Designing a Programming Education Environment as a Cloud Computing Service: Framework and Architecture

Mr.Bhanu Chander Pachimadla[1]., T.Nikitha[2]

1 Assistant Professor, Department of CSE, Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

2, B.Tech CSE (20RG1A05P5),

Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

Abstract

E-learning on the cloud is a promising new technology for LMSs of the future. Several different cloud computing models for e-Learning have been suggested. However, an e-Learning platform tailored for computer-programming instruction—including a programming workbook, program features include central logbook for tracking student progress, online development environment, automated grading, and plagiarism detection, etc. Teaching content management, course administration, examination, performance management, student management, and instructor workload management are all examples of e-learning cloud problems that require fixing. The aforementioned factors are taken into account while developing the suggested architecture for the Programming Education Environment as Cloud Computing Services.

1. Introduction

It's no secret that cloud computing is playing an increasingly vital and dynamic role as a facilitator of data sharing and transmission. This innovation followed the introduction of Web 2.0, or the "second wave" of Internet computer development in the 2000s. As a result of Web 2.0 developments, people are now able to utilize the software that allows users to upload data to the online, read and write using Internet software, and connect with others using sound and live video. One of the many spheres of human activity in which cloud computing has had a transformative effect is the realm of learning and teaching. As ICT continues to develop, there is a growing need to rethink how lessons are taught in the classroom. New technology, such as cloud computing, is being used to create an online educational system that is quickly replacing the conventional method of delivering education. There will be ongoing improvements to both facilities and curricula at educational institutions. Unfortunately, most educational institutions lack the resources necessary to implement and reliably maintain cutting-edge information and communication technology (ICT) systems in the classroom that would benefit teachers, researchers, and programmers alike. Institutional budgets will continue to feel the effects of the rapid pace of development in ICT technology. The rise in internet bandwidth has made cloud computing a viable option for cutting down on ICT expenditures and relieving businesses of the burden of keeping Up with costly and time-consuming software and hardware upgrades [15]. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are the three main types of cloud computing services (SaaS). There are currently available commercial implementations of IaaS and PaaS, such as Amazon EC2 and S3, Microsoft Azure, Google App Engine, and IBM Cloudburst. Cloud Services based on "pay as you go" models for computers were originally aimed at corporations. Financial considerations have led to the recent use of cloud computing in educational institutions [14]. This has allowed for the transformation of aging computers into fully working virtual machines. The potential for cloud computing to save costs, streamline operations, and make educational institutions more accessible has been acknowledged by educational institutions in the United States by means of a shift from campus-based to remote computing [16].

As an alternative to cutting down on services for staff and students, some colleges are actually able to increase them by using cloud computing resources [12]. Due to the high cost and unreliability of their own email systems, several UK institutions have switched to Google Apps [13]. Cloud computing, which is backed by giants like Google and Microsoft, is so popular that even colleges and schools in Africa's poorest nations are adopting it [11, 17]. A cloud computing platform has been investigated [10, 16] for use by students of computer science as a testing ground for large-scale distributed computing experiments. However, there is no comparable service for programming classes, even though they are essential for providing these students with the solid grounding they need. It calls for a platform with specialized applications like automated marking and plagiarism detection software, a centralized logbook to track students' progress and grades, an online programming environment, etc.

In this excerpt from their conversation, Lavishing and Zhengxia talk about the difficulties and potential solutions of using the cloud for online education. There will be many additional challenges to implementing e-learning cloud computing due to the significant contrasts between traditional educational settings and online learning environments. They focus on the inadequacy of online courses as a substitute for actual classroom instruction and the problems inherent in current systems of educational administration. As a possible solution, establishing a set of comprehensive management rules for cloud-based e-learning mode, including teaching content management, course management, examination management, performance management, student management, instructor workload management, and so on, could be implemented.

2. Related works on cloud computing and e-Learning

As with many other concepts, "Cloud Computing services" have several definitions depending on whom you ask. For instance, Red Hat/Amazon Elastic Compute Cloud (EC2) [2] offers cloud computing as a cluster of Linux servers with built-in storage capacity [3], and Google's Cloud Computing platform [4] abstracts away the complexities of locality and scalability so that developers can focus on writing applications. Microsoft sees this as a virtualization layer between the hardware and the OS and is releasing a developer toolkit to facilitate the delivery of "software plus service" to end users by connecting applications written for a specialized application programming interface (API) [4]. [5]. That is to say, with Cloud Computing applications, a user doesn't execute processes on their own terminal equipment, such a computer, but rather, on large-scale server clusters accessible over the Internet. In Cloud Computing, data is kept in an off-site data centre and user operations are not carried out in a user's local environment. The company offering Cloud Computing services is accountable for ensuring the integrity and continuity of the data centres it employs. Cloud computing allows users to access their data and applications through the Internet from anywhere at any time.

