Cloud-Based E-Learning Platform
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Abstract
The benefits of using cloud computing with the integration of Web 2.0 Collaboration technologies for supporting educational performance in eLearning environment. This presentation presents a cloud computing based solution for building a virtual which combines a wide range of technology, and tools to create an interactive tool for science education. The proposed application is for a fully integrated educational content as well as creating a platform for exploring ideas. The system allows exchange of educational content and integrate different pedagogical approaches to learning and teaching under the same environment. It also offers a module for global classrooms where you can enroll students form different countries and allows collaboration using the web 2.0.

- Quick overview of the cloud architect.
- Benefits of cloud computing E-learning environment and its architecture.
- Benefits from applying the E-learning systems in the cloud as a fully-integrated system.
- E-Learning Model Design for dual system: a) School/University Management – management of educational services. b) Enterprise Resource Planning ERP.
- Demo a real application offering all these features.

Key words: cloud – eLearning – platform

Cloud-Based E-Learning Platform

Part (1) Introduction:

This research aims at identifying the benefits of developing cloud-based eLearning platform with the integration of Web 2.0 Collaboration technologies to offer interactive learning and increased educational effectiveness in an eLearning environment. This research is different from all others in the sense of not being based on theoretical untested statement of research based or based on theories and other research. Instead, we base this research on real tested documented results on the performance of our own cloud-based eLearning application AAIM-EDU. This research is based on our own our Research & Development engineers to provide well-tested proven eLearning platform based on lessons learned aiming at offering the best Cloud eLearning platform.

The research is organized as follows:

Part 1: offers introduction about Cloud computing history and definition.

Part 2: offers an overview of the cloud architecture and services deployment models.

Part 3: offers an in-depth analysis of intelligent cloud design for optimum eLearning platform and our own model of AAIM-EDU.

This third part explores successful practical cloud computing models, architectural design, culminating with our own (AAIM-EDU) in applying cloud technology for eLearning. AAIM-EDU is an application by AAIM Corp. of New York (Intel Partner). AAIM Corp. manages Intel's E-Learning programs in West Africa, including the famous SAMAPC project that integrated eLearning with PCs bundled with resources. AAIM-EDU allows exchange of educational content and integrate different pedagogical approaches to learning and teaching under the same environment. It also offers a

module for global classrooms where you can enroll students from different countries and allows collaboration using the web 2.0.

We will explore the various benefits and Critical Success Factors CSF of using cloud computing with the integration of Web 2.0 Collaboration technologies for supporting educational performance in eLearning environment. This research presents a cloud computing based solution for building eLearning architecture that combines a wide range of technology, and tools to create an interactive tool for eLearning. The proposed application is for a fully integrated educational content access as well as creating a platform for exploring ideas. This research can be summarized in the following core areas:

- Quick overview of the cloud architect.

- Benefits of cloud computing E-learning environment and its architecture.

- Benefits from applying the E-learning systems in the cloud as a fully-integrated system.

- E-Learning Model Design (AAIM-EDU) for dual system:

  o School/University Management – management of educational services.

  o Enterprise Resource Planning ERP.
- Demo a real application offering all these features.

Constraints

Although there are many formal definitions for the E-Learning and Cloud computing, there are still no widely accepted definitions for either term that gained prominence. Academicians offered little support to even explain or define either phenomenon. There are not even clear terms to describe either trend. This situation is due to several reasons:

New model: E-Learning is a new concept and technology that is still in the making and has not yet matured to a certain level off optimum performance. Many institutions offer E-Learning for business as many students are becoming more interested in E-Learning.

Diversity: Cloud computing is still a vague phenomenon for many people, both technical and non-technical. It involves engineers and researchers with diverse backgrounds, who work on cloud computing technology from different perspectives. Many still confuse cloud computing with Grid computing.

Technologies: technologies enabling Cloud Computing, such as Web 2.0 and Service oriented computing, are still in a growing in development.

Lack of skilled intelligent configuration: Computing Clouds still lack large-scale deployment and practice, which would lastly explain the main concept of Cloud computing (Lizhe et al, 2010).

