An Ecosystem in e-Learning Using Cloud Computing as platform and Web2.0

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ABSTRACT
Research community has believed that an e-learning ecosystem is the next generation e-learning but has faced challenges in optimizing resource allocations, dealing with dynamic demands on getting information and knowledge anywhere and anytime, handling rapid storage growth requirements, cost controlling and greater flexibility. Additionally, e-learning ecosystems need to improve its infrastructure, which can devote the required computation and storage resources for e-learning ecosystems. Cloud computing technologies although in their early stages, have managed to change the way applications are going to be developed and accessed. These technologies are aimed at running applications as services over the internet on a flexible infrastructure. Cloud computing provides a low cost solution to academic institutions for their researchers, faculty and students. This setup provides an additional benefit because all browsers based applications can also be accessed through mobile devices in addition to being available to a variety of laptop and desk top computers, provided internet access is available. In this paper we combined various technologies to achieve this goal. We present an interactive tool that can be used for science education; integration between cloud computing as a platform and web 2.0 are presented as a solution for building effective e-learning ecosystem.

Keywords
Cloud Computing as a platform, E-Learning, Ecosystem, Web 2.0, Virtual Community.

1. INTRODUCTION
During the last years, the nature of the Internet was constantly changing from static environment to a highly dynamic environment that allows end users to run software applications collaborate, share information, and creates new services online [1]. There is no doubt that the future belongs to the cloud computing. This new environment supports the creation of new generation of e-learning ecosystem that is able to run on a wide range of hardware devices, while storing data inside the cloud.

The need for e-learning is increasing constantly and the development and the improvement of the e-learning solutions is necessary. Also, the e-learning systems need to keep the pace with the technology [1], so recently research community has believed that e-learning ecosystem is the next generation of e-learning [2] and the new direction is building and hosting e-educational system into the cloud. Also, there are several tools that offer support for e-learning ecosystem among this tools web 2.0.

Web 2.0 has changed the World Wide Web from the original traditional publishing model of information into a collaborative information creation model. The great diffusion of Web 2.0 as new instrument is having strong effect and change on the way people search, find, collaboratively develop and consume information and knowledge. Today people are extensively using some of the Web 2.0 applications such as Wikipedia, YouTube and Twitter to create and share information. Cloud Computing presents a new way of deploying applications. Today we can get Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS). There are elastic clouds where memory and processing power get allocated based on computing resources required at the time [3].

Unlike the traditional web service technology, a light weight approach is available by Web2.0 services. Web 2.0 as term is closely associated with Tim O’Reilly is considered as a collection of web applications that reuse user generated content, initiate social interaction [4](Interaction typically occurs through discussion, commenting, collaborative writing, or working together on projects[5]) and enable collaborative functionalities based on more usable and convenient technologies such as AJAX(Aynchronous JavaScript and XML), JavaScript, XSLT/XML(Extensible Stylesheet Language Transformations/Extensible Markup Language), XHTML(Extensible Hyper text Markup Language), CSS(Cascading Style Sheet) and Document Object Model, XML-RPC,REST (Representational State Transfer), RSS ("Rich Site Summary" or “Real Simple Atom”, wikis, podcast, mashups, Syndication”), Social Bookmarking [4].

In advance, these technologies facilitate the subscription, access, propagation; reuse and compilation of small chunks of content (micro content), interactive information sharing with the group members and/or with other learner groups, user-centered design. A Web 2.0 site gives its users the free choice to interact or collaborate with each other in a social media dialogue as creators of user generated content in a virtual community [6].