A model for enabling on-demand network access to a shared pool of configurable computing resources (such as networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction; this is what the authors of this paper call "Cloud Computing." [1]. There are five main features of Cloud Computing that are outlined in this definition.

I On-demand self-service, or the ability to use cloud computing resources whenever desired without contacting the cloud service provider.ii) Extensive network accessibility: users may use conventional devices, such PCs, to get remote access to a variety of computer resources like computers and cell phones.

Sharing of resources (iii): makes available a central location where users may access and make use of a pool of available resources. Cloud computing allows for quick flexibility, so users may quickly add additional cloud-based resources to their operations.

In order to evaluate the quality of a service, it is necessary to collect data on how the service is being used. The concept of online education has been broken down into its component parts. The following definition of e-Learning is one of the consensus definitions: It is important to note that the term "e-learning" refers to the broader category of education that makes use of electronic means to facilitate teaching and study. It is the information and communication technologies, whether they are used for networked learning or not, that serve as the medium via which instruction is delivered [7]. In recent years, cloud computing has developed as a key platform for online education. The use of cloud computing in e-learning will create a new learning style and medium, which is believed to be the third generation of e-learning system, given that learning, is a significant part of everyone's everyday activities. Previously stumbling blocks to the dissemination of education through electronic media may now be overcome with the help of these elements. The cloud provider in the e-learning cloud computing paradigm is the one in charge of constructing and maintaining the cloud infrastructure and providing any necessary technical assistance. Those interested in using the e-learning cloud must submit a service request to their cloud provider. The services needed by users will be made available through the e-learning cloud. In a nutshell, the paradigm shown in Fig. 1 has servers providing users with assistance throughout the cycle.

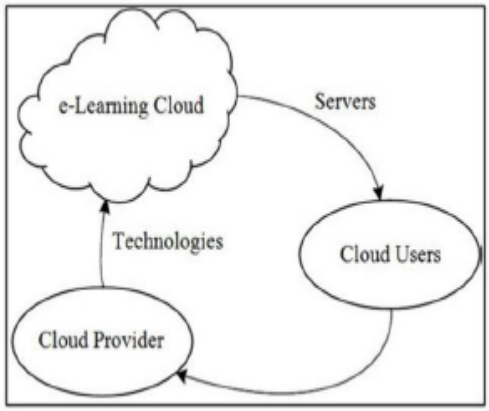

Fig. 1. Model of e-Learning cloud computing [8]

The difficulties encountered by e-learning developers and their respective solutions are listed in Table 1 [9]. They hope to address these issues and improve performance via future application development [9].

Table 1. Challenges and solutions of e-Learning

Challenges	Solutions
User idea. E-learning cloud, as a cloud computing infrastructure and IT service delivery and usage patterns, subverts traditional idea of the use of computing resources, so the user's awareness and acceptance will profoundly affect future operation and development mode for e-learning cloud.	Build successful cases, and promote their applications as an opportunity.
Education management rules. Because of a difference between school education and e-learning cloud education, the introduction of e-learning cloud computing will bring a lot of new problems.	Establish a suit of comprehensive management rules for e-learning mode based on cloud, including teaching content management, course management, examination management, performance management, student management, teacher workload management and so on.
Resource development. There will have a group of e-learning cloud materials of high quality, high-grade, for e-learning program, which requires investing a lot of human and material resources and using the intelligence of educational experts, technical experts and art experts in cooperation to create a set of scientific, interesting and artistic learning resources.	A variety of experts are organized by e-learning providers to complete the work.

In Fig. 2, we see how the hardware, software, and sources of support for e-learning that are part of today's and tomorrows cloud computing infrastructure for e-learning compare and contrast. As we examine the building blocks of the e-learning cloud, we might classify them as the hardware resource layer, software resource layer; resource management layer, service layer, and application layer are the five logical levels that make up a system. In the e-learning model, the lowest level, or "hard resource layer," consists of the actual hardware, such as a computer's RAM and central processing unit (CPU). The focus is on making improvements to existing infrastructure. Using virtualization technology, a server, storage, and network are combined into a single virtualization group that can be accessed from a higher-level software system. Availability of physical hosts is fluctuating. In order to enhance the amount of raw processing power, a new physical host might be installed.