U.S. NIST (National Institute of Standards and Technology) offered common Key elements that are widely used in the Cloud Computing community which includes cloud architectures, security, and deployment strategies: "Cloud computing is a model for enabling convenient, on- demand network access to a shared pool of configurable computing resources (e.g., applications, networks, servers, storage, , and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

Part (2) -- Cloud Architecture and Services Deployment Models

Cloud Service Providers

Cloud service providers and computing resources including (storage, memory, processing, virtual machines and network bandwidth) are pooled together to server multiple users across the Internet using either multi-tenancy model or the virtualization model. Mell and Grance (2009) proposed various physical and virtual resources to be dynamically assigned and reassigned according to user demand. This pool-based computing model is based on two important factors: economies of scale and specialization (Mell and Grance, 2009). Pool-based models results in making physical computing resources become 'invisible' or unseen to users. According to Dillon (2010), users do not have control or knowledge about the location, creation, and originalities of these resources (e.g. database, CPU, etc.), and users have no explicit knowledge of the physical location where their data is mapped to be stored in the Cloud.

What are the key features of Cloud-Based E-Learning Platform?

- Integrated Courses & Testing Platforms

- Cloud-based resources

- Integrated E-Commerce

- Web-RTC based HTML5 Virtual Classroom

- Learner Tracking & Reporting Dashboard

- Video & Audio Streaming

- Themed Courses

- Multi-Language Support

- Assignments & Feedback

- Unified Content Management

- Built-in Collaboration Layer

- Unified Content Management

- Powerful Reporting & Tracking

- Recruiter tools for Pre-Hire Testing

- Upload content - DOC, PPT, PDF, MP4, MP3

- SCORM support

- Social Networking tools

- Collaboration

- Scalable & Secure

- Developer API available

- Fully Managed and Hosted

- Mobile/Tablet ready & Responsive Layout

- Embed links from Slideshare, Scribd, YouTube, Vimeo

- Public & Private Courses, Tests, & Live Classes

Software as a Service (SaaS)

SaaS is designated for cloud-based foundation for **software** and **applications** over Internet on demand. SaaS enables single or multiple users as well as educational organizations to access web-delivered contents. These content are available through any Internet browser. Cloud hosting organizations charge for use based on a number of factors, primarily on basis of storage, RAM, virtual, dedicated, etc. All these services are offered on a pay-as-you go basis.

There many advantages for SaaS service including:

a) Speed of delivery of software to clients;

b) Scalability to offer users access;

c) Simplicity of integration as user can access databases by any browser;

d) Lower cost as the data center exists within the cloud;

e) Software use for members without violating any laws as customer can add users to get the same benefits of commercially licensed users as needed.

The most important benefit is simplicity of installation by disregarding the demand to install and run the application on the customer's PCs. Additionally, SaaS reduces the customer's need for software maintenance, ongoing operation, and support.

Infrastructure as a Service (IaaS)

IaaS is the primary foundation layer of all the cloud services. It offers space for storage and enables cloud users to access and use basic IT services (storage, imaging, backups, processing, networks, firewalls, and other basic computing resources) provided by vendors in the IaaS cloud over a host of various types of virtual platforms. Organizations and single users can place huge amount of data on these infrastructures and reducing massive initial investment. It eliminates the use of hardware and networks. Users can use infrastructure as a service without installation of server software and without cumbersome configuration of hardware and thus avoid many underlying complexities. Users can directly access resources and storage over the network. IaaS deploys extensive virtualization in order to integrate and mix physical resources to meet the various needs of customers. The goal here is develop independent virtual machines (VM) that are isolated from both the underlying hardware and other virtual machines VMs. However, this strategy is not the same as multi-tenancy model, which aims to direct the application software architecture to run several instances from many cloud customers on a single application (i.e. the same logic machine).

Dillon (2010) and Caytiles (2010) offer various examples of IaaS that include: Private cloud, Amazon Elastic Compute Cloud (EC2), Rackspace Joyent, IBM Computing on Demand, Windows Server and System Centre and VMware.

Data-storage as a Service (DaaS)

DaaS is considered as a special type of (IaaS). Users can access, edit or save heterogeneous data in different formats without any conflict and without any need for parsing data coming from different sources. In a DaaS, we can compile data, store it, and make it available on demand in virtual servers in a separate Cloud service: "data storage service". (DaaS) allows users to pay on demand for their actual requirements and usage rather than paying and maintaining an entire database suite.

