# U-ALS: A UBIQUITOUS LEARNING ENVIRONMENT

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**ABSTRACT**

The diffusion of the use of the learning virtual environments presents a great potential for the development of an application which meet the necessities in the education area. In view of the importance of a more dynamic application and that can adapt itself continuously to the students' necessities, the "U-ALS" (Ubiquitous Adapted Learning System) was proposed and developed. This system was built based on the learning virtual environment Moodle and on the Module Mle-Moodle, available in a Cloud Computing infrastructure and it has as a main purpose the adaption to the student's computational context, glimpsing technical characteristics like the environment adequacy to the user's speed connection. The obtained results show the feasibility of working with systems that are sensitive to the context, bringing improvements in the students' access to the materials and tools.

**KEYWORDS**

Ubiquitous Learning Virtual Environment, U-Learning, U-ALS, Adapted Environments, Cloud Computing.

## 1. INTRODUCTION

The use of the Virtual Learning Environments (VLEs) in the academic environment has become very common. The use of these environments with the support and help in the teaching and learning processes make the VLEs an important pedagogical resource (RIBAS, 2009). In this case, making the environment adequate to the student, considering its individual characteristics is a necessity today. In this field the ubiquitous learning (U-learning) is inserted, which enables the access to the educational resources with total mobility and adaptation of the system to the students' computational context. In this context, this paper seeks for proposing a new application for these environments where the students, besides having the facilities of mobility and adaptation of the device through the Mle-Moodle, they will have an environment which will adjust itself to its computational context, making the materials adequate to the different speed connection, available in a Computational Cloud infrastructure which guarantees availability and access through different devices.

The Cloud Computing emerges as a technology to improve and make the use of computational resources more efficient, through characteristics like availability, elasticity and the adaptability of services, where the user will be able to access his programs remotely and he can have a larger capacity of storage and processing available, without the necessity of owning more expensive equipments, because his data will be available in the cloud. In this computation model, the technology resources are allocated on a scalable way, this way these services are offered to external clients through technologies via Internet (CEARLEY, 2010).

According to David Cearley, the clients don't need to know how it works; they will simply be able to use the offered services. Thus, Cloud Computing is a model in which the computation (processing, storage and software) is somewhere in the net and it's accessed on a remote way (CEARLEY, 2010).

The increasing of size, complexity, the number of users in the internet problem, as well as technological diversity that the same use to access the net brings the necessity of treating each user on a specialized and individual way, identifying the profile and developing applications in virtual environments able to adapt themselves.

The existent VLEs own static platforms, enabling only the selection of the contents and the tolls that will be used by the teachers, without considering the students' individual characteristics that will use the environment.

The trend to the VLEs' evolution is to evolve to aggregation tools which seem to be able to help to materialize the PLE (Personal Learning Environment) concept (OLIVER AND LIBER, 2011). The central idea of PLE is to give the student or, more generically, to the learner, a personal space where it adds the contents that are useful, produced by others, but also the ones that it produces itself, and that this way provides according to its interest. In other words, instead of using a designed space similarly to a group of students, as it happens in the traditional VLEs, it creates its own space as well it keeps it under control. This evolution has been referenced as the transition from a "one for all" system to "one for me" systems and it permits to highlight the control question, being the learner able to determine his own choices and action course (HARMELEN, 2006).

From the researches done through a speed measurer integrated to the VLE Moodle and to the Module Mle-Moodle of the X School (XX), we noticed through the register of accesses of the environment for desktops and of the accesses in the environment for mobile devices, the several ways that the students can access the environment, through mobile devices or desktop computers and the great range of connection speed, showing that the students' computational context bring a problem in the usage of the VLEs, because with lower speeds of connection problems of access to bigger files arise, because it takes them a long time to be loaded, transferred or open and to use tools that need a larger broadband internet connection like the chats.

This work makes the VLE Moodle dynamic, with characteristics of a *software u-learning* through the creation of a module that can identify the student's computational context when he enters into the course. The module identifies the student's connection speed and adapts the contents and the tools, that with the module Mle-Moodle brings to the environment the characteristics of availability, mobility and sensibility to the context. With this work, the VLE *Moodle* and the Module *Mle-Moodle* became not static and didn't serve as simple repository of information where the teachers put their subjects and they can just select the tools that they will use to become an environment that identifies user's variables that influence in the way that the teachers access the environment and in its usage. The Science Computer usage in the Clouds brings the advantage that it's not necessary to keep the hardware infrastructure, enabling the increase of the storage capacity, memory and processing because of the increase in the number of students, dispensing the maintenance of the TI staff to keep, update and reconfigure the environment according to the necessities. In the education area the Science Computer technology usage in the Clouds justifies itself by the fact that the informations can be accessed from anywhere, through the Internet, the elasticity of available resources and the wide access through personal computers, smart-phones or PDAs.

