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Four Phase Pedagogy for Computer Experiments Based Curriculum using Cloud Computing Enabled Lab.

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Abstract: -During COVID-19 pandemic, people faced several behavioral problems and nasty emotions, thoughts and physical sensations such as boredom, aimlessness education related issues, conflicts with parents and educators. COVID-19 changed the Teaching-Learning scenario, during and after pandemic, all teaching institutions shifted to online or blended (online and offline) teaching mode. Hands-on practical experience through lab work has long been recognized as an essential part of the computer science / information technology

education. Successful computer science hands-on activities need to be operation full time. In this scenario, concept of four-phase pedagogy with cloud enable computer lab provides a better solution for higher education organizations or for IT training programmes. The proposed model permits the teachers and students to perform the experimental tasks and complete their curriculum without physically being present in the lab. It breaks the boundaries of time and distance; user can work in lab round the clock. Earlier students have to be time bound and restricted for hands-on activities and lab experiments. The term "cloud computing" is used for the computation over the Internet and ability to run a program or application on many connected computers over the network at the same time. In this, authors discussed working of four phase pedagogy using cloud enable computer lab and Concept, general paradigms also discussed. It includes andragogy for effective students teaching and learning process. Students should know why syllabus contents are important prior to learning it.

Keywords: Online Education, Pedagogy, Andragogy, online Computer Lab, Cloud computing

I. Introduction

On Feb 11, 2020*World Health Organization* gave acronym for Corona virus disease 2019 as COVID-19 [14]. WHO declared the outbreak of corona virus a Public Health crisis of International Concern on 30 January, and a pandemic on 11 March. Govt. of India had officially announced a nationwide lockdown with effect from 25 March 2020.The COVID-19 affected the not only India [12] but also whole world the virus led to serious and unexpected financial, psychological and moral problems. During this pandemic, people faced several behavioral problems and nasty emotions, thoughts and physical sensations such as boredom, aimlessness education related issues, conflicts with parents and educators [11&13]. Only in India more then 32 crore students have affected [14]. During this pandemic online education did not provide equal opportunities, students were exposed to the lack of technology and access limitations in

online educations, and the parents were not well informed about online education. Pre-COVID-19 and during COVID-19 no specified pedagogical model to teach the computer sceience practical oriented curriculum was available. Due to this, teachers are unable to conduct computer oriented practical experiments and students fail to perform practical experiments at their home.

Educational institutes are not able to supply the professionals. Including IITs dropout rates are a major issue for the computer science stream and information technology [1].Thus the potential shortage of professional skills developers is in India [2]. There for, how to increase the limited resources utilization, carried out effectively lab activities, professional knowledge and maximize the usage, it becomes a big concern for researchers. Recent studies in the Learning Future of Education in Computer Sector in Egypt highlights two main challenges in ICT Education in Faculties of Computers and Information Sciences in Egypt: (I) Rarity of ICT Faculty members; (II) Lacking to the high performance infrastructure [3].

Cloud computing enabled computer science / information technology lab used to manage the cloud computing system and provide dedicated compute environments according to users' need. A conceptual view of the proposed lab on Cloud Computing environment is demonstrated in Figure No.1. Through this lab built-in resource scheduling system, a user can connect to the Lab web portal to request access to a desired application environment and computing resource for a limited time. It provides better solution of the availability of software and desired resource without physically being at the lab.

Pedagogy refers to art and science of teaching. More specifically Pedagogy involves different approaches used by teacher/s in the classroom; it refers to styles and methods of instruction that used in the teaching profession. It promotes the understanding of subject matters for pupils, help to develop conceptual cognition and motivation learn in challenging environment [4].

This emphasis continues to be on pedagogy leading the use of Technology, instead of adapting what to Technology offers. The variety of learning Technologies, outside the laboratory or classroom off from the teacher, exposes new regions for the education. Information technology prompt a diverse reasonably correlation between the teacher and pupil and what subject matter may be taught. Yes, we need rethinking the style teaching and explore scope of pedagogy as the digital age continuous to grow up with new technology driven challenges. Teaching society have a great attitude that, with learner access to increase resources

on the internet and with their technical skills, we must reform the education that pupil can learn more with their own learning. Currently open-source educational resources movement has started on the internet to provide global educational repository of online lectures or teaching material, which is well-formed learning resources, that available to all [5].

In literature different researcher proposed many virtualizations or cloud-based computing labs.

Navy Virtual Lab: The Naval Postgraduate School (N P S) [6] has developed a distance learning solution that allows non - resident students to perform signal processing laboratory assignments.

