Human-Computer Interaction Consideration for Education Information System: Teaching the Concept of DLD

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Abstract
This study aims to facilitate students with VLE programs to digest some basic and advanced concepts of digital logic design DLD. In a distance or online virtual learning environment (VLE), usually, logical thinking becomes difficult for students to understand advanced concepts of the engineering-related subject's i.e. digital logic design (DLD). In the present study, seven different groups comprising of students in one control group and second experimental group have been taken for experiment. In the control group campus program (F2F), online virtual learning education (VLE), correspondence based distance education (Paper-based DE) have been included. On the other hand, in the experimental group of students, there are included VLE, Paper-based DE, Face to Face (F2F) and the blended group is included. After conducting pre-test and post-test, analysis of results shows that the use of simulator was effective in learning of DLD concepts as there was a 67% improvement in BL, 39% in VLE, 50% in F2F and 35% in Paper-Based DE respectively. The results of the present study showed that the use of a software simulator while teaching DLD has a significant positive effect on student learning outcomes.

Key words:
Digital Logic Design (DLD), Virtual Learning Environment (VLE), Face to Face (F2F), Distance Education (DE), Blended Learning (BL).

1. Introduction

The present study aims to illustrate that there are a great role and potential of the Education Information System (EIS), especially in technical education. It is also relevant to assert that in any education and technical training stations a single technology is not enough. In this situation, the trainers should be aware of different alternatives that may be helpful for technical training. With the pssage of time, there has come an improvement in the field of education and in technical education that caused an improvement in productivity in different fields. There is a lot of improvement in the industry as well as technology that resulted in betterment in productivity. This was a gradual improvement in the field of EIS. There is immense use of this field of technology now the aim is to make the students of the modern era fortified with the technology that is happening in the field of EIS. The field that is enhancing and progressing in the biosphere as there is progress in the ground of Digital Logic Design (DLD). Now there is a struggle that is being made that the technology of modern time should be utilized productively. But this is a sorry figure that still there are so many flaws in the technological world and it is a need that the students of the modern-day had better aware of these flaws so that they should be removed in the future. For this reason, there is an enormous need that there would be introduced methods of technical education and the students must be made aware of the techniques that are the core and crux of modern time. In this regard the role played by the computer cannot be neglected and computer hardware. The computers make the individual's active members of problem-solving. In this esteem, the study is to learn behavior modeling and to train how to process it in different circumstances. The presented paper has the center of focus to create responsiveness on the importance of using full-scale simulation training in education. Although the process of understanding is very complex once in a while it may be achieved by simplified representation. Simulation can be very effective because of Graphical representation and user interaction. These two features

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increase the simulator affectless and increase the importance of software which can help to understand the difficult concept of different subjects. (Gelbart, Brill, & Yarden, 2009)conducted a review on the science training that incorporated an area on the utilization of simulation and games for training. In their study,(Gelbart, Brill, & Yarden, 2009) focused on both the affective and cognitive domains with a specific end goal to research the impacts of computer simulation on students' inspiration and association. They supplanted some portion of the conventional method in a subject titled "Electrical Machines and Installations" with a software-based method that made utilization of a computer simulation. This seemed to animate discourses among the students themselves and with the educator amid the meeting to generate new ideas. (Jelemenská, 2012).

Medley and Horne (2005) are of the view that DLD simulators are very important that enables the students for experimental learning in a safe environment. It provides a safe environment for the new as well as experienced practitioners. The new training tools help and facilitate the simulation- based learning environment and in various disciplines. On the other hand, the new training techniques are simulation-based learning that may be a beneficial and effective method. If the methods are effective and appropriate, they have to considered for the wider adoption as they may be used in the technological system and engineering as well as science and education. This test has some limitation and it does not prove that the simulation system is an effective training method. The adaptability, usefulness of the system depends on the feedback of the students that further depends on the likeness or unlikeness of the students or the facilities that were used in the approach. The students like the demonstrative approach rather than the approach that forces them to think(Nikolic, Radivojevic, Djordjevic, & Milutinovic, 2009). In this regards for the better understanding we have completed a comparative study on different learning models. These models are BL, F2F,VLE and Paper-based learning model. After the keen observation of experiments and results we concluded from that in this time of pandemic the Blended learning model is one of the best model.