Wikipedia, Flickr, YouTube, LinkedIn, MySpace, Facebook or Google Maps are representatives of Web2.0 applications. An important characteristic of these applications is that they provide a range of their functionality and data via web interfaces for third parties. Also, in all these social networks participants are as important as the content they upload and share with others [4]. Education and learning are not an exception of Web 2.0 trends, as the number of Web 2.0 empowered e-learning environments are booming. So, researchers using Web 2.0 applications in e-learning ecosystem in order to [30]:

- Place learners at the centre of online activities and facilitate supposedly new forms of creation, collaboration, and consumption,[20]
- Allow learners to personalize learning environments [18].
- Allow learners to engage with new illiteracies and express themselves in different media.
• Encourage a proficiency in the publication of content, which creates a sense of ownership, audience engagement, peer assessment, and informal learning.
• Facilitate learning [21].
• Use collaborative problem solving [22].
• Provide prompt feedback.
• Offer learners unprecedented opportunities to create and share content and to interact with others [21].
• Make e-learning environment more effective and successful [20].
• Provide flexible and cost efficient e-learning ecosystem.
• Offer very attractive capabilities for learners to collaborate and share learning contents (e.g. learning objects, drawings, animations, pictures, digital videos, texts etc.) [30].

This paper is organized as follows: Section 2 describes how ecosystem can improve e-learning. Section 3 focuses on cloud computing concepts and the benefits of cloud computing for education. Section 4 illustrates an enhanced e-learning ecosystem based on an integration between cloud computing and web 2.0.

2. E-LEARNING ECOSYSTEM

The aim of this section is to summarize the complex situation for learning in environments of the 21st century by applying the ecosystem concept and identify high level requirements for our proposed flexible learning environment. Today’s educators have access to new technologies such as cloud computing and Web 2.0 and they should capitalize on this advantage to facilitate learning and make learning environment more successful and effective [7].

In recent years, we have witnessed significant growth and massive changes in the e-learning industry. Dondi and Delrio expressed concerns about first generation e-learning as follows [8]:

- Isolation of learners, lack of educators’ feedback, student collaboration and campus social context.
- Uncertainty of costs for institutions and learners.
- Uncertainty about e-learning quality (resources, technology and support services) and e-learning evaluation.
- Shortage of competencies required for e-learning implementation among teaching staff, technical staff, and students.
- Domination of technology and market forces over educational aims and institutional development strategies.

According to Cowley and others, there are set of contextual elements should take into consideration to make e-learning more effective and successful and to facilitate learning in complex and intricate situations:

- Environment: learners need a certain environment (PC, Connection, software).
- Teach skills: learners need to know something about how to use whatever learning system exists.
- Subject matter skills: learners need to have some prerequisite skills to benefit from the course.
- Support: there has to be a mechanism to get support when learners run into problems.
- Content: must be designed for interaction.
- Instructor: aware of learners’ needs/concerns and involvement levels, attempts to draw learners into discussion early, organizes schedule, provides resources for learners in need of additional learning.
- Technology: should play effective role.
- Organization: focused on learning, time and resources made available [8].

These elements belong to e-learning ecology or ecosystems that lead to the emergence of a second generation of e-learning [12]. This model is comprehensive and is capable of adapting new technologies and tools, integrating new learning approaches, adaptable to a variety of learning styles, and is responsive to the learning conditions [7].

Ecosystem is defined according to the Encyclopedia Britannica as a “complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space” also, ecosystem is more flexible which can be of any size as long as organism, physical environment and interaction exists [9]. The British ecologist, A.G. Tansley in 1935, and the American Raymond L. Lindeman define ecosystem “a biotic community or assemblage and its associated physical environment in a specific place.” [10]. Tansley indicated that ecology should appropriately consider the activities and effects of humans in ecosystems. The fact that he recognized new kinds of ecosystems that result at least in part from human actions is important [11]. The definition implicitly shows the interactions between the living (biotic) and non-living (abiotic) components, and intrinsically within highly complex elements.

The ecosystem is classified by biotic and abiotic components and their entire interrelationship in specified physical boundaries and its applicability to various application domains that lead Chang and Gütl to integrate the idea of the ecosystem to the learning domain [10].

The generic model developed by Chang and Gütl depict learning ecosystem (LES) that “consists of the stakeholders incorporating the whole chain of the collaborative learning processes, the learning utilities and the learning environment, within specific boundaries, called environmental borders” also, show difference between living or biotic and non-living or abiotic components. This difference is to confirm that learning is a simple process between the living and non-living components but growing awareness of the different styles of potential learners, aware of learners’ needs and early adopters’ experiences, strategies and the existence of modern utilities, Pursuit of better learning via ICT (Information and communication technologies) for lifelong learning, emergence of adaptive hypermedia and the growth of open source software (OSS), the need to improve quality of e-learning, and systems compounded by internal and external environmental factors create a greater need to offer flexibility to survive in a complex learning environment [9].

