiveness was also reviewed, which identified elements of ILE that appealed to students overall. The paper highlights that the use of narrative-based frameworks in designing learning environments to engage and motivate students. For students who may find a subject difficult. More research is needed on the effectiveness of this event. [11].

This paper describes a computer program designed to facilitate the construction and simulation of digital circuits. The program allows users to work with both standard and custom integrated circuits, as well as virtual environments and interactive tutorials and showcases the benefits of using virtual logic units, which enable users to insert integrated circuits into breadboards, trace wires, change switches, and check outputs in displays, Almost like in a real-life lab. The program also supports the reuse of digital circuit designs, allowing students to study more applications while saving time and money. The program is also a valuable tool for teaching digital circuits and provides an engaging and practical learning experience for students. The ability of the program to support multiple educational methods..[12].

3. THE PROPOSED MODEL

There are many models that have been developed as models for designing any educational program, and these models may differ or agree on some points, which can be used when designing a virtual learning environment. Virtual e-learning; This is when designing the virtual learning environment, as this model consists of five main stages, each of which includes sub-

steps; These stages are the study and analysis stage, the design stage, the production and construction stage, the structural evaluation stage, and finally the stage of deployment and use.

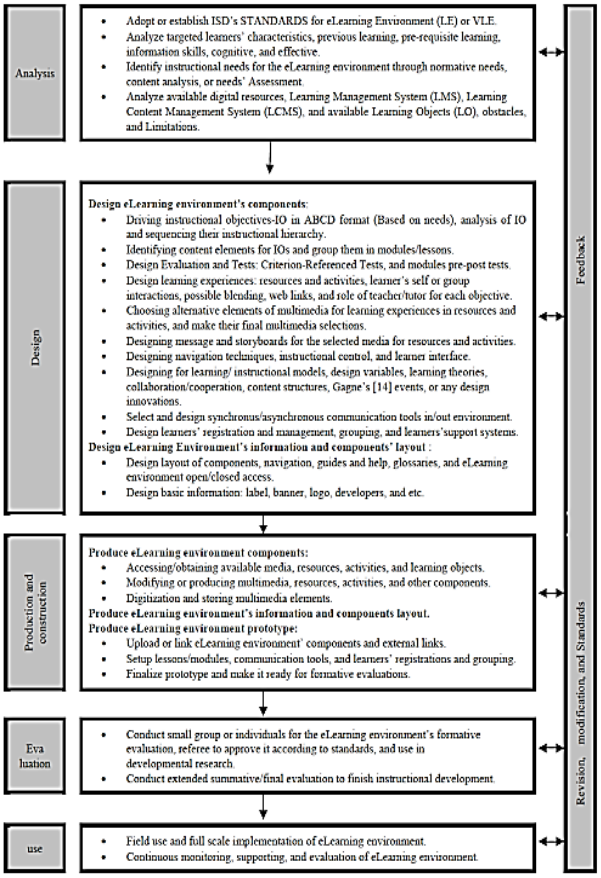

Figure 1 :Al-Jazzar Model for Instructional Design for E-Learning Environments (2014)

3.1 1.Implementation steps:

Instructional design standards for a virtual learning environment.
(Educational): 7 standards,
61 performance indicators, 44.53% relative weight
(Technical): 6 Standards
76 Performance indicators 55.47% relative weight

3.2 . Search procedures:

a) The exploratory application of the proposed measurement tools (an achievement test for the logical design course – the note card for the performance side) to determine internal stability and consistency, calculate the ease and difficulty coefficients for the items, and review and modify the items.
b) Creating a virtual learning environment consisting of (website – educational platform – virtual lab – educational software – YouTube channel – communication channels) and the participation and interaction of students on it with the steps to implement the proposed educational butcher model 2014.
c) Post-application of measurement tools on a sample of students.
d) Perform statistical treatment.
e) Analyze and interpret the results.
f) Presentation, discussion and interpretation of the research results in the light of the theoretical framework and education theories
g) Provide research recommendations in the light of the results.