For better comprehension of the research and the results found, this article is structured in six chapters, being the second chapter the presentation of some concepts referent to the cloud computing; in the third chapter are presented definitions about mobile VLEs; in the fourth chapter are presented some correlated works; in the fifth chapter is presented the methodology and the development of the Moodle U-ALS; in the sixth chapter are presented the results and discussions.

## 2. CLOUD COMPUTING

Cloud Computing is a new trend of technology that intends to be global and to provide services to people that go from the final user that hosts personal documents in the Internet to companies that outsource all the TI infrastructure (Technology of Information) (BUYYA el al, 2009). The Cloud Computing is justified by the fact that as the software resources as the hardware ones, get obsolete in a short period of time, making the computing platforms usage of third ones the ideal solution to the infrastructure problems. To use their systems the user doesn't need high computing resources, being of software or hardware, decreasing the machine purchase cost (MACHADO and MOREIRA, 2010).

The infrastructure of the Cloud Computing environment is usually formed by several physical machines connected by a net. Each machine has the same configuration of software, but they can range the hardware capacity related to the processing, storage and memory power. Inside each physical machine there are a variable number of virtual machines or nodes in execution, according to the physical machine (SOROR et al, 2010).

Nowadays there are several technologies that permit the creation of a new infrastructure of cloud computing, among them: *Amazon Web Service*, *Google App Engine*, *OpenNebula*, *Nimbus* e a plataforma *Eucalyptus*, chosen for this work.

## 2.1 Eucalyptus

It's an open code infrastructure that permits the creation of a compatible infrastructure for the users can try the Cloud Computing (LIU, LIANG and BROOKS, 2007). The architecture of the eucalyptus is simple, flexible and modular and it also has a hierarchical conception that shows the common resources of the environment.

An installation in Eucalyptus cloud can add and manage resources from only one cluster or several ones. The cluster is a group of machines connected to the same LAN. It's possible to have one or several instances of a NC (Node Contrller) in a cluster, and every one of them manages the instantiation and the termination of virtual instances (IBM, 2011).

According to Machado (2010), the Eucalyptus has as a purpose to help the research and the development of technologies for Cloud Computing, with simple implementation using tools for administration and help to the users' and system management, with the ability of setting several clusters.

# 3. VIRTUAL ENVIRONMENT AND MOBILE LEARNING

In the last decades, we have been experienced the appearance of a connected mobile society, with a variety of information resources, technologies and ways of communication available. Before the advancing that the Mobile Computing is achieving, is the fact that, the usage of mobile devices is reaching all kinds of users and usages, among them the usage in VLEs (MOZZAQUATRO, 2010).

The Moodle is a software of orientation Open Source (free), its development objects the management of learning and collaborative work in virtual environment permitting the creation and the management of online courses, work groups and learning communities. In Brazil, the Moodle was approved by MEC as platform for Distance Education, which will be able to be adopted by any institutions that want to apply this kind of teaching. The Moodle presents several resources, like discussion forum, diaries, glossaries, tasks, chats, questionnaires that can be selected by the teacher/manager in a way to create a more flexible learning environment, that attend to the pedagogical goals and to the students' necessities, providing a module to the access via mobile device too (FRANCO, 2010).

The possibility of personalizing the environment where the student interacts in the teaching search, helping all the ones involved in the teaching/learning process to get their goals, it makes the VLE dynamic. An important factor during the student's accompaniment process is to be aware about the context where the student is acting, enabling the adaptation of teaching strategies according to the specific student's reality, enabling an adaptive support, where each student will have their characteristics referent to the environment and to the presented contents. This adaptation of the environment is characteristic of the Sensitive Environments to the Contexts that are presented.

## 3.1 Environments Sensitive to the Context

Sensibility to the Context refers to all that happens around the user, and that influences the way as he interacts with the environment and with the other people. To the ubiquitous computing, sensibility to the context is similar, where computing systems can perceive the context and interact according to him (PERNAS et al, 2009).

Sensibility to the context refers to the capacity of a class of systems to the usage of the contextual information to offer of better services to the user, in a flexible and manageable way (DEY et al, 1999). A system that is sensitive to the context is able to extract, interpret and use the contextual informations and to adapt its functionality to the current context of usage, to provide services to a person particularly, place, time, event, etc (BYUN and CHEVERST, 2004).