![Fig.1 Simplified representation for the learning ecosystem (LES) [10]](image)

The generic model is outlined as follow: The biotic units (living parts) in the learning ecosystem constitute the learning communities and other stakeholders such as teachers, tutors, content providers, instructional designers and pedagogical experts who can interact and
collaborate synchronously and asynchronously with one another and play significant roles in teaching and learning [10].

The learning utilities comparable to the abiotic units represent the non-living parts; include the static and dynamic learning media (content and pedagogical aspects), background knowledge in the form of external sources such as Wikipedia, digital libraries, technology, and tools applied in teaching (Laptops, desktop computers, podcasting, Personal Digital Assistance (PDA)). The technology may consist of the architecture and infrastructure platform for the management, delivery and tracking of e-learning in the form of learning content management system (LCMS), learning management system (LMS) and content delivery system (CDS)[7].

The learning environmental boundaries, an analogy to the specified physical boundaries of the ecosystem defines the physical and logical borders of the learning system. That is one of the system's characteristics, which are in common specified as the learning ecosystem conditions [10].

The learning ecosystem dynamic conditions are affected by external and internal influences, such as evolution of knowledge, educational goals, learning tasks, cultural and sociological aspects, and expectations by society, private industry and business organizations, the government, public service and not-for-profit organizations. Changes in the learning ecosystem conditions have important impact on the “behavior” of the system and its components. To be successful and to be valuable for the system, each individual and group must adapt to the environmental conditions to find their niches. In order to fit them all together, proper learning utilities must also be available.

Any learning situation consists of biotic and abiotic components which, their relationships and interactions together with the ecosystems' condition so that, researchers confirm that LES can be used with any learning situation, such as in classroom teaching or e-learning [9].

The major interests in the learning environment are relationships and interactions related to the information flow as well as knowledge transfer and transformation. Like a biological ecosystem, in a learning ecosystem, individuals can shape groups and can interact with each other or with learning utilities at the individual or group level. They also can perform, change or adapt specific behaviors in order to contribute to the success of the learning ecosystem [10].

Extending ecosystem to e-learning defines E-learning ecosystem “is the term used to describe all the components required to implement an e-learning solution.”

By focusing on the learning utilities component (abiotic unit) of ELES, the learning communities (biotic unit) of ELES must be self-organizing. This self-organization is required to avoid a single point of failure. Furthermore, the interaction between learners and educators and improvement of the productivity of learning environment must be taken into account to achieve this cloud computing and web 2.0 as platform to develop e-learning ecosystems [7].

3. A WALK IN THE CLOUD COMPUTING

What is cloud computing and what does it mean for IT? A question that is frequently asked by people inside and outside technology industry. Information technology is changing rapidly, so cloud computing birth came to explore the next generation in computation. Cloud computing has become one of the hottest buzzwords in the IT area. Many companies and institutions are rushing to define clouds and provide cloud solutions in various ways [2].

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid [25]. Due to the fact it involves the existence of data centers that are able to provide services; the cloud can be seen as a unique access point for all requests coming from the world wide spread clients [1].

![Fig. 3 Cloud computing](image)

It allow users to use applications without, the need to purchase, install, or support software on their local computers and/or servers, worrying about how to maintain these applications, in addition to enable the users to access their personal files anywhere in the world, anytime, from any internet-enabled device, from their phones to their desktop computers, only the user pay according to how much and how often he need services [26].

New advances in processors, virtualization technology, disk storage, broadband internet access and fast, inexpensive servers have all combined to make cloud computing a compelling paradigm [33]. One of the most important featured ideas behind cloud computing is scalability, and the key technology which make it possible is virtualization [2]. Virtualization breaks down the physical barriers inherent in isolated resources, and automates the management of these resources as a single entity through hypervisor technology such as VMs (Virtual Machines).