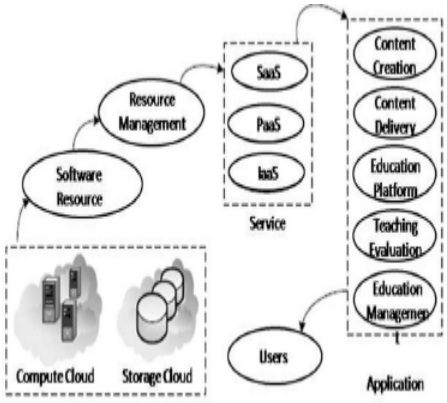

Fig. 2. Architecture of e-Learning cloud [7]

The operating system and middleware are the primary components of the software resource layer. Through the use of middleware technology, developers have access to a standardized API that allows them to create a wide range of apps without having to learn many sets of APIs.make all of our software assets, even those housed in the cloud, readily accessible. The secret to achieving loose coupling between software and hardware resources may be found in the "resource management layer." Virtualization's flexibility and cloud computing dynamic scheduling technique allow for the seamless transfer and distribution of software over a wide range of hardware at the click of a button. Seas (Software as a service), PaaS (Platform as a service), and IaaS (Infrastructure as a service) may all be found at the service layer of a cloud architecture (Infrastructure as a service).

In the application layer, components such as content creation, learning goals, content delivery systems, evaluation, and management are located [7]. Application developers may modify the application layer components to better facilitate a chosen cloud service, such as a cloud-based programming instruction service. Given that we provide cloud-based services for use in pedagogical programming applications, all of our efforts have been concentrated at the application layer. The database and C++ Workbook program will be stored on Google's cloud. In this article, we focus on the responsibilities of the school's administrators, students, and teachers in the context of a computer programming class. It is the responsibility of educators to provide course materials and establish learning goals. In order to help students prepare for their classes, teachers have the option of uploading course-specific goals and learning outcomes. Teachers have the option to create and distribute their own materials. Professionally crafted material is also available to them. In addition, educators choose the medium through which their lessons are presented. Videos may be streamed online and used as a learning resource. Teachers are also in charge of establishing classes, assigning students to them,

coming up with programming problems, assigning certain problems to certain classes, and deciding on evaluation criteria. The administrator is in charge of maintaining question banks, managing modifications to the program, building classes, assigning teachers to certain classrooms, registering teachers and students, and more. Automatic grading of multiple-choice exams is another service the system offers. Automatic program grades will be available in the near future.

3. Requirements of Programming Education Cloud Services

C++ Workbook is a service provided by cloud computing for teaching computer programming. It offers a number of features geared at the convenience of the individual user. Students must submit a registration form, read the course materials, complete the assigned exercises from the selected problem set, turn in their solutions, and see their grades and outcomes. verity of right responses Instructors are responsible for establishing classrooms, generating problem sets, selecting questions for each problem set, assigning exercises or problem sets to certain classes, establishing evaluation criteria, and placing students in appropriate classrooms. Teachers may check up on how their pupils are doing as well. In addition to managing user accounts, an administrator must also set up and manage classrooms, assign new teachers to existing classes, update question banks, and deal with application change management. The characteristics for each defined job are summarized in Fig. 3.

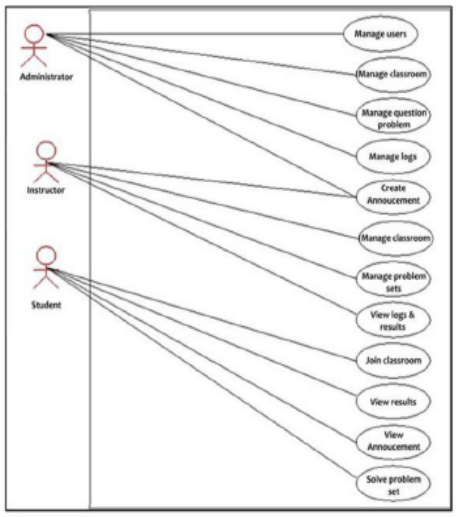

Fig. 3. Roles for users of programming education cloud service

4. Framework and architecture of Programming Education Cloud Service

We analyzed existing solutions for delivering a virtual classroom for computer science education in order to inform the design of Cloud C++ Workbook. The publisher may also provide supplemental resources in the form of an online application called an e-workbook to complement the textbook. Institutional teachers may get their hands on a set of programming tasks complete with answers. Three generations of improvements have been made to the online learning management system known as ELearning. In the first generation of e-learning, traditional educational materials and services like textbooks, articles, training courses, lessons, and workshops are made available online via the World Wide Web. In the second generation of e-learning, however, the focus shifts to providing a network of interconnected learning opportunities as opposed to a collection of isolated online texts and courses. Recently, many schools and universities throughout the globe have begun using cloud computing, which offers several advantages for education. As shown in Fig.4, the proposed framework integrates features from an e-Workbook, an e-Learning system, and cloud computing technologies to provide a platform for online programming instruction. The Programming Education Environment's features include an activity log, a plagiarism checker for computer code, a grade book generator, and a programming workbook. This study is dedicated to designing a framework for a workbook application in programming. C++ Workbook is a SaaS application that was built to showcase the framework's inner workings (SAAS).