Each student accesses the VLE under determined conditions. The student can be at home or in another environment, he can use a personal computer or a mobile device, he can have knowledge acquired from other sources or having no knowledge about the content, he can have done part of the activities or done none of them (PERNAS et al, 2009). So, each student has his situation characterized and too individual, so to determine these variables that can interfere directly in the student's teaching is a very important task.

## 3.2 U-Learning Environments

To Chiu (2008), u-learning is a system aware of the context and that can fell the student's informations and the informations around the students in the real world, and then can offer personalized services. So, the students can learn the knowledge, abilities and problems and be able to solve while interacts with the real world through authentic scenarios.

To Weiser (1993), the computers should be embedded on a implicit way to the user's environment, with human-computer interaction on a non-intrusive way, without the artifacts usage imposition like keywords and remote-controls, being this one closer to the way that the human-been gesticulate, talk or write to communicate.

U-learning environment, in counterpoint to the traditional VLEs that usually are static and own contents, structures and static presentations, they object to provide an environment with functionalities that permit the adaptation of this environment to the specific situation lived by the user in every interval of time, thus, a very innovative propose.

In the educational area, the focus of this work, many virtual environments of learning are not more than a static repository of content, with the same materials, structures and presentation to all the students (GASPARINI et al, 2009).

# 4. WORKS CO-REPORTS

Since 1994 we notice the initiatives of software development with context treatment, we can mention: the Shopping Assistant (1944), the XeroxParc (1996), the Cyber guide (1996), the Conference Assistant (1999), the Lookout (1999) and the Campus Aware (2002).

The SEDECA objectified to identify and to adapt the VLE MLE Moodle to the student's cognitive style through a system created to diagnosticate learning styles. The analysis of these categories permitted to define indicators that enabled the adaptation of the learning virtual environment MLE Moodle to these different cognitive styles to the adaptive hypermedia. The materials and proposed activities in the adapted environment were presented according to the four cognitive styles that highlighted the most in the research: Holist, Serious, Divergent and Reflexive (MOZZAQUATRO, 2010).

The Adapt Web (Adaptive Teaching-Learning Environment on the Web) is an AS (Adaptive System) of EAD based on the web, open source. The Adapt Web has the purpose of adapting the content, the presentation and the navigation according to the user's profile. Its adaptation is supported by the creation of a student's flexible model (user's model), where, for each student are saved personal informations like his background, knowledge, preferences, navigational historic and technological resources (PALAZZO et al, 2008). The educational contents are organized by a hierarchical structure of concepts, establishing criterions of pre-requirement. The structure is defined during the authorship level and it is stored in the XML format (Extensible Markup Language). These XML documents pass by an adaptation before being presented to the students. The adaptation occurs as in the content, as on the interface and in the navigation (PERNAS et al, 2009).

# 5. METHODOLOGY AND DEVELOPMENT OF THE U-ALS MOODLE

Talking about the nature of the research, this paper presents an applied research, because seeks for the solution of a specific problem and about the technical procedures used, the research is classified as experimental research, because it selects variables that are able to influence the studied goal (SEVERINO, 2000).

The general goal of the U-ALS Moodle development was to provide, in a Cloud Computing infrastructure, an adaptive environment as to desktop computers as to mobile devices providing an environment adequate to the student's computing context, through the adaptation of the content and of the available interface, according to the speed connection.

The proposed architecture presents an organization in two distinct layers, the Interface Layer and the Communication Layer, more the integration with the DBMS (Data Bank Manager System). On the Interface

Layer, where the student accesses the content to do the activities, the content will be already available according to the each student's speed connection. On this layer the contents and the tools are accessed. On the Communication Layer, the architecture proposes an Adaptation Agent that has the function of treating the executed informations on the Interface Layer by the students, providing the adequate material.

The treated informations are the speed connection identification, which is stored in the XML file (Extensible Markup Language). From this the Adaptation Agent modifies the environment for the student to have an adequate navigation. The adaptation of the environment is done in the provided materials and also in the tolls that are provided according to the student's net context, being the variable analyzed by the Agent and the access speed Variable to the VLE. The Agent is going to communicate with the Data Bank Manager System (DBMS) and to adequate the environment to each student.

Despite the DBMS saves the inserted informations, the stored variables to the adequacy of the environment to the student's profile, considering its speed as IP, connection speed and student's access date in the VLE are stored in an XML file, which is saved inside the Moodledata, placed in the Cloud provider created, and these data are useful for posterior statistic analysis. The student's speed identification will indicate what contents and what tools will be provided in his access to the environment.