1.1. Problem statement

DLD concepts are difficult to understand for the students of the undergraduate level specifically as some first logic and electronics-related course. “Keeping in view limited laboratory resources, selecting a simulator that addresses pedagogical needs of instructors as well as introduces a clear understanding of complex concepts to the students is the problem which is a concern of this study”.

1.2. Scope

In this study, we investigate the possibility and enhancement of the Digital Logic Design concepts. For this purpose, we are not going to make a software or programming Tool. We make a model that finds out the effectiveness of such a system in BWP students. We calculated the features and concepts which is essential for the student's test and getting more attraction to studying the DLD concept.

1.3. Objective of the Study

1. To identify effective teaching Modes for DLD.
2. To explore the Tools for improving the teaching concept of DLD for undergraduate students.
3. To evaluate the different possible Tools in terms of Usability and acceptability.
4. To understand the reasons behind the effectiveness of teaching Mode.

2. Related Work

(Isayama, Ishiyama, Relator, & Yamazaki, 2016).The point of research in this paper is on the education of computer science students of grades 1-12. As high tech is increasing rapidly from some last eras. So, the education of computer science is becoming vital for grades 1-12. the main purpose of the computer science education should be to create computational thinking skills in the students.

(Figueiredo, Sousa, & Lousada, 2017)This paper is based on the decrease in some cognitive function that has been related to the maturing procedure. Computer-based cognitive preparation programs have been considered as a promising

way to deal with the upkeep or potentially change of cognitive capacities. TV Neurons is a computerized cognitive preparing program for solid and cognitive weakened more established grown-ups. In any case, there are at present no approval thinks about with TV Neurons.

(Sirkiä, 2018)This exploration paper makes sense of how to program, a student designer must appreciate the dynamic, run time some portion of program code, an implied notional machine. Understanding the machine can be less requesting when it is addressed graphically, and apparatuses have been created to this end. Nevertheless, these devices commonly support only a solitary programming dialect and don't work in a web program.

(Škrinárová & Vesel, 2016)This work concentrates on the issue of a superior computing education given frameworks, for example, lattice, cloud, HPC bunch or frameworks with half and half situations. The objective depends on the examination of the High-Performance Computing Strategic Research Agenda in Europe and the distributed discoveries in the USA in the setting of requirements for education and preparing particularly in HPC and Compute Intensive Science.

(Sriharsha, 2012) They have present a combined study of different models. They work over the models of the education system. This work is enhanced work for learning strategies. After this, they have again presented an enhanced study.

(Takahashi et al., 2015)In many computer science programs the course digital Logic design is required. Typically, the Lecture of this course covers the logic design essentials, with application and technologies covered in the laboratory. As new technologies develop, it is more difficult to complete the desired course in 3 or 4 credit hours. The specific impulse for this study was prompted the efficient issues.

(Alsadoon, Prasad, & Beg, 2017)In this paper, the authors describe that several strong computation simulation software is available for undergraduate engineering programs that allow students to design and simulate system behavior. But for students, these are not easy to understand the things created the way. Because a student's learning capability can be increased by different simulation software.

(Parker & Guzdial, 2015)The applied stimulus for this study is expressed by three perspectives. To start with, the requirement for ponders on senior center school material science understudies. Elective originations hinder understudies' theoretical comprehension and effect on their logical education as future residents.

(Breivold & Crnkovic, 2014)As cloud computing is emerging in the industrial area for providing efficient services to users. The advantage of using cloud computing is that the user can easily and faster access to any information. Cloud computing provides storage over the network other than the local server.