Remote Network Labs (RNL), a network cloud facility from where end users could request network equipment to construct a virtual test lab the virtual network topology is built after visual drawing in a browser, and then result data is stored in JSON format, which is used for automatic deployment of virtual nodes through Open Nebula cloud system API [7].

P. Li, J. M. Jones, and K. K. Augustus proposed research project that partially sponsored by the HP Catalyst Initiative grant at East Carolina University. Cloud computing can be applied in numerous forms [8].

C. Yan "Presented new approaches toward building a Computer Networks Laboratory Service Platform (NLS-Cloud) where students could freely perform experiments designing, organizing, and troubleshooting a network scenario [9].

V. Pardeshi Proposed an Architecture for implementing cloud in the Higher Education (HE) institute in Indian prospective including numerous Deployment Models and Service Models [10].

Xiao, Z. & Xiao, Y., (2013) identified and integrates factors that influence users' adoptions of cloud-based learning system in higher education. [15].

O. Christopher & Fagbola Temitayo M conducted a study, results can really help organizations reduce high costs of Computing/IT and maintenance. It offers enhanced availability, low environmental impact, reduced IT complexities, mobility, scalability, increased operability and reduced investment in physical asset [16].

Bayan. H. Alamri & M. R. J. Qureshi proposed a novel solution to raise the level of higher education in Kingdom of Saudi Arabia. A study conducted to evaluate the proposed solution. A questionnaire designed that consists of fourteen close-ended questions that are further divided into four goals. This study will provide a roadmap to apply cloud computing in higher education for educators and students [17].

E. Muli & J. Kimutai conducted a study in selected public and private universities to analyze the strengths, weaknesses, opportunities and threats regarding adoption and use of cloud computing. Structured interviews open and close ended questionnaires, observations and examinations of educational reports were done. The researchers observe the target respondent in 12 universities mostly the ICT Directors, Deans or Directors of Schools, colleges, HOD of departments and ICT officers. To determine perceptions of adoption of cloud computing in universities a descriptive survey method was adopted. The findings showed that most universities deployed SaaS for learning management. [18].

This paper is divided in to following five sections, the section-I describe introductions and presents literature related proposed research work. In Section-II research objective are described. Cloud Computing Enabled Lab is discussed in section III and Four Phase Pedagogy for Teaching Computer Science through CBCL is discussed in section IV. In section V management model of proposed study is discussed. In section VI result of the study is discussed last section VII discusses the conclusion and future work

II. Objectives and Research Methodology

Based on available literature, remote/virtualization tools & discussion with experts, authors designed a Cloud Enabled Pedagogical Model for teaching computer experiment-based curriculum. Firstly, authors orient to students and educators about proposed model, after orientation quantitative data collected using Pre-Training Knowledge Test, Post-Training Knowledge Test and five point Likert scale questionnaire. Effectiveness and reliability of model checked through collected data and Results.

This paper carried out mainly two objectives; the first objective is orient about the Four Phase Pedagogy and Cloud Computing Enabled Laboratory and second objective to to know the effect of proposed pedagogy.

III. Cloud Computing Enabled Laboratory

In this lab authors developed a Cloud Servers in each server consist four cores of processing power CPU, four Giga Byte RAM, 100 TB shared storage, 22 virtual machines/Virtual Box. Multiple VM with operating systems and related software tools in single Cloud server. For example, an Oracle Virtual Box server host Microsoft Windows 7/8, and Linux virtual machines at the same time. Every user can access a specific virtual machine (shared Computing Resource) with the help remote desktop protocol. This lab facilitates educational software

having Microsoft Windows and UNIX operating system with required application software (Java, C, C++, Notepad+, Linux, office automation tools and basic software) for semester long curriculums. The proposed model involves three sub layers: Cloud Lab Class room, Cloud Computing Lab Servers (Containing VMs), and Cloud Lab Client (User/Students zone)**.** Web portal was developed in HTML5, CSS, Java Script and bootstrap for frontend and MySQL, NODE. js, PHD for backend and database. Students, teachers, and other employees required to register on this lab web portal via lab management model and authenticate their identification before using the lab resources.

To access the resources of this lab user must Login to lab portal with ID and password to access assigned the remote lab resources at any time, and anywhere. After compilation of practical experiment session, the user notified to save their data and log off from the system to make the system resources free to utilise to the other users. The end users do not manage or control the underlying cloud infrastructure.