The Agent that does the content adaptation watches the environment while the student is logged-in, at each interval of 60 seconds showing the speed on the screen and saving the data. If the student has his speed reduced, the environment adapts itself to this speed and if the speed increases the Agent also provides materials and tools to this connection.

The material to be used by the students is stored in distinct categories, one for low speeds and other for normal and high speeds, making the environment totally personalized, and that the student will only visualize the ideal files for his connection speed, as well as the adequate tools to his navigation.

The cloud infrastructure provides to the development of the U-ALS, is based on nine computers, with the following format: a gateway that permits the access to the environment through the net; a provider with the cloud controller, cluster controller and storage controller functions and; seven machines serving the node controller, which ones provide the cloud processing. All the machines used in this environment, as node controllers, own the technology of native visualization in hardware, being six computers powered with Dual Core processors and one with Quad Core Processor, totalizing the maximum of sixteen cores in the computing cloud.

The Eucalyptus framework choice was because it is open source and to enable the implementation of scalable and efficient clouds. Through the virtualization it is possible that several instances of the operational system be executed simultaneously in only one computer, being possible to control the usage of the CPU, memory and storage and even to permit that the operational system migrates from a machine to another. In this paper, the KVM (Kemel-based Virtual Machine) was used to the virtualization. The KVM is native in the Ubuntu Operational System, being possible to load Windows and Linux clients being used to raise the instances in the Eucalyptus framework.

The Cloud Computing usage brings the elasticity of resources advantage to VLE, because if the number of users or the necessity of more space to store more content, it is not necessary the purchase of more hardware resources like new providers with more space or more power of processing, the necessary resources are automatically allocated by the cloud, and the reallocation of resources can be done in real time, without the necessity of stopping in the system.

The computing cloud implantation model is private, and the service model is a kind of SaaS that has as a purpose to make easier and more accessible the resources providing to the students.

The U-ALS works in a transparent way to the user, when the student enters into the environment, this one does not present any apparent change, having characteristics of U-learning software. When the student clicks on the course the system will check its connection speed and it provides the materials that are adequate to that connection usage. The U-ALS also provides the tools that are showed.

The adapted environment stores the students' connection speeds and the adapted materials that were accessed, making the students' profile study possible, with the possibility of indicating improvements of the VLE conditions to attend the students' necessities, and thus influencing in the final quality of the course.

# 6. RESULTS AND DISCUSSIONS

The validation of the U-ALS Moodle was done at X (XX) School, in the subjects about Wireless Technology and Computer Architecture, where were collected data that will be presented in this paper. The Figure 1 presents the U-ALS Moodle screen showing the users' connection speed and the adapted materials, in the Wireless Technology Subject.

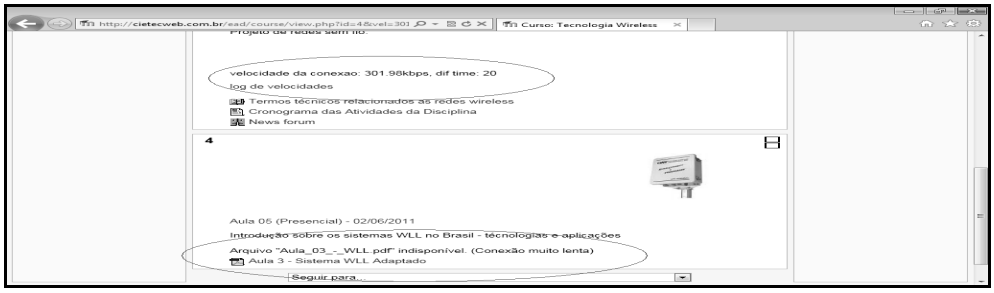


Figure 1. U-ALS Moodle with Adapted Materials

The graphic of the Speed Range, of the Figure 2 in the horizontal position, "X" axis, presents the five lanes of speed divided to present the students' range of speed who accessed the environment and the vertical axis, "Y" axis, presents the number of students that accessed the environment, making this way the connection among the number of students with the access speed. We can notice that most of the students still have connection speed considered low comparing to the available speeds, until 15 mega via broadband connection (OI, 2011).