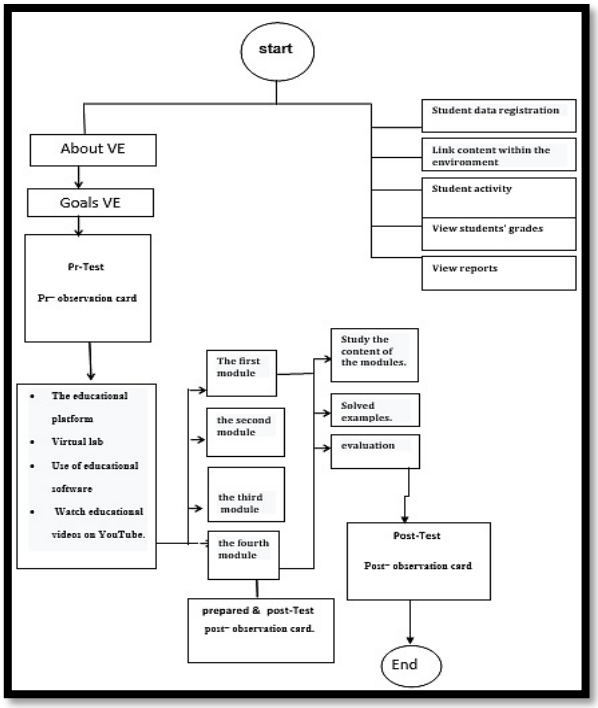

Figure5: Walkthrough map within the virtual learning environment

Preparing the cognitive achievement test for the logical design course:

a. The vocabulary of the achievement test was formulated, and the test was conducted from (50) items in the multiple-choice pattern distributed on (6) cognitive levels (remember – understand – apply – analyze – synthesis – evaluate) Bloom's levels.
b. Calculation of test stability coefficient: The researcher confirmed the stability of the achievement test by measuring the "Alpha Cronbach" coefficient using the statistical software package for the social sciences (SPSS).
c. Calculating the coefficient of ease and difficulty of the test items: By calculating the coefficient of ease and difficulty of the test items, it was found that the coefficient of ease of the test items ranges between (0.2) and (0.8), and this is an indication of the suitability and agreement of the test questions.
d. Calculating the discrimination coefficient for the test items: It became clear from the results that the discrimination coefficient for each test item ranged between (20% - 80%), which is an indication that the test items have an appropriate discriminatory ability, and thus the number of test questions became (50).

Preparing the special note card for the performance aspect of computer circuit design:

a. Determine the purpose of building the observation card: The observation card aims to measure the ability of first-year students to calculate the performance aspect related to computer circuit design skills. The card included a set of basic and subsidiary skills, which include (3) basic skills and (33) sub. Skills. – Skills related to computer circuit design skills, preliminary image of the note card

b. Quantitative Measurement of Student Performance: skill performance level – Performed the skill himself (3 points). Perform the skill with the help of the teacher (2p). Execute the skill without detecting the error (1p). Skill (0p) not executed. Thus, the maximum score for the observation card became (99) degrees and the lowest score (0) degrees.

c. Assessment of the validity of the card: The card was presented to a group of arbitrators specialized in the fields of: (computers, artificial intelligence, engineering, curricula and teaching methods, and educational technology), in order to ensure the integrity of the procedural wording. card vocabulary.

d. The coefficient of agreement and the coefficient of difference on the performance of each student were determined from the results with the average coefficient of agreement of the observers (92.45%)which is a high stability coefficient, and that the card is valid for use and application to the research sample as a measurement tool.

e. The rates of ease and difficulty of the test range between (20% to 80%) and thus the appropriate vocabulary for the rates of ease, difficulty and excellence becomes 33 items, which is the final image of the observation card.