DaaS can be customized under the layer IaaS with various provisions for storage and retrieval of various types of data including Relational database management system (RDBMS), Big Data, and file systems. Customization can include table-style concepts that are intended to scale out to store and retrieve large amounts of data within a very limited timeframe as well as enable on-the-fly data retrieval shortly after upload, adding data, or editing data. In the past, database companies (data warehouse) required extensive hardware and software to manage data. It also used to cost a lot of money for data warehousing and data management of most commercial RDBMS. Examples of DaaS include: Apache HBase, Amazon S3, Google BigTable.

Platform as a Service (PaaS)

PaaS model lies directly above IaaS layer on the stack, and caters to developers instead of end-users. PaaS offers support to programming, testing, debugging and execution environments. It offers developers all they may possibly need of software, operating systems, middleware, and more. In a PaaS environment, programmers can write code, test and perform multi-layer service as well as execute applications in what may be characterized as a safe mode. PaaS provides the essential underlying hardware technology such as: development tools and software for building and testing application for users, operating systems, network support and database systems in a myriad of programming languages, which users can use to develop their own

applications. Commercial examples for (PaaS) include: Microsoft Windows Azure and Google App Engine (Omotunde , 2012).

Therefore, it is important to know that the difference between SaaS and PaaS is that SaaS enables users to install, host and use finished cloud applications, whereas PaaS presents a development platform that hosts both finalized and on-going cloud applications. Most widely used examples of SaaS include Gmail, Google Drive, Google Docs, 4-shared.com, Exchange online Business Productivity Online Suite, CRM Online, and Salesforce.com (Caytiles et all, 2012) & (Ibikunle et al, 2011). It is equally important to note that many software companies moved to offer cloud-based solutions across the board instead of the old-fashioned way of shipping software on CDs or sending links for downloads. Hackers became highly skilled to develop cracks, serial numbers, bootleg software – all for a fraction of the price prompting users to rush to buy cracked copies. Ironically, about 15 years ago, my company was awarded a major US Government contract to digital access and deliver online web access to users over a VPN. Next, I purchased Windows NT for 50 users and paid about $500 for the server software. When I handed it to the server hosting company in New York, they refused to install it and installed a hacked version instead. When I asked why, they explained their hacked version is a lot lighter and bug-free.

Private Clouds

Normally, a large enterprise may choose to build its own private cloud to manage all its activities, ERP, or other enterprise solutions. Therefore, a private cloud can be built and totally managed by a single enterprise to achieve several goals including: optimization of all available resources, meeting security goals such as data privacy and trust, and cost reduction for data transfer, and performing special functions such as real-time synch. Last, but not least an enterprise may choose to pay for the premium cost of a private cloud to maintain full control over serious activities that exist behind their

firewalls. Educational institutions may need a private cloud for research and management of an e-learning system (Dillon, 2010). Thus, organizations may build

private clouds primarily for either privacy issues, or for maintaining the highest control over data, security, and quality of service within the enterprise. Private clouds can be deployed within an enterprise data center, or at colocation facility (Caytiles et al, 2012)

Public cloud

This is the most common type of cloud models and usually the least costly. It is the most appropriate for and individual, small business or a small medium enterprise. It can be used and managed by the client or by the service provided at an added cost. Many entities will choose to use public cloud for cost reasons and also for ease of use. The main disadvantage of the public cloud is that it could be less secure especially for an inexperienced user. Many popular cloud services are public clouds including: Amazon EC2, S3, Google AppEngine, and Force.com (Dillon, 2010).

Hybrid clouds

Hybrid clouds can be used to offer data access, migration, transfer, edit, update, imaging, etc. They can be formed eclectically to provide virtual IT solutions by combining two or more clouds (public and/or private). The main advantage of hybrid cloud is integrating infrastructure for load-balancing between clouds. Businesses can use the hybrid cloud model to meet scalability requirements as well as achieving data optimization of resources by load balance and other tools to increase their primary business functions into the cloud and still managing essential activities. It is important to note that we can configure hybrid clouds to meet sudden variations of workload and data on demand requests (Dillon, 2010). For example, in a school or a university environment, hybrid clouds can fully eliminate the constraints at certain times of student registration, course registration when you have all students logging-in at almost the same time. Hybrid clouds can be easily configured to meet this sudden server requests by load balancing and virtualization and maintain service levels consistent through private cloud.