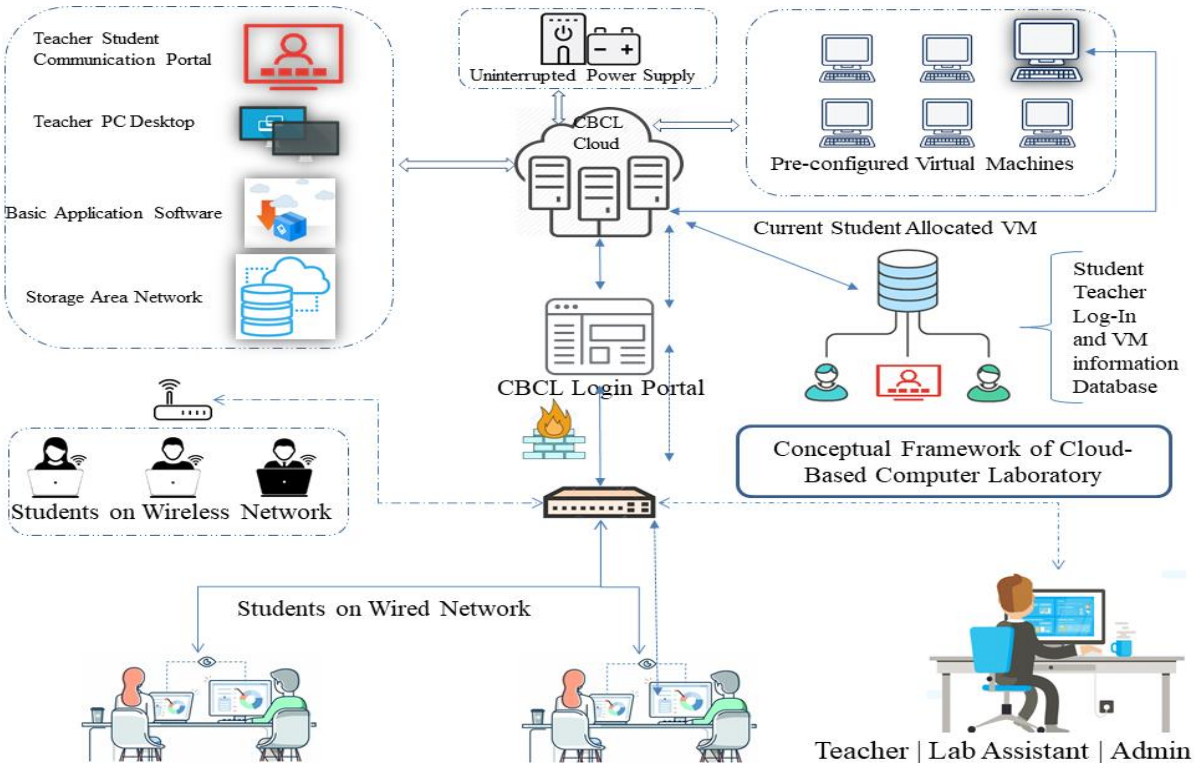

Fig. 1. Theoretical Framework of Cloud Computing Enabled Laboratory

IV. Four Phase Pedagogical Model

The Four Phase Pedagogical Model is a practical experiment-oriented teaching algorithm and proposed methodology for teaching computer science. The proposed model is not meant to provide substitute the traditional laboratory environment, but rather provide a valuable and cost-effective additional educational instrument to support the computer science teaching. Following Table No.1 describe four phases of the pedagogical model for CBCL, each phase describes Role of Teacher, Pedagogy Aspect, Pedagogical Aims, Role of Students. Andragogy Aspects, Andragogy Aims

Table. 1 Four Phase of the Pedagogical Model for CBCL

Phase	Role of Teacher	Pedagogy Aspects	Pedagogical Aims	Role of Students	Andragogy Aspects	Andragogy Aims
I Planning and Scheduling	Teacher analyzes the subject matter, number of pupils and resources for experiments on CBCL.Planning of Teaching situations.	Content & Coverage.	Preparing pupils for experiments.	Pupils must know Basics of Cloud Computing and subject matter/problem, which is taught by teacher on CBCL.	Problem Oriented	Pupils must know importance of Subject matter/problem.
II Operational Phase/ Teaching Approach	Make descriptions of subjects matter depending on ICT Skills of the teacher.Teacher may take support of L.A or admin of CBCL.	Teaching or Instructional Objective.	Demonstrating/ delivering the Subject matter and practicing to solve the problem.	Gain the knowledge delivered by teacher.	Ready to Learn	Pupils become ready to learn when they see the subject matter.
III Review	Observe the Activities of pupils and Assist them. Response on Pupil's Demands. Reaction may be real time, on demand available, or Recorded as for webcast.	Analyze Concepts.	Creating Test/Exam and Challenges. Prepare pupils for Collaborative Study.	Perform basics experiments and submit assigned task. Pupils may perform advanced activities like project work, or Solve the problem with co-operation among classmates	Have Experience	Pupil's experiences to solve the problem have great importance.
IV Assessment or Feedback	Grading and Feedback.	Feedback and Evaluation.	Improving/Gaining Knowledge of pupils as per their Course Curriculum	Get grading/Marks and Feedback Remarks from teacher.	Self-Motivation	Pupils should be motivated by internal forces.