4. EXPERIMENT AND RESULTS

The virtual environment was used to teach four modules for the duration of the research experiment on first-year students on computers Through the educational platform, virtual lab, and educational software**.**

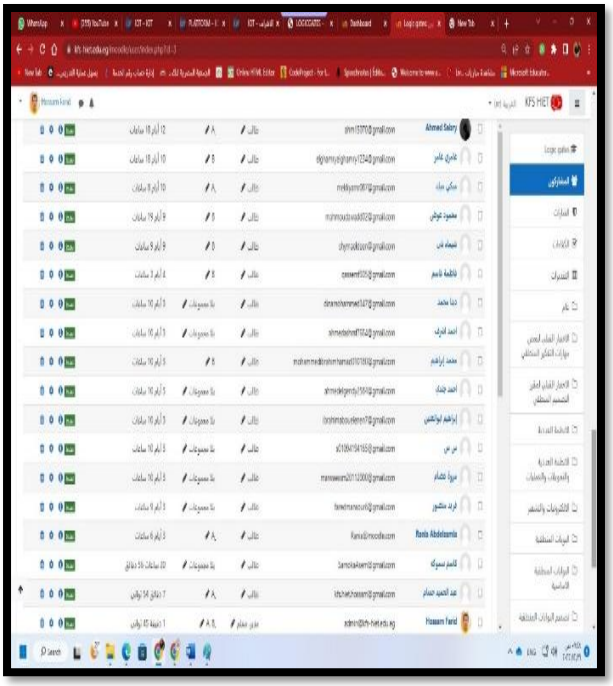

Figure 2: Environmental education platform

The figure shows the educational platform Moodle and the interaction of students inside it, specifying the time of entry and exit of students.

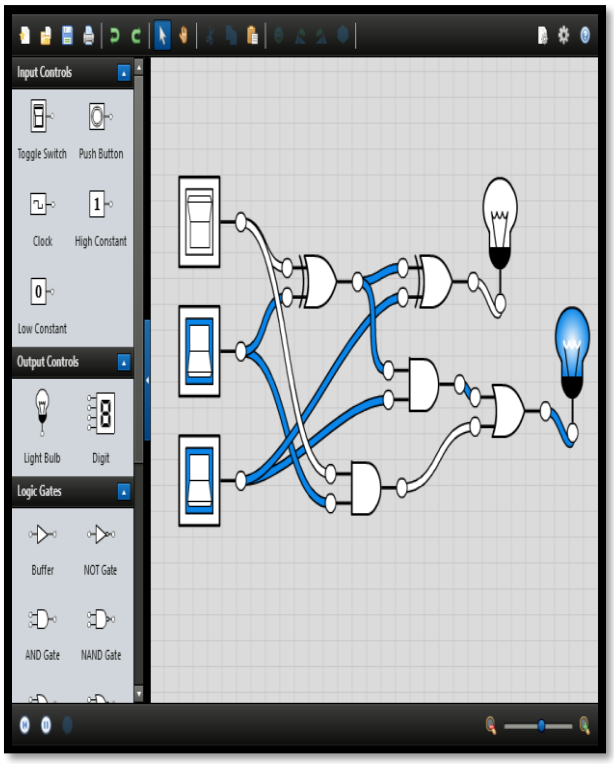

Figure 3 : Environment virtual lab

The figure shows the environment of the virtual laboratory to connect more than one electronic circuit and test its connection.

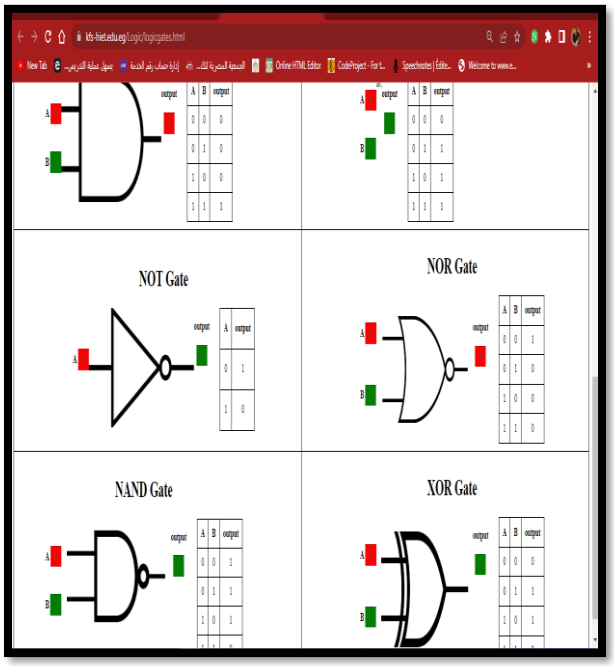

Figure 4: Educational Software

The figure shows the educational software that helps students achieve the truth table of the logical gate by determining the input and output of the gate. The software shows the difference in the truth table between the logical gates when the input and output are constant