(Nikolić, Häusler, Singer, & Maass, 2009)As said before, the conventional hands-on part of a DLD course uses discrete rationale entryways to actualize the circuits talked about amid addresses. This strategy for the most part begins with a subjective portrayal of the conduct of a circuit. This is trailed by the advancement of truth tables for the circuit.

3. Models

This study is based on the student of NCBA&E Bahawalpur Campus. As we know the human behavior differs from area to area and intellectuality. Modern countries are spending their main part of the budget on the effective education of the students. In this study, our main focused on the learning ability of the students. All the outcomes of experiments are depending on the learning capability of the students. Preliminary we investigate the capability of the students of the National College of Business Administration & Economics (NCBA&E) Bahawalpur Campus. In NCBA&E there are many departments, but my topic is related to conceptual technical subjects especially Digital Logic Design which is the Key

subject of Engineering, Electronics, Information Technology & Computer Science. So we select the Engineering and Computer Science Department. For achieving our objective, we take Seven different groups comprising of students in one control group and one experimental group from each: on-campus program (F2F), online virtual learning education (VLE), correspondence-based distance education (paper-based DE) and one group of students as blended learning (BL) group.

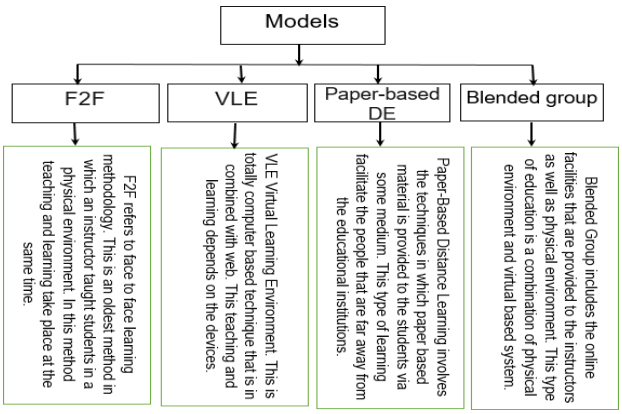


Figure 1: Different Learning models and their descriptions.

3.1 Face to Face Learning

The traditional classroom or face-to-face instruction is when the instructor and the students are in a place devoted to instruction and the teaching and learning take place at the same time.

3.2 Virtual Learning Environment

Virtual learning environment (VLE) is a collection of software tools supporting academic administration, teaching, and research using the Internet, particularly the World Wide Web.
In VLE, students take the lectures by videos, so if the students are facing any problem to understand the topic there has no tool or option for asking.

3.3 Paper Base Learning

This study is based on handouts and assignments. Teachers just give the handouts to the students and the students learn from the handouts and make the assignment just like the method of Alama Iqbal University.

3.4 Blended Learning Group

In this group, students will learn by utilizing the white Board and Simulation Both. Blended learning is a training program (formal or non-formal) that consolidates online digital media with normal classroom techniques.

4. Methodology

We take 20 students for each group from the engineering and computer science department of 3rd and 4th Semester session in Spring 2017, About 90 % of the students were taking at least one class. A total of 80 students participate in this experiment. In this experiment, three groups are repeated for Pre-Test and Post-Test and one group is the Blended group.

An eleven-thing questionnaire was created togather illustrative information concerning every member's statisticdata, educational background, and previous advanced hardware encounter. Statistic and related data asked for from the participant included age, gender, year in college, the real field of study, and college review point normal. The participant was likewise asked to describe the sort of experience they may have had with logic gates in either course-related exercises. Results of the questionnaire uncovered that the normal age of the members was twenty-Three. Twenty-five out of sixty understudies are females and staying thirty-five are male in Pre-Test and thirty one out of eighty members are females and staying forty-nine are guys in Post-test. Sixty-seven percent of members out of a hundred percent announced that they had no formal education in advanced hardware. Digital logic is one of the key information regions in the

Computer and Engineering specialization. Because of the multifaceted nature in the subject, conveyance strategy ought to incorporate address classes as well as commonsense work utilizing simulators.