Hybrid clouds can be designed to control workload points in surge computing environment. Design engineering is important to deploy hybrid cloud as a buffer to achieve stabilization in a public or even a private cloud. Therefore, a hybrid cloud is used to stabilize load balance and optimize performance.

Data size is important in managing hybrid clouds and it is important to plan size wisely in relation to server type and RAM size as well. We suggest testing deployment of hybrid cloud with smaller data than planned. The smaller is the data, the more successful a hybrid cloud can be than if larger amounts of data must to move into a public cloud for a small amount of processing (Sun Microsystems, 2009). Additionally, hybrid Cloud offer security support for control of data and application. It offers support for users to access, edit and manipulate data over the Internet. It can be configured to permit interfaces with other management systems. More importantly, hybrid clouds can be configured to integrate cloud computing and web 2.0 to support collaboration.

Web 2.0

It stands for the web applications that supports collaboration and enables interactive information sharing. The primary function of Web 2.0 is to enhance the interconnectivity of Web applications and to allow users to access web applications efficiently. This feature is especially important for web portals requiring collaboration in real time like schools, e-learning, or law enforcement. It enables data access and sharing in real-time. Web 2.0 is a generic term used for characterizing collective Web-based technologies that include blogging, wikis, social networks multimedia sharing sites, podcasting, newsfeeds, Really Simple Syndication (RSS) feeds, content next-generation technologies and other emerging social media networks. Cloud-based computing services are essentially Web applications that use the Internet as a computing platform and provide on-demand computing services. There are ongoing research and enhancements to optimize Web 2.0 infrastructure relevant to cloud computing. Web 2.0 provides a learning environment that has the ability to change the basic nature of learning and teaching, by the development of learner controlled learning

web (Al-Zoube, 2014). With Web2.0, students become the consumers and producers of learning resources as they have diverse access to various databases and resources.

Part (3) – Cloud-Based E-Learning Systems

E-learning is a generic name that emerged referring to Internet-based learning applications to design, and implement either or both synchronous or asynchronous learning processes. E-learning offers various forms of learning portals with the advantages of flexibility, diversity, measurement, opening and more (Masud, 2012). However, in traditional e-Learning environments, services are based on anytime technologies that supports a business model where an educational institution can plan to enroll students in a virtual environment without investments in physical infrastructure. (Arura & Sharma, 2013).

According to Zheng (2013), eLearning organizations faced many challenges in different area including: optimizing resource allocations, managing dynamic data demands for accessing and retrieving information from anywhere and anytime, dealing with increased storage requirements and with growth rates. E-learning constraints emerged as a result of the varied needs of learners accessing e-learning systems that were not properly planned and designed to meet the learners; need to access multiple databases on the e-learning platform. With increased loads of e-learning wep portals available today, learners experience more problems accessing data because the inefficient e-learning platforms that are not always compatible with Web 2.0. Nowadays, it is imperative for e-learning systems to keep pace with the appropriate technology needed for development and continued improvement. However, today's technologies (such as Web 2.0, Cloud, etc.) are designed to build viable educational environment, which deliver collaboration and interaction in eLearning environments. Nonetheless, The challenge here is how to use and integrate these emerging technologies and to apply the accurate tools that allow the best deployment for e-learning systems (Ouf et al, 2010). Cloud computing and Web2.0 are two important technologies that are starting to strongly impact the development, deployment and usage of e-learning applications.

Cloud-Based E-Learning Computing

We contend that E-Learning based on cloud-based platforms integrated with Web 2.0 technology is the most viable infrastructure to satisfy learners' insatiable need for learning from multiple sources that include: multimedia, interactive, collaboration, blogging, social media and real-time interaction. Cloud-based systems deploy e-learning applications dealing with the resources effectively and in dynamic scalability. It provides a new trend of deploying applications. In cloud, teachers can communicate with students, parents, and administration in real-time. The blended learning strategy, interactive content and virtual collaboration are all integrated together to offer a new era of interactive education by means of e-learning. E-learning deploys a number of cloud levels: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS). E-learning shifted now to utilization of virtualized resources offering services for educational institutions to be accessed by students and teachers. Cloud computing can benefit ELearning systems by using:

a. Infrastructure: an eLearning solution is on the provider's infrastructure.

b. Platform: the usage and development of an eLearning solution based on the provider's development interface.

c. Services: the eLearning solution offered by the provider of learning resources (Bora and Ahmed, 2013).