4.1 Pre-apply measurement tools:

The pre-application of the research tools began in the computer lab on Monday and Tuesday corresponding to 9-8/2/2022 AD, where the researcher applied the research tools:
the cognitive achievement choice
observation card
on the two groups

- control "30 students"
- experimental "30 students"

to measure the cognitive and skill aspects of the research sample, and the results were shown in a table (1) and table (2) that the average scores of the students for the achievement test and the notes card showed closeness and homogeneity between the two groups.

Table (1) Significance of the difference between the mean scores of the two research groups (experimental and control) in the pre-application of the cognitive achievement choice

Variables	Groups	Average	Standard deviation	t	Significance	ETA2
remember	Exp	1.43	1.22	-0.96	0.34	Non-function
	con	1.73	1.20			
Understand	Exp	1.97	1.63	-0.67	0.51	Non-function
	con	2.27	1.84			
apply	Exp	2.07	1.28	0.00	1.00	Non-function
	con	2.07	1.20			
Analyze	Exp	1.40	1.07	0.36	0.72	Non-function
	con	1.30	1.06			
installation	Exp	1.03	0.96	1.03	0.31	Non-function
	con	0.77	1.04			
evaluate	Exp	1.23	1.38	0.78	0.44	Non-function
	con	0.97	1.27			
educational	Exp	7.30	4.94	-1.57	0.12	Non-function
	cont	9.10	3.89			

Table (2) Significance of the difference between the mean scores of the two research groups (experimental and control) in the pre-application of the observation card:

Variables	Groups	Average	Standard deviation	t	Significance	Eta2
Drawing	Exp	1.30	1.53	0.52	0.61	Non-function
	con	1.10	1.47			
conduction	Exp	0.90	1.32	-0.46	0.64	Non-function
	con	1.07	1.46			
Truth table	Exp	0.40	0.89	-0.31	0.76	Non-function
	con	0.47	0.78			
card	Exp	2.60	2.93	-0.04	0.97	Non-function
	con	2.63	3.12			

4.2 Results

4.2.1 Results of the first question:

The first question of the research was: "What is the impact of a virtual learning environment on developing the cognitive aspect of computer circuit design skills for computer and information students? ".

To answer this first question, the first hypothesis of the research was formulated, which is:

"There is a statistically significant difference at the level of significance ($0.05 \geq \alpha$) between the average scores of the students of the control and experimental groups in the dimensional measurement of the cognitive test of computer circuit design skills , in favor of the dimensional measurement of the experimental group."

Table (3) The significance of the difference between the average scores of the two research groups in the dimensional application of cognitive achievement selection

Variables	G	Average	Standard deviation	t	Significance **	Eta2	Impact size
remember	Exp	5.80	0.61	1.11	0.27	0.02	Medium
	con	5.57	0.97				
understanding	Exp	11.73	0.69	2.25	0.028 *	0.08	Medium
	cont	10.97	1.73				

apply	Exp	10.60	0.67	4.29	0**	0.24	big
	con	8.77	2.24				
analyze	Exp	6.73	0.58	6.41	0**	0.41	big
	con	4.67	1.67				
installation	Exp	5.70	0.65	10.64	0**	0.66	big
	con	2.03	1.77				
Evaluate	Exp	7.63	0.72	15.37	0**	0.80	big
	con	1.87	1.93				
Educational	Exp	48.20	1.32	13.42	0**	0.76	big
	con	33.87	5.70				

(*, Δ) Statistically significant at the level of significance (0.0 1)

The validity of this hypothesis was verified by calculating the average scores of the research sample (experimental group and control group) in the telemetry of the cognitive achievement test for computer circuit design skills.

and the Wilcoxon test was used for the associated samples to verify a difference between the average scores of the telemetry in the two complexes (experimental and control), and to determine the size of the impact of the virtual learning environment In the cognitive achievement, Q (η^2) was calculated in the following table.