Cloud computing has critical impact on important areas of IT, like security, infrastructure, investments, and more [27]. It away to increase

![Fig. 2 E-learning ecosystem components](image)
capacity or add capabilities on the fly, reduce enterprise IT costs & complexities while improving workload optimization and service delivery, allows for much more efficient computing by centralizing storage, memory, processing and bandwidth without investing in new infrastructure, training new personnel, purchase software, or licensing new software [13]. So, cloud computing becomes an adaptable technology for many of companies and institutions with its dynamic scalability and use of virtualized resources as a service through the internet. Advances in technology offer new opportunities in enhancing teaching and learning so cloud computing has a significant impact on the educational environment.

Potential Values of Cloud computing for education are:

- Provide opportunity for ubiquitous computing [30].
- No need for backing up everything to a thumb drive and transferring it from one device to another.
- No need to copy all stuff from one PC to another when buying a new one. It also means students can create a repository of information that stays with them and keeps growing as long as he wants them.
- A convenient tool to engage in the scholarship of teaching and learning.
- Provides large amounts of processing power comparable to supercomputer level.
- Crash recovery is nearly unneeded. If the client computer crashes, there are almost no data lost because everything is stored in the cloud [1].
- Allows students to work from multiple Places (home, work, library, etc), find their files and edit them through the cloud and browser-based applications can also be accessed through various devices (mobile, laptop and desktop computers, provided internet access is available) [14].
- Most software is free, available and ready-to-use.
- Students can have a richer and more diverse learning experience, even outside standard school hours.
- Allows students to create content through the browser, instead of only searching through the browser.
- It provides a low cost solution to academic institutions for their researchers, faculty and students [29].
- Flexibility. Scale infrastructure to maximize investments. Cloud computing allows user to dynamically scale as demands fluctuate [15].
- Accessibility. Help make data and services publicly available without jeopardizing sensitive information.

Also cloud computing provides some major security benefits for individuals and educational institutions that are using/developing e-learning ecosystem, like the following:

- **improved improbability**: it is almost impossible for any interested person (thief) to determine where is located the machine that stores some wanted data (tests, exam questions, results) or to find out which is the physical component he needs to steal in order to get a digital asset[1].
- **Virtualization**: makes possible the rapid replacement of a compromised cloud located server without major costs or damages. It is very easy to create a clone of a virtual machine so the cloud downtime is expected to be reduced substantially.
- **Centralized data storage**: losing a cloud client is no longer a major incident while the main part of the applications and data is stored into the cloud so a new client can be connected very fast. Imagine what is happening today if a laptop that stores the examination questions is stolen.
- Monitoring of data access becomes easier in view of the fact that only one place should be supervised, not thousands of computers belonging to a university, for example. Also, the security changes can be easily tested and implemented since the cloud represents a unique entry point for all the clients [24].

Cloud computing is an excellent alternative for both colleges which are specially under budget shortage to transform from traditional learning to e-learning and colleges which do not have the resources and infrastructure needed to run top e-learning solution effectively[15].

There is several cloud computing services providers that offer support for educational systems. The internet giant Colleges advantages of available cloud-based applications offered by service providers and enable their own users/students to benefit from a set of online productivity tools and applications in the cloud such as email, contact lists, document storage, calendars, photo sharing, creation and sharing (spreadsheets, word processed documents, presentations etc), and the ability to create websites[27].

Google is one of the most prominent companies offering software as a free online service to billions of users across the world (Google Apps, Maps and Gmail are all based in the cloud). It already owns a massive computer infrastructure (the cloud) where millions of people are connecting too.

In 2008 Google has released Google App Engine as a platform enables the user to build and host web apps on the same systems that power Google applications. App Engine offers fast development and deployment; simple administration, with no need to worry about hardware, patches or backups; and effortless scalability [33].

IBM's CloudBurst is a self contained, pre packaged cloud that includes hardware, software, applications, and middleware for faster application development and deployment turnaround time [3, 36].