This paper studied a scope of such simulators accessible in the market, and after that assessed three simulators that were uninhibitedly accessible and were appropriate for research center utilization. The technique adjusted in the examination talked about the ease of use, moderateness, accessibility, and the course substance secured by various simulators previously enlisting them into the exploratory work. One of the main findings of this research is that incorporating these types of digital simulators to the student learning system related courses enables the students to do more practice-based learning and study remotely until they are familiar with the concepts.

Pre-test

The pretest was a paper-and-pencil test which initially consisted of twenty-two questions. The test was administered to sixty-five undergraduate students at Iowa State University during the Spring of 1989. The reliability analysis of the test was based on these data. It was found that the Cronbach Reliability Coefficient was 0.82.

The pretest that was used in this study was a paper-and-pencil test and consisted of nineteen questions. The first nine-question were problems in which the student had to identify the figures that satisfied the corresponding logic rule. This nine-question was based on five different types of logic rules; AND, OR, AND-AND, OR-OR, and AND-OR. The figures had different shapes; circle, triangle, rectangle, and square. The figures were either solid or shaded or left empty.

Each item consisted of one logic rule and approximately nine figures. The student was asked to circle those figures that satisfied the corresponding rule. Using Bloom's Taxonomy (1956), these questions belonged to the application category in the cognitive domain. The next ten questions were based on the concepts involved in logic gates. In six of those questions, students were asked to match the logic symbols with the corresponding logic gates.

Post-test

The post-test was also a paper-and-pencil test and consisted of twenty-seven questions. The test was administered to seventy-two undergraduate students at Iowa State University in the spring of 1989. The students majored in Industrial Education and Technology. These students did not have any prior knowledge of logic circuits and therefore represented the population described in this study. The sample was thus appropriate for the pilot study. The Reliability analysis of the test was based on these data. The RELIABILITY procedure in the SPSS statistical program was used to determine the Reliability Coefficient. Procedure RELIABILITY performs an item analysis on the components of additive scales by computing commonly used coefficients of reliability. This procedure also prints basic summary statistics including item means, standard deviations, inter-questions covariance, and correlation matrices, scale means, and question-to- question correlations. Five different models are available in this procedure. The ALPHA model which computes Cronbach's alpha was used to determine the reliability of the instruments. Since the data were in dichotomous form, the corrected correlation coefficients between each question and the total test score were positive and all questions were judged to be good questions by the program. The content validity of the test was confirmed by four professors at Iowa State University, who are knowledgeable in this area. The remaining seventeen questions belonged to the analysis, synthesis, or evaluation categories of the cognitive domain. These questions were classified as "transfer" type of questions.

Simulator

We chose Logisim, Cedar, Deeds, and tiny cad simulators for the understudies to investigate a portion of the handy side of the DLD. The

accompanying is a brief clarification of every one of them. Digital logic is one of the key information regions in the Computer and Engineering specialization. Because of the multifaceted nature in the subject, conveyance strategy must incorporate address classes as well as commonsense work utilizing simulators. The technique adjusted in the examination talked about the ease of use, moderateness, accessibility, and the course substance secured by various simulators previously enlisting them into the exploratory work.

The students liked most of the newly designed labs. One of the main findings of this research is that incorporating these types of digital simulators to the student learning system related courses enables the students to do more practice-based learning and study remotely until they are familiar with the concepts. Incorporating these types of simulator-based teaching or learning will a very useful tool for the universities transferring the programmed from the traditional face-to-face environment to blended learning or fully online courses. Our future work incorporates the investigation of a substantially bigger number of simulators because of attributes. The results that are generated with the use of CEDAR simulator are much better than the other one. As the students were asked to complete the survey for evaluation purposes during class time, the survey response rate was above 94%.