It is clear from Table (2) that all the values of (Z) are statistically significant at the level of significance (0.01), which indicates a statistically significant difference between the average scores of the experimental group students from the control group students in the dimensional measurement of the cognitive achievement test for computer circuit design skills, and in favor of the experimental group. The first hypothesis is accepted

As it was clear from the previous table, the average scores of the experimental group members were higher than the control group in the post application of the cognitive achievement test at each level of the achievement test (remember - understand - apply - analyze – installation – evaluation). The average scores of students in the telemetry I cognitive achievement test for computer circuit design skills can be represented graphically as follows:

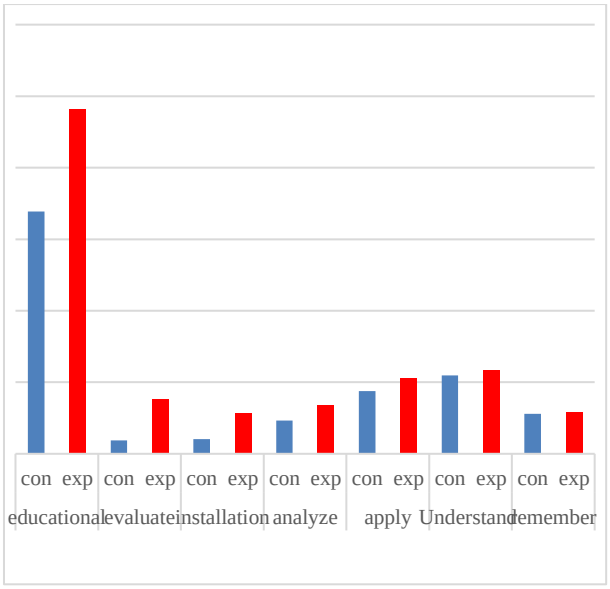

Figure (6): Graphic representation of the average scores of the post-cognitive achievement test

It was also found that the size of the effect of using the virtual learning environment in the development of cognitive achievement associated with the design of computer circuits, where the value of (T) ranged between (1.11 – 15.37), which is a high value. . Compared with the value of (0.8), which in turn enhances the acceptance of the first hypothesis.

It was also clear from the previous table that the impact factor rose by a large percentage among the members of the experimental group than the control group in the post-application of the cognitive achievement test at each level of the achievement test (apply – analyze – installation – evaluate) and the average came at the level of (remember – understand) and this is normal in the basic levels of the Bloom cognitive pyramid as (remembering and understanding of the research sample).

4.2.2 Results of the second question:

The **second** question of the research was: "What is the impact of a learning environment on developing the performance aspect of computer circuit design skills for computer and information students?".

To answer this second question, the second hypothesis of the research is formulated, **which is**:
"There is a statistically significant difference at the level of significance ($0.05 \geq \alpha$) between the average scores of the students of the control and experimental groups in the pre- and post-measurements of the card to note the performance side of the computer circuit design skills , in favor of the post-measurement of the experimental group."

The validity of this hypothesis was verified by calculating the average scores of the research sample in the dimensional measurement of the two groups (experimental and control) of the observation card to measure the skill side of students, and the "Wilcoxon" test was used for the associated samples to verify the existence of a difference between the average degrees of the dimensional measurement, and to determine the size of the impact of the learning environment, the following table was calculated, asη in the following table:

Table (4) The significance of the difference between the average scores of the two research groups in the post-application of the test The performance aspect of the observation card

Variables	Groups	Average	Standard deviation	t	Significance **	Eta2	Impact size
Drawing	Exp	32.37	1.50	7.57	0**	0.50	big
	con	26.40	4.05				
conduction	Exp	35.10	4.36	9.21	0**	0.59	big
	con	25.33	3.84				
trues table	Exp	24.60	4.05	10.17	0**	0.64	big
	con	15.07	3.16				
card	Exp	92.07	7.36	12.61	0**	0.73	big
	con	66.80	8.14				