In 2006, Amazon extended its AWS (Amazon Web Service) suite with a new component called Amazon Elastic Compute Cloud (or EC2) that allows to the users to rent from Amazon processing power to be used to run their own applications [31].

Microsoft has also spent big bucks on cloud computing. The firm announced that Azure will go live in January 2010, Windows Azure platform as a flexible cloud–computing platform that lets user focus on solving education problems, addressing students' needs and provides necessary web tools for education. Using Azure platform will bring the education institutions closer to its vision and giving the flexibility to education IT departments [29].

**Which cloud is right for the user?** The choice to move to the cloud is not an all-or-nothing proposition. With different types of cloud offerings, user has flexible options about which services to obtain in the cloud and which to keep on-site. User priorities and security requirements determine the level of cloud capabilities to explore. If we look closely at the cloud, we will see three distinct sets of offerings:

- Infrastructure as a service (IaaS).
- Platform as a service (PaaS).
- Software as a service (SaaS).
Software as a Service (SaaS): Deliver applications to the browser of user or customer from the cloud. It helps organizations learning process with limited IT resources to deploy and maintain needed software in a timely manner while, at the same time, reducing energy consumption and expenses. A growing number of academic institutions are turning to SaaS for their desktop applications (Hinds Community College uses an email solution hosted in the cloud) Students now have the free collaborative tools they want [19].

Platform as a Service: Cloud platform services or "Platform as a Service (PaaS)" deliver a computing platform and/or solution stack as a service, often consuming cloud infrastructure and sustaining cloud applications[13]. It facilitates development and deployment of applications without the cost and complexity of buying and managing the underlying infrastructure (hardware, server, storage and network), and associated software (operating systems virtualization technology, file system)) [24]. Cloud platform provide all of the facilities required to support the complete life cycle of building and delivering web applications and services entirely available from the Internet [33].

Infrastructure as a Service (Data centers on demand): Cloud infrastructure services or “Infrastructure as a Service (IaaS)” get on-demand computer infrastructure. Rather than purchasing servers, software, data center space or network equipment, clients instead buy those resources as a fully outsourced service [17]. The service is typically billed on a utility computing basis and amount of resources consumed (and therefore the cost) will typically reflect the level of activity. It is an evolution of virtual private server offerings [25].

Using data centers means the user can scale with ease and speed to meet the infrastructure needs of his entire organization or individual departments within it, globally or locally [19]. Amazon Web Services Elastic Compute Cloud (EC2) and Secure Storage Service (S3) are examples of IaaS offerings [33].

- **Virtual Desktop**: Use any networked desktop in the users’ enterprise to access the applications, data and other resources.
- **Virtual Data Center**: Add or reduce computing power and capacity as needed, control costs through a pay-per-use structure, and offer accessibility from anywhere [34].

E-learning ecosystems can use benefit from cloud computing using:

- **Infrastructure**: use an e-learning ecosystem on the provider's infrastructure.
- **Platform**: use and develop an e-learning ecosystem based on the provider's development interface.
- **Services**: use the e-learning ecosystem given by the provider.

4. CLOUD COMPUTING AND WEB 2.0

Technologies and Services for building efficient E-Learning Ecosystems

There have been many new advances in the computing field in recent times. Cloud Computing and Web 2.0 are two such areas that are beginning to significantly impact how we develop, deploy and use e-learning ecosystem model. As shown in Section 2, e-learning ecosystem involving various stakeholders’ needs to integrate a variety of services and content types, increasing e-learning ecosystem productivity and scalability. Moreover, learning environment must be flexible and adaptable towards users' needs and concerns. This raises the question of whether cloud computing and web2.0 can meet the indicated requirements. To answer this question, Figure 5 introduces the proposed model with new technologies, integration between cloud computing and simple web 2.0 layer model will be linked with learning processes. Each layer will perform specific functions which contribute in achieving the paper objectives.


1) **Web2.0 Technologies**: The first layer includes technologies which make Web services and applications more usable and convenient, such as AJAX, JavaScript, XSLT/XML, XHTML, Cascading Style Sheet (CSS), REST, RSS, Atom, and the like. These technologies allow users to create, share, collaborate & communicate, improve system performance and make the user interface more attractive. From this layer we will use only the tools that compatible with cloud computing.