Table 1: Summary of gender selected in all groups

		Frequency	Percent
Valid	Pre-Test	60	42.9
	Post Test	80	57.1
	Total	140	100.0

Table 2: Detail of All Groups along with No. of Students

		Frequency	Percent
Valid	Male	74	53.6
	Female	66	46.4
	Total	140	100.0

Table 3: No. of a participant in Pre-Test and Post-Test

		Frequency	Percent
Valid	Blended Group	20	14.3
	virtual learning Education	40	28.6
	paper Based education	40	28.6
	Face to Face	40	28.6
	Total	140	100.0

Table 4: Ages of students

Table 1: Age of the Students

Ages	Frequency	Percent	Valid Percent	Cumulative Percent
18	20	14.3	14.3	14.3
19	25	17.9	17.9	32.1
20	24	17.1	17.1	49.3
21	21	15.0	15.0	64.3
22	13	9.3	9.3	73.6
23	2	1.4	1.4	75.0
24	19	13.6	13.6	88.6
			4.3	92.9
			2.9	95.7
			4.3	100.0
			100.0	

Table 2: % of education previous

Previous Education	Frequency	Percent
Yes	45	32.1
No	95	67.9
Total	140	100.0

5. Results and Discussion

Performance of Students

In this study, we discuss the Performance of the students having a computer department and Engineering department on DLD subject 40%

Group of the Computer science students give the correct answer about the OR Gate. In Pre- test, but after the training session, we found a 54% improvement in computer science students. 20 % of engineering students give the correct answer in Pre-Test and 40 % Engineering students give the correct answer in Post Test. questions are based on the basics of DLD which are denoted by Simple questions and some questions are based on circuits which are denoted by complex In Tables. Many students are pass or fail in different groups and indifferent in the type of test that is Pre-Test and Post-Test. We don't take Pre-Test from Blended Group just take Posttest. 24 questions are False and 96 questions are true from the simple portion and 62 questions are false and 158 are true from the complex portion of Blended Group students. 58 questions are False in Pre-Test and 31 questions are false in Post Test and 62 questions are true in Pre-Test, 89 questions are true in the Post Test from the simple portion. 152 questions are false in Pre- Test and 106 questions are false in Post-Test and 68 questions are true in Pre-Test and 114. In the experimental group, we take four different groups which are discussed above in detail.

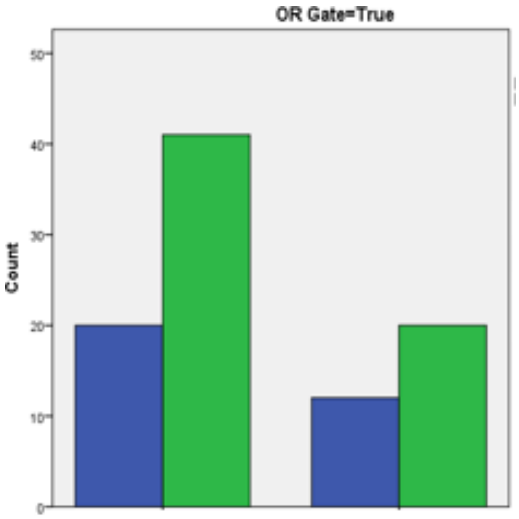
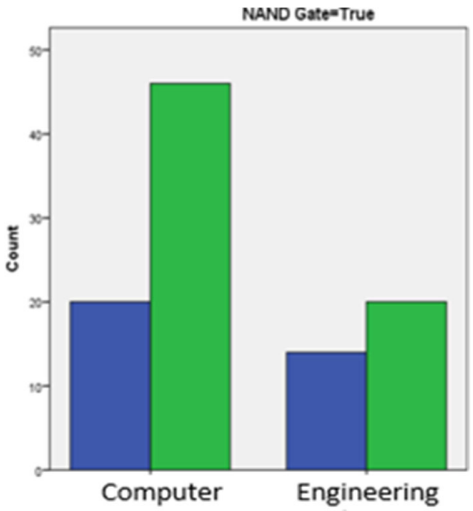