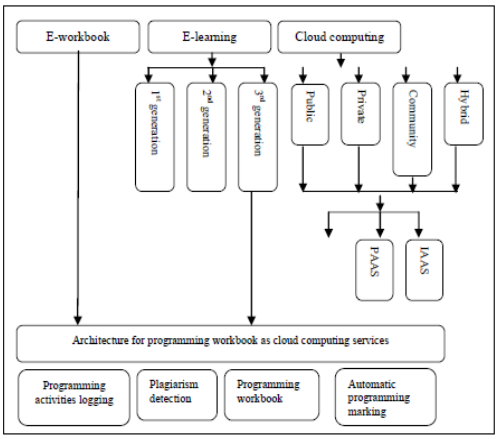

Figure 4: A Cloud-Based Infrastructure for Teaching Coding

The application's architectural components have been separated into three distinct groups, each of which caters to one of the three possible user types: administrators, teachers, and students. A case in point of to which Fig.5 provides an illustration.

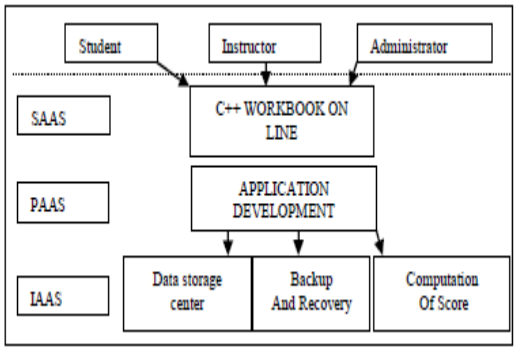

Fig. 5Architecture of C++ workbook as cloud service

5. Implementation of cloud C++ workbook

Google App Engine provides the platform and infrastructure services for C++ WORKBOOK. Java was used to create the program. The section that follows provides a high-level summary of its most salient qualities. In Fig. 6, the intended audience is broken down into three groups: the administration, the teacher, and the student.

Fig. 6. A Screenshot of the C++WORKBOOK main page

Administrator features

Instructor and student accounts, classroom setup, assigning new teachers to current classes, question bank maintenance, and application update management are all the purview of the administrator. Figure 7(a) and Fig.7 (b) depict these characteristics (b).

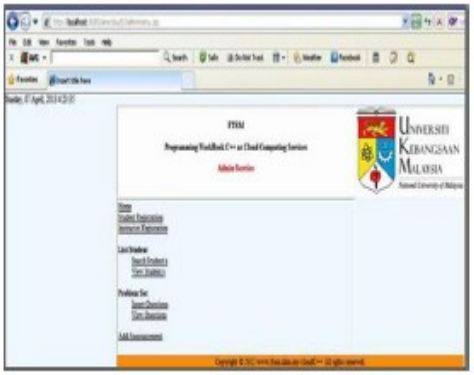

Fig. 7(a). Administrator main page

Fig. 7(b). Setting questions for the question bank

Instructor features

Using the system, a lecturer may set up a classroom, designate a teaching assistant as the classroom's instructor, place students in the appropriate classroom, establish a problem set for an exercise, quiz, or exam, and choose questions from a question bank. It is possible for a teacher to act as a supervisor. Those entrusted to his care, he will assist in the resolution of issues posed by the pupils. As a consequence, he can keep tabs on how his pupils are doing and respond to their workout outcomes and overall grades. Screenshots of the instructor's user interface for the aforementioned functionalities are shown in Figures 8(a), 8(b), and 9.

6. Conclusion and future work

Using an administrative, technological, and financial lens, this study examines the difficulties of e-learning and the promise of cloud computing to alleviate them. In this paper, we offer a paradigm for cloud-based programming instruction that integrates established pedagogical techniques with emerging technologies. Tools like workbooks, electronic courses, and cloud storage are being used. Programming workbooks, automated exercise and program grading, activity logs, and plagiarism

detection tools are only some of the cloud services that make up the framework. To ensure that our suggested framework works as intended, we have created the architecture and deployed one of the application services, the C++ Workbook, in the cloud. In the future, we want to expand our offerings to include the various kinds of help you've described. At conclusion, the idea of an e-learning environment may be realized in educational institutions via the use of cutting-edge methods like cloud computing technology. The low overhead of a cloud computing environment, along with its high availability, simple interface, and low learning curve, makes it an attractive financial option for educational institutions.

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