Integration of Cloud Computing and Web 2.0 in E-Learning

Intelligent integration of cloud environment and web 2.0 can offer significant enhancement to eLearning systems and eLearning processes as well as collaboration. Over the recent years, many e-learning institutions shifted from traditional eLearning systems to more collaborative interactive learning environments. (Méndez & González, 2011) contend that the limitations of traditional e-learning pointing that traditional e-learning systems failed to attract students for both synchronous and asynchronous systems, and that e-learning institutions lost massive investments.

We contend that cloud computing is able to contribute critical features to eLearning in many ways such as: real-time configuration and data update, utilization of resources, on-demand resource sharing and better management for software or hardware. The cloud- based system is about the only platform to support next-generation of eLearning systems that is accessible from a wide range of hardware devices with data storage takes place in a cloud environment. Ouf, Nasr and Helmy (2010) proposed an e-learning system based on the integration of cloud computing and Web 2.0 technologies to allow real-time collaboration and add to e-learning environment with new services such as flexibility and ease towards students' need for collaboration and for setting more efficient integration of e-learning business sectors.

Similarly Zheng (209) proposed a platform architecture based on Windows Azure and Web 2.0 for developing intelligent virtual learning community based on the integration of cloud computing and web 2.0 and make the learning environment more productive, scalable, flexible and adjustable towards students' need for Information and Communication Technologies ICT. The architectures integrated cloud platform infrastructure, Web 2.0 Feed and Web API to create ELearning system on local computers resulting in user-friendly system for students to access the system with different clients including different browsers.

E-LEARNING CLOUD BASED ARCHITECTURE

In recent years, many educational organizations raced to deploy e-learning platforms primarily for business motives without due diligence to technology and pedagogy priorities. Many ELearning cloud architecture systems emerged to satisfy an increased demand for e-learning. According to Fasihuddin (2010), new viable models of e-learning emerged to revolutionize both synchronous and asynchronous e-learning systems. Dang et al, (2009) and Laisheng and Zhengxia (2011) were the pioneers to present first prototypes of cloud-based e-learning system architecture. They divided the cloud architecture into several layers: Infrastructure layer, software resource layer, resource management layer, service layer, and application layer.

e-Learning Cloud-Based Layers:

A. Infrastructure layer

Offers dynamic and scalable physical host. This layer is placed in the bottom layer of cloud service platform and composed of information infrastructure including (Internet/Intranet, system software, information resources management system and other software and hardware) and teaching resources that are gathered in traditional teaching model and distributed in various departments and domains. This structural layer provides the basic computing power such as physical and CPU memory. The use of virtualization technology enables upper software platform to call physical server, storage and network form virtualization group.

B. Software resource layer

Offers an integrated interface for eLearning developers, by using middleware technology; different software resources are configured to deliver an integrated interface for developers to enable them to develop applications based on available software resources and make them available for users in the cloud.

C. Resource management layer

To achieve integration of software and hardware resources for virtualization and cloud computing to achieve on-demand flow, scheduled data synch, and distribution of software over different hardware resources.

D. Service layer

This layer consists of three levels of cloud computing services, SaaS (Software as a service), PaaS (Platform as a service), and IaaS (Infrastructure as a service). In SaaS, learners can access information with pay-as-you-go basis, with no need to purchase software and hardware, and no need to maintain and upgrade.

E. Application layer

This layer is primarily for teachers and teaching resources integration in the cloud-computing model. It includes interactive courses and sharing teaching resources. This layer supports sharing of teaching resources such as: curricula, lesson plans, material, information resources and human resources sharing. This layer provides content production and delivery technology, collaborative learning, assessment and management features.

BENIETS FROM APPLYING CLOUD COMPUTING TO E-LEARNING

According to Boran & Ahmed (2013), eLearning systems in the cloud can achieve a myriad of benefits to include:

A. Lower Cost

Using cloud infrastructure reduces the cost of building educational information system significantly (Guili and Liu, 2010). Fasihuddin (2010) pointed that the software licensing cost is reduced as it is offered as a service from providers who will also take the responsibility of some computing maintenance from IT staff. Students in E-learning environments do not require specific computers with large memory to store data and run the applications they need, they can run the applications from the cloud through their personal devices such as PC, ipad, mobile, and tablets. Cost is reduced as users pay only for the software they need by the time used.