Figure: 4 Major subjects

In this study, two types of questions are taken some 40 % of the Computer science students give the correct answer about the OR Gate. Questions are true in the Post-Test from the complex portion of Virtual Learning. 49 questions are False in Pre-Test and 34 questions are false in Post Test and 71 questions are true in Pre-Test, 86 questions are true in the Post Test from the simple portion. 144 questions are false in Pre-Test and 114 questions are false in Post-Test and 76 questions are true in Pre-Test and 106 questions are true in the Post-Test from the complex portion of. Paper Base Learning Education. 49 questions are False in Pre-Test and 34 questions are false in Post Test and 71 questions are true in Pre-Test, 100 questions are true in the Post Test from the simple portion. 144 questions are false in Pre-Test and 109 questions are false in Post-Test and 76 questions are true in Pre-Test and 111 questions are true in the Post-Test from the complex portion of Face to Face learning Education.



Scomplex Frequencies

		Responses		Percent of Cases
		N	Percent	
Scomplex	False	831	54.0%	593.6%
	True	709	46.0%	506.4%
Total		1540	100.0%	1100.0%

Table 6: This table shows the total percentage of simple portion .31.5 % questions are false and

68.5% are true percent cases are also mentioned here about the false and true report.

$simple Frequencies

Table 7: This table presents the repot about Complex frequencies of false and true values. In complex frequencies percentage is changed for false from 31.5% to 54.0% and True is turned from 68.5% to 46.0%.

		Responses		
		N	Percent	Percent of Cases
$simple	False	265	31.5%	189.3%
	True	575	68.5%	410.7%
Total		840	100.0%	600.0%