(*, Δ) Statistically significant at the level of significance (0.0 1)

It is clear from Table (3) that all the values of (Z) are statistically significant at the level of significance (0.01), which indicates a statistically significant difference between the average scores of students in the experimental and control groups in the dimensional measurement of the observation card , and in favor of the experimental group;

The average scores of students for the experimental and control groups in the dimensional measurement can be represented graphically as follows:

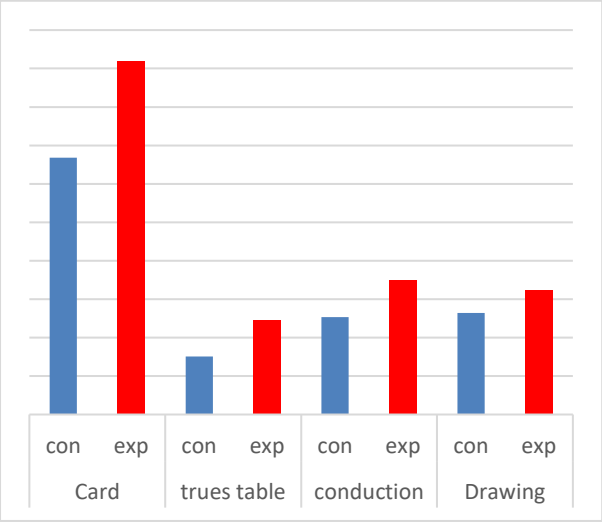

Figure (7): Graph of the average scores of the observation card after

It also turned out that the size of the impact of using the virtual learning environment is large in developing the skill aspect of the observation card, as the value of (d) ranged between (7.57-10.17), which is a high value compared to the value (0.8), which in turn enhances the acceptance of the second hypothesis of the research.

It was also clear from the previous table that the impact factor increased by a large percentage among the members of the experimental group than the control group in the dimensional application of basic skills with the observation card by a large percentage.

5. DISCUSSION AND INTERPRETATION OF RESULTS

The current research is based on the virtual environment and its main tools, the virtual lab, the Moodle educational platform, and the educational software, with the advantages it provides to students, including:

a) Achieve faster learning outcomes.

b) Providing self-learning is the most viable.

c) Collaboration during learning, which strongly affects the learning process, reduces the cognitive burden on students, and the breadth of students' visions, perspectives and knowledge.

d) Participate in the work of educational activities within the environment.

e) Interaction between students and the teacher, where communication with the teacher is carried out through the environment through (written chatting) and audio and video through the applications in the environment, which are characterized by their support for the Arabic and English languages.

f) The interaction between students and content, and this is done through various navigation methods within the environment using the educational platform and has been programmed with the (Moodle) system because of the strong and effective content management system that is used in most universities and institutes of the world, which contributes to providing students with a sense of immersion.

g) The statistics showed that the impact of the virtual environment is very clear and positive for students, especially in the technical and practical aspects of designing computer circuits.

h) The interaction between students and the applied (practical) content, and this is done through various navigation methods within the environment using the virtual laboratory for designing computer circuits (Logic Gates VL), where this application has an easy-to-use and clear environment in terms of instructions, icons used, and a drag-and-drop system that willprovide students with a sense of Easy connection and the practical aspect of designing computer circuits.

6. RECOMMENDATIONS

In light of the findings of the current research, the researcher recommends the following:

Benefiting from the virtual environment in developing students' skills in designing computer circuits.

1. Benefiting from the virtual environment in developing students' skills with logical thinking.

2. Faculty members and teachers take the necessary courses to use the virtual environment and the tools it contains in the educational process.
3. The need for educational bodies and institutions to adopt the use of virtual learning environments in the educational process to develop educational outcomes.
4. The virtual environment supports technical research and development in the field of electronic circuits, as it can be used to test and improve new technologies and develop innovative applications.
5. In the future, the electronic circuit lab will become part of the infrastructure for research and development in the field of future technologies such as artificial intelligence, quantum computing, the Internet of Things, and others.

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