2) **Web2.0 Services and Applications**: The second layer consists of web 2.0 services and application built on Web 2.0 technologies layer that demonstrate the foundations of the web 2.0 concept, and they are already being used to a certain extent in education, these applications include weblogs, wikis, social writing tools, social bookmarking, social tagging, podcasts, media sharing tools, social networks, mashup and the like. These are not really technologies as such, but services built using the building blocks of the technologies and open standards that underpin the Internet and the Web. The universities can make use of these applications to communicate and interact with learners, staff and the wider academic community. From this layer we will use only the tools that compatible with cloud computing.

3) **Web 2.0 Based Activities**: The third layer contains specific activities are depending on web2.0 services and applications. These Web 2.0-based activities include collaborative content writing, sharing, communication, messaging, information linking, information presentation and the like.

4) **Learning Processes**: The learning processes are summarized as a number of the learning processes are defined by the Learning tasks. Each of the learning tasks can be controlled by one or even several
learning activities. Such activities can be provided through the Web 2.0 services and applications by Web 2.0-based activities.

(5) Cloud computing as a platform:

Cloud computing as a platform is a new era of cloud computing offers the academic organization a familiar development experience, on-demand scalability, scale up when it need capacity and pull it back when it don’t, cost savings, and reduced time to market for the applications, all in a secure environment[35]. It is a new instrument to host and deploy e-learning ecosystem in more effective way. We will use windows azure as a platform.

(6) Windows Azure: Provides a Windows-based environment for running e-learning ecosystem application and storing data on servers in Microsoft data centers.

(7) Windows Azure AppFabric: provides a comprehensive cloud middleware platform for developing, deploying and managing e-learning ecosystem application on the Windows Azure Platform. It delivers additional developer productivity adding in higher-level Platform-as-a-Service (PaaS) capabilities on top of the familiar Windows Azure application model. It also enables bridging the existing applications to the cloud through secure connectivity across network and geographic boundaries, and by providing a consistent development model for both Windows Azure and Windows Server.

(8) SQL Azure

Is a highly available and scalable cloud database service built on SQL Server technologies? With SQL Azure, developers do not have to install, setup, and patch or manage any software.

Benefits of windows azure:

Agility: Take advantage of development tools, automated service management and global datacenter presence to respond faster to customer needs, focus on his competitive differentiators, and reach new markets.

Efficiency: Windows Azure improves productivity and increases operational efficiency by lowering up-front capital costs.

Focus: Focus on delivering services and value to user and not on managing technology infrastructure. Windows Azure enables user to spend less time on operational hurdles and more time focusing on his competitive differentiators.

Simplicity: Utilize user existing skills in familiar languages such as .NET to create and manage web applications and services.

Trustworthy: Enterprise class service backed by reliable service level agreements and a rich online services experience.

Emerging web 2.0 layers with windows azure as a platform meet the needs of the education communities in the educational institutions.

5. SYSTEM ANALYSIS AND DESIGN

Fig 6 and Fig 7 show a deep understanding of the goals, tasks, and requirements of the proposed enhanced e-learning ecosystem.

6. CONCLUSION

The design of e-learning ecosystems is still in its infancy. With the huge growth of users, services education contents and resources, e-learning ecosystem is facing challenges of optimizing resource allocations, dealing with dynamic concurrency demands, handling rapid storage growth requirements and cost controlling. So the best solution for this is using new technologies (integration between cloud computing and web 2.0). In the field of ICT sourcing cloud computing is currently one of the biggest topics. Cloud computing is a delivery model that allows users to rent ICT services and performance on an on-demand or project basis through networks (e.g. the Internet or an intranet) instead of
purchasing them. These services can be software (SaaS – Software as a Service), platforms for the development and operation of applications (PaaS – Platform as a Service) or basic infrastructure, e.g. storage space (IaaS – Infrastructure as a Service).

7. REFERENCES