B. Improved learning performance

Since all the applications on the cloud, when the client machines work they will not cause any issues on the overall and learning performance. Dillon (2010) contended that the learning process will be clearly affected in a positive way as more IT team will be dedicated to focus on providing better support for learners rather IT maintenance issues.

C. Immediate software updates

Students will have instant update as the applications on the cloud are automatically updated in the cloud source.

D. Enhanced document format compatibility

Students will not face the problem of not opining their files from different devices due to different formats compatibility, since they open files from the cloud. Thus students do not have to worry about their PCs or mobiles supported file formats.

E. Benefits for students

Students will have more advantages through cloud based eLearning by taking online courses, having exams online, having feedback about the courses from teachers, uploading projects and assignments online, and collaborate and share resources and course contents over the cloud. Moreover, students will have uninterrupted access to up-to-date resources with all the required tools to achieve the learning goal in a flexible environment; the can resources and course contents can be evolved collaboratively over the cloud and shared.

F. Benefits for teachers

Bora and Ahmed (2013) asserted that teachers can utilize the most out of prepare online tests for students, use content management to create better content resources for students, evaluate tests and projects done by students, communicate with students and send feedback.

G. Data security

Many contend security issues relating cloud. Cloud computing provides more security advantages for persons and organizations who use or develop E-learning environments.

H. Better learning recourses management

I. Multimedia

Cloud supports the use of multimedia learning contents in mobile learning and offers a chance to build a mobile educational resource library (Muhaideb, 2010). According to Fasihuddin (2010), cloud computing provides more interactive learning resource management and better integration and consumption of learning resources and this is by providing improved management method, automated deployment and high level virtualization.

CONCLUSION AND FUTURE WORK

Cloud computing quickly emanated to serve as a new development Internet-based computing model. It is a significant alternative for today's educational perspective, especially in the eLearning environment. Cloud environment offer students and teachers the chance to rapidly and economically access several application platforms and resources across the web pages on-demand anytime anywhere. The most significant aspect is the cost reduction of cloud platform which results in minimizing the cost of organizational payments and presents strong functional capabilities. As learning needs exceeded in recent years, eLearning received a major segment primarily based on cost reduction as well as ease and rapid deployment. ELearning society faced challenges in optimizing resource allocations, dealing with dynamic demands for accessing information anywhere and anytime. Cloud offers key advantages including fulfilling rapid storage growth requirements, cost managing and flexibility, rapid deployment, and better management.

Cloud based eLearning is increasing continuously and it is necessary for eLearning systems to keep pace with the right technology needed for development and improvement. Therefore eLearning systems must keep pace with the right technology needed for development and improvement, thus it cannot ignore the cloud computing and Web 2.0 trends, and the benefits from their integration. Using cloud computing with the integration with Web 2.0 collaboration technology for eLearning affects the way an eLearning software projects are managed, enable to build more successful and effective

educational environment, that provide collaboration and interaction in eLearning environments. The most significant benefits of cloud eLearning are that it enables resources accessibility from multiple devices, such as computers and smartphones, allows for a wide network of individuals for formal and informal learning, increase collaboration activities and enhance educational performance for learners.

In summary, the movement towards cloud computing can be a greater variation of Internet ready devices, applications accessed directly from the Web, data placed in the cloud, and company applications controlled and hosted by third party service suppliers. Our paper suggests that introducing cloud computing with the integration of Wen 2.0 collaboration technologies into eLearning environments is feasible and it can greatly increase the collaboration activities and educational performance for learners.

For practical purposes, we developed our own cloud platform to offer both Enterprise Resources Planning and school management into one application. We made optimum use of Web 2.0 allowing collaboration between all users of students, teachers and others. In addition, we just tested and documented a new function to support not just community members, but also global users in our fist prototype of a global classroom.

Based on the foregoing, we assert that the most viable cloud based system will include ERP, educational support, global class and SCORM. AAIM-EDU offers all of these components in a seamless user-friendly environment.

For future research, our aim is to implement an eLearning system by using integration of Cloud computing and Web 3.0.

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