V. CBCL Pedagogical Management Model

The Management Model will used to manage of the proposed cloud enabled computer. This model consists the working of the proposed pedagogy like management of the system information, system outcomes, resource managements and other things. This model consists four main sub-system each module divided into further sub systems.

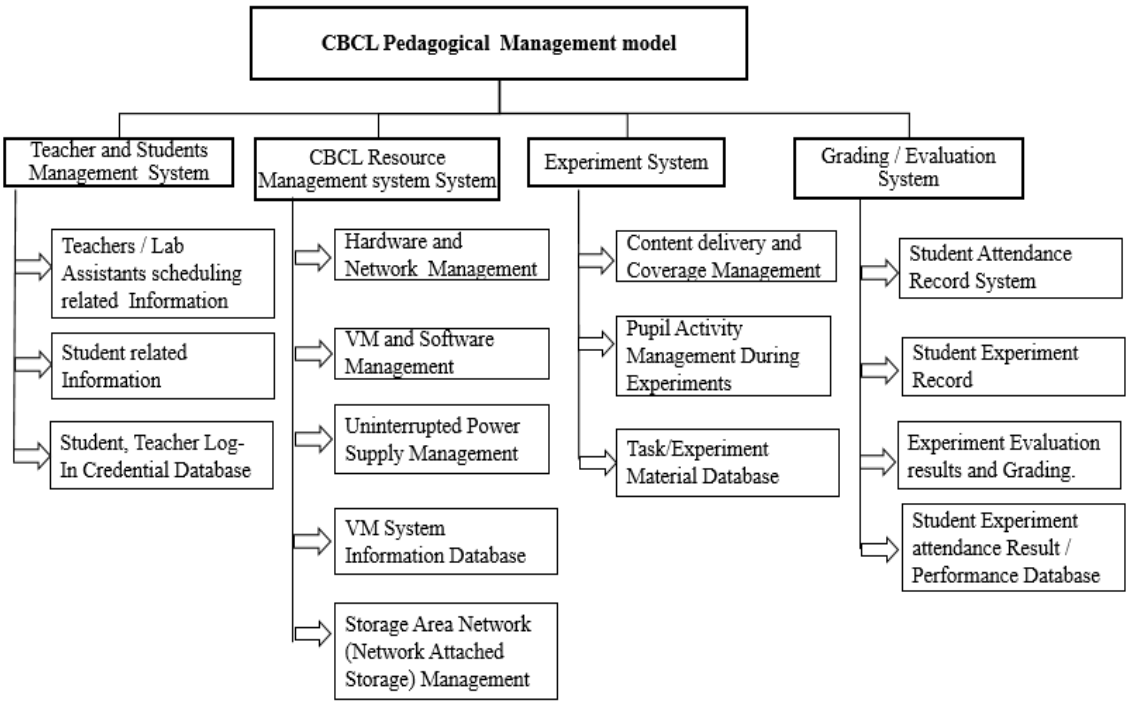

Fig. 2 Management Model of Proposed Model

VI. Result and Discussion

Authors start this study with two hypothesis H0= There is no significant difference between Cloud based Pedagogical Model and conventional method instruction and H1= There is more difference between Four Phase Pedagogical model and conventional method instruction. Two types of groups selected for experiment one is heterogeneous and second is homogeneous. In heterogeneous group students selected from different course (M. Tech, MCA and MCA-LEET) and semester (MCA-1st, MCA-3rd and 5th and M. Tech-1st Semester). In homogeneous group students selected from same class and course (MCA-5th Semester of MCA). After successful compilations of both groups' teaching/training, authors prepare and conduct a Pre-Training knowledge test and post-Training test was conducted to know the

knowledge improvements. The given tables present the results in the form of simple Percentage, Mean, Standard Deviation (SD), and T-test on both Heterogeneous and Homogeneous groups.