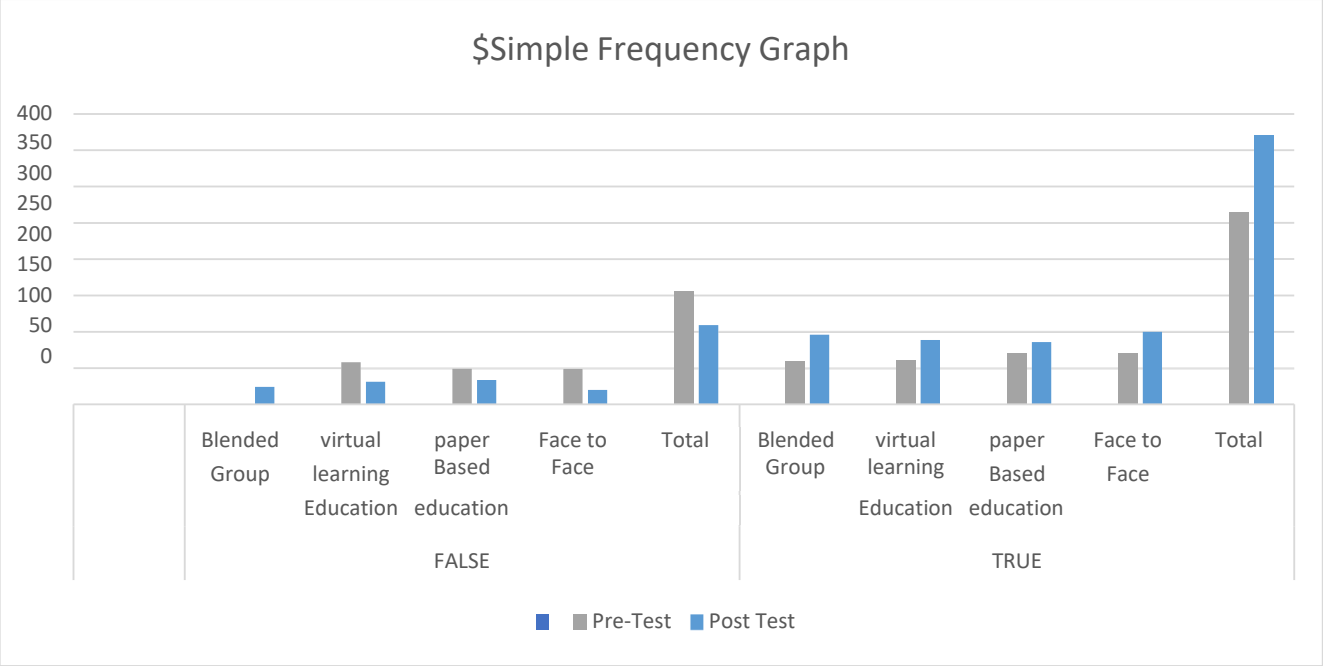
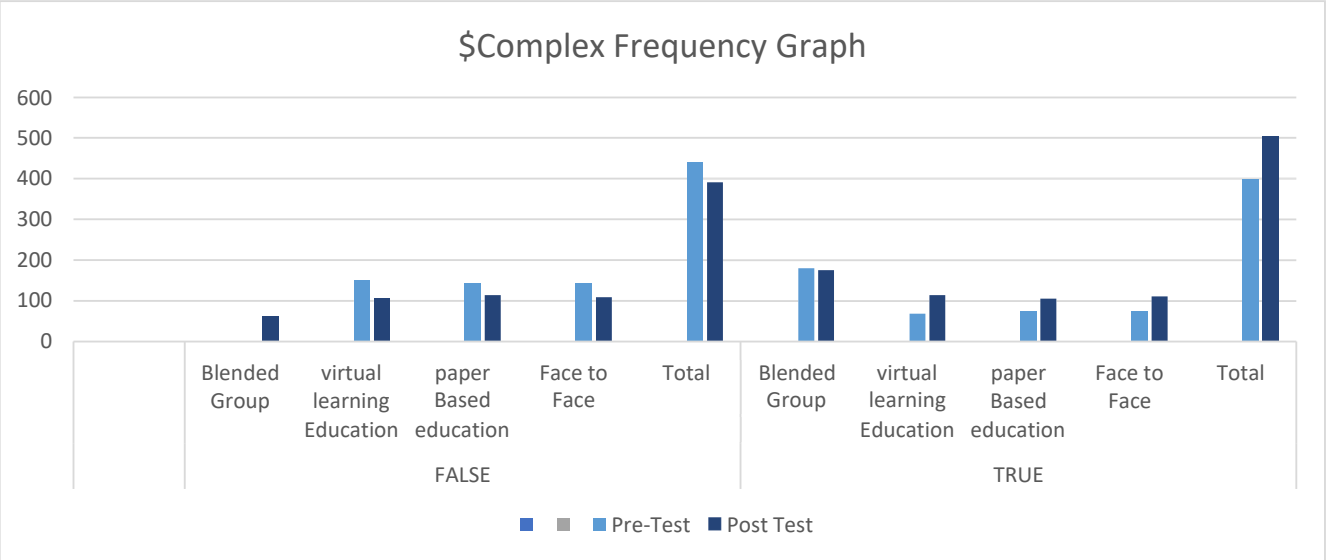


Figure 4: This graph represents the simple frequencies between different models that are used in this paper. Pre-test and Post-test are mentioned separately



Fgure 5: This graph shows the complex frequencies and value difference between these four models Blended, F2F, Paper-based learning.