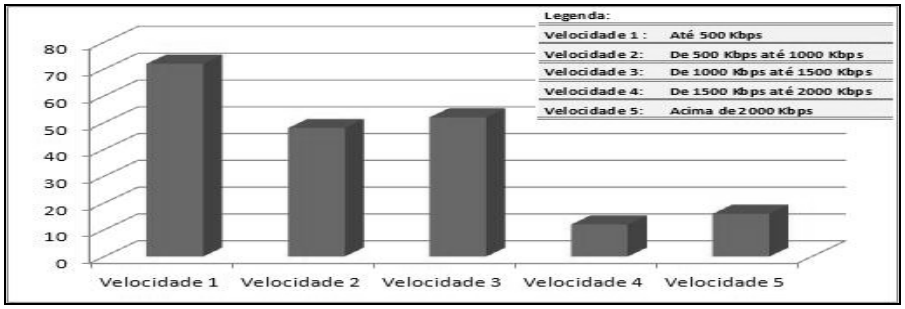


Figure 2. Graphic of Speed Range

The graphic shows the importance of the creation and availability of environments sensitive to the context in the computers net area to an improvement in the quality of the students' access to the materials. The static VLE, without identifying the student's speed variables indicate that about 70 accesses of the 200 selected accesses in the research would show problems, in other words, 36% of the students would have problems watching videos or opening heavier files. If adapted materials were not provided these students would end up without the contents or partially presented and non-stimulated to access the environment again.

The Figure 3 presents the Graphic with the number of students that accessed adapted contents in the period. The Graphic shows that the selected sample, 64% of the students that accessed the environment did not need that the materials were adapted, but 36% of the accesses presented a computing context that needed that the tools and the materials were adequate to a better AVA usage. From the 200 selected accesses, 72 of them were with connections with until 500 Kbps as we found in the Graphic of the Picture 2, of the Speed Range, with this, 36% of the students had access to the differentiated materials, showing this way the necessity of each time that the VLEs treat each student in a personalized and individual way.

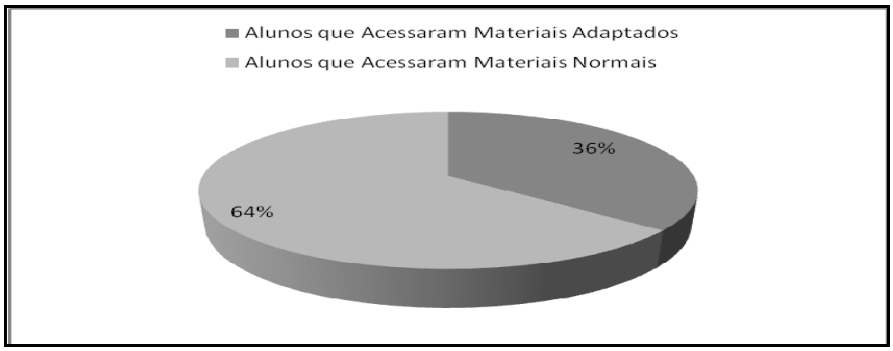


Figure 3. Graphic showing the number of students that accessed adapted materials.

One of the problems of the usage of a standard virtual environment (unique for all the students) and that is about different user's net contexts is in the fact that many limitations in the access occur, decreasing the environment usage by the students that have speed limitations. This can reflect in the resistance or even in the abandonment of using the environment, if a course in the distance modality, can also influence in the course evasion.

It is necessary that all the VLE structure help in an effective way on its usage, being necessary that alternative ways of access be available, like the use of mobile equipments and also that the environment have guarantee of availability, what in this U-ALS Moodle is granted through the created cloud.

From the finding that the same user can access the environment in more than one way, using different equipments like computers, laptops, smart-phones or tablets and from different places, the student can access from home or from school, it becomes extremely necessary the usage of technologies like Cloud Computing, because this guarantees that the environment will be always available when the student chooses to do his works. We also found that despite most of the accesses occur in the morning and in the afternoon; some students accessed the environment during the night, increasing thus the necessity that the environment be always available.

The elasticity of resources is also another advantage found from Computing Technology in Cloud, because the teachers have, thus, the possibility of creating new courses and register new students without worrying about the physical part of the structure where the VLE is installed. The facility of adding resources is another advantage found, because the teachers don't need a technical staff to maintain the system working, not having investments with the TI staff and with the infrastructure.

This new scenery shows the contributions of the U-learning environment to the course development as on the presence modality as on distance, making necessary the implementation of systems that make the access to the easy and stimulant to the student. It is necessary that all the structure of these environments be adequate to the student and work in a way that provides diversity and facility of access, that's why the necessity that the virtual environments be improved and adapted arises more and more to their users' individual characteristics.

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