Effect of CBCL Four Phase Pedagogical Model on Heterogeneous Group

Further, in heterogeneous, group students we select two types of groups one is control group and second is experiment group. In control variables, no treatment was given after/before of Pre-Training and Post-Training and in experiment group training/teaching was given by proposed model. Statistical outcome of both groups are discussed in following tables.

Table. 1.1 Pre-Test of Experimental & Control Group

Test/Exam	Number of Students	Mean	Standard Deviation (SD)	T-Value
Experiment Group	20	22.95	7.14	0.85
Control Group	20	23.40	5.93	

Table No. 1.1 clearly shows that the mean scores of experimental group and control group are 22.95 and 23.40 respectively and standard deviation are 7.14 and 5.93 respectively and the calculated value is 0.85 which is less than the table value at 0.05 level of significance. So Hypothesis i.e. “There is no significant difference between Clouds based Pedagogical Model and conventional method instruction” is accepted. It means there is no significant difference between experimental group and control group at initial stage.

Table. 1.2 Post-Test of Experimental & Control Group

Test/Exam	Number of Students	Mean	Standard Deviation (SD)	T-Value
Experimental Group	20	43.08	4.17	15.61
Control Group	20	24.05	5.88	

Table. 1.2 shows that the mean scores of experimental group and control group are 43.08 and 24.05 respectively and standard deviation are 4.17 and 5.88 respectively the calculated value is 15.61 which is greater than the table value at 0.05 level of significance. So, Hypothesis i.e. “There is no significant difference between experimental group and control group” is rejected. It means there is significant difference between Post-Test of experimental group and control

group. Means value of Experiment group is higher than control group. So as per above results we can say that the proposed model is effective.

From the table no. 1.1 it is found that there is no significant difference between experimental group and control group at initial stage.

The table 1.2 shows the result of students after teaching/training using proposed model, it was found that there is significant difference between experimental group and control group. The mean value of Experimental group is higher than control group.

So it is concluded that proposed model is effective for computer science teaching in comparison to traditional teaching method.

Effect of CBCL Four Phase Pedagogical Model on Homogeneous Group

In Homogeneous group researcher includes students from same class and course (MCA-5th Semester of MCA). Researcher conduct an academic semester long training/teaching and deliver prescribe course content of JAVA and .NET using proposed model. In this group we select only experiment variables. Statistical Outcome of Pre-Training Test and Post-training was discussed in the below table

Table. 1.3 Homogeneous Experimental Group

Test/Exam	Number of Students	Mean	Standard Deviation (SD)	T Value
Pre-Training Test	31	9.12	2.90	17.86
Post Training Test	31	17.04	4.90	

Table. 1.3 shows that mean scores of Pre-Training and Post Training Test of Homogeneous experimental group are 9.12 and 17.04 respectively and SDs are 2.90 & 4.90 and the calculated value is 17.86 which is grater then table value at 0.05 level of significance. So, hypothesis i.e. “There is no significant difference between pre-training test and post-training test of homogeneous experimental group.” is rejected. It means there is significant difference between pre-training test and post-training test of homogeneous experimental group. The mean score of post-training test is greater than the mean score of pre-training test of homogeneous experimental group. It clearly shows the model positively effective for computer science curriculum.

VII. Conclusion and Future Work

Present study was carried out at department of Computer Sci. and Engineering in Chaudhary Devi Lal University Sirsa before and during Covid-19 pandemic. The experimental evaluation was carried out by applying the proposed pedagogy on MCA and M.Tech (CS) students for full semester. The proposed model tackled the problems of online teaching very well.

This study explores the applications of cloud computing in the area of teaching computer science more effectively. Proposed research increases the working efficiency teachers in higher education institutions. It also decreases the running cost of the institutions. It recognizes important factor affecting teaching and developing guidelines for adoption in higher education institutes. This study is not meant to provide substitute of the traditional laboratory environment, but rather provides a valuable and cost-effective additional educational instrument to support the computer science teaching.

This study has truly implemented online education and redressed some important gaps in it. Furthermore, the authors will keep collaborating with volunteer participants to develop meaningful and critical dialogues by presenting the study findings to relevant individuals, institutions and organizations via active advocacy. Various statistical tests like T-test, standard deviation and means etc. have been applied on the data collected during experiments and will be explained and discussed in next paper.

However, this is only a step in this direction, and several issues are yet to be addressed. Dedicated CBCL web portal may be designed for specifically for Indian higher education institutions.

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