6. Conclusion

In this study to achieve objectives of this study, we divide the population into Seven different groups comprising of students in one control group and one experimental group from each: on-campus program (F2F), online virtual learning education (VLE), correspondence based distance education (paper-based DE) and one group of students as blended learning (BL) group. After conducting pre-test and post-test, analysis of results shows that the use of simulator shown effectiveness in the learning of DLD concepts. Like 67% improvement in BL, 39% in VLE, 50% in F2F, and 35% in paper-based DE. We have learned by these results that the use of a software simulator while teaching DLD has a significant positive effect on student learning outcomes. Despite the overhead of learning time required to use the simulator, we recommend using simulators and activity perform during the lectures to ask some questions to the students for getting attention on the topic in VLE and paper-based DE. As information and communication are increasingly conducted online such systems have become part of the essential educational infrastructure in many higher education establishments. Just as with e-mail, VLEs are centrally provided services that are delivered right across the institution largely to enhance existing academic practices, not to replace them.

7. Future Work

This Study is based on the students of the CS and Engineering Department of NCBA&E. In the future, this study can be applied on a large scale considering the top five colleges and University level students of Bahawalpur region. In Bahawalpur, there are many female colleges and universities. This survey can be conducted on female students, on this behalf we can extract more facts & figure about the nature of male and female students at college and university level.
It is a fact that the capability of male and female students is varied. The resources and environment of different colleges change. So, it is expected than we can find new phenomena.

References

[1] Alsadoon, A., Prasad, P., & Beg, A. (2017).
[2] Using software simulators to enhance the learning of digital logic design for the information technology students. European Journal of Engineering Education, 42(5), 533-546.
[3] Breivold, H. P., & Crnkovic, I. (2014). Cloud Computing education strategies. Paper presented at the 2014 IEEE 27th Conference on Software Engineering Education and Training (CSEE&T).
[4] Figueiredo, D., Sousa, A., & Lousada, M. (2017). Acceptability and usability of a computer-based cognitive training program: An exploratory study with community-dwelling older adults.
[5] Paper presented at the 2017 12th Iberian Conference on Information Systems and Technologies (CISTI).
[6] Gelbart, H., Brill, G., & Yarden, A. (2009). The impact of a web-based research simulation in bioinformatics on students' understanding of genetics. Research in science education, 39(5), 725.
[7] Isayama, D., Ishiyama, M., Relator, R., & Yamazaki, K. (2016). Computer science education for primary and lower secondary school students: Teaching the concept of automata. ACM Transactions on Computing Education (TOCE), 17(1), 1-28.
[8] Jelemenská, K. (2012). Integration of ICT and unconventional teaching approaches into the digital systems design education towards its efficiency enhancement. Paper presented at the 2012 IEEE 10th International Conference on Emerging eLearning Technologies and Applications (ICETA).
[9] Nikolic, B., Radivojevic, Z., Djordjevic, J., & Milutinovic, V. (2009). A survey and evaluation of simulators suitable for teaching courses in computer architecture and organization. IEEE Transactions on Education, 52(4), 449-458.
[10] Nikolić, D., Häusler, S., Singer, W., & Maass, W. (2009). Distributed fading memory for stimulus properties in the primary visual cortex. PLoS biology, 7(12), e1000260.
[11] Parker, M. C., & Guzdial, M. (2015). A critical research synthesis of privilege in computing education. Paper presented at the 2015 Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT).
[12] Sirkiä, T. (2018). Jsvee & Kelmu: Creating and tailoring program animations for computing education. Journal of Software: Evolution and Process, 30(2), e1924.
[13] Škrinárová, J., & Vesel, E. (2016). Model of education and training strategy for the high performance computing. Paper presented at the 2016 International Conference on Emerging eLearning Technologies and Applications (ICETA).
[14] Sriharsha, K. (2012). IPTV and Cloud computing based education program. Paper presented at the Fourth International Conference on Advances in Recent Technologies in Communication and Computing (ARTCom2012).
[15] Takahashi, A., Kashiwaba, Y., Okumura, T., Ando, T., Yajima, K., Hayakawa, Y., . . . Uchida, T. (2015). Design of advanced active and autonomous learning system for computing education—A3 learning system. Paper presented at the 2015 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE).