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THE IMPLEMENTATION OF A CLOUD SYSTEM FOR ELECTRONICS LEARNING IN A MOROCCAN PUBLIC UNIVERSITY

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Abstract- Educational laboratories are places for realizing experimentations and they are important for modern engineering education. The problem is what if there are simply not enough devices or time for conducting experimentation in a local lab? Other factors that prevent the use of local lab devices directly by students are inaccessible or dangerous phenomena, or polluting chemical reactions. The new technologies bring additional strategies of learning and teaching, so it becomes a challenge to integrate the information and communication technologies ICT into the engineering sciences learning. Nowadays, there are two types of online labs, virtual and remote labs. Virtual labs that provide simulation environments for experimentations, remote labs are based on conducting the experimentation remotely through the Internet. In this paper, an example of a successful development and deployment of a cloud based remote lab in the field of engineering education, integrated in the Moodle platform, using very low-coast, high documented devices and free software. The remote lab is user friendly for both trainers and students.

Index terms*:* Remote lab, Cloud, Online learning, Moodle, Arduino, Engineering education, web 2.0.

I. INTRODUCTION

After having graduated, engineering sciences laureates will be face-to-face with real electronic and mechanic devices and technical equipment, to solve problems and find solutions with only what they learn in their universities. The problem is: was it enough what they learn during the studies? Or do they get in touch with real equipment? The engineering students spend the most of their time in the lecture hall following the course's content trying to understand and memorize, and in some cases with no experimental session for what they learn. To change this truth and to develop practical skills during their studies, students have to spend more time in laboratories with real technical devices than in a lecture hall listening to the professor explaining a scientific course. Being in contact with real lab devices is a necessity to learn sciences. Some factors that prevent the use of lab devices directly by students are number of students per group, inaccessible or dangerous phenomena, or polluting chemical reactions. Technologies bring new approach to education; we integrate remote labs into higher education to develop technical competences and skills for students and being able to use lab devices remotely. By combining new technologies in high education, we can not only attract and motivate students, but also offer new way to prevent dropout as encourage student to choose engineering career on the one hand [1] on the other hand the RLs are designed for universities that they cannot provide all the laboratory technical devices [2].

The paper has three logical parts, in the next chapter, an overview about the use of labs in higher engineering education, and showing a study about online tools used in education. The second part illustrate the web 2.0 experimental online E-Learning including remote laboratories, the third chapter presents the online remote lab overview. Full user evaluation and survey result Analysis are reported in fourth chapter then a conclusion. All this work will be carried out as a project of the Open Digital Space for the Mediterranean (e-Omed).

II. ENGINEERING EDUCATION AND ONLINE TOOLS

Due to the rapid development of engineering technologies, industries expect from the academic institutions that engineering students throughout their studies having the ability to perform devices and science laboratory equipments whereas conducting experiment, analyzing by themselves while testing new concepts to reach their own conclusions. Engineering education today provides very high level engineering competences, the demands for a highly skilled workforce are challenges for the teachers and training community. Teachers and trainers including Hands-on laboratories are a key element in meeting these demands. Laboratory activities are considered essential for increasing the effectiveness of teaching and learning engineering, so students can know how equipments work by themselves for their future professional world.

Hands-on labs demand time and physical presence for both students and trainers. Moreover it is necessary to upgrade the laboratory components frequently. Furthermore, most experiments are prepared for larger classes of student that demand higher financial investments. Because of some reasons, the impression of being in a real lab with real technical devices cannot be provided, so it is a challenge to make practical work available for students in higher education environment that is why remote labs are called by Aktan the “Second Best to Being There”. Furthermore, there are more good reasons to provide students with studying remotely:

1) Studying remotely from the Institution

All practical experimentations are provided locally in the institution in our case the university, remote experimentations in the online education context offer the possibility of access to real experimental devices remotely.

2) Expensive technical devices required

Usually laboratory equipments are very expensive, in some cases those equipments are used only for a part of the year, using remote labs it is possible to share the use of devices between many institutions.

3) Constraints of limited devices and lab space

Remote laboratory provides online experimentations over 24/7 through the Internet. This context offers the use of the same device by a large number of students using a booking system for students. The Booking System will additionally check if the student has allocated a time-slot that comprises the current time to use the devices. Thus, higher education institutions are lately strongly engaged to introduce new technologies and remote learning in education. They are advocating for investing more in modernizing engineering labs.

Nowadays online education has been strongly enhanced after many researches, those Researches indicate that in the next near years, the following ICT have to be applied for education: (1) online experimentation laboratories regardless virtually and remotely, beside other technologies, such as (2) Cloud computing, (3) Mobile Learning, (4) Virtual reality and simulations.

In our research, we are trying to answer this question: how to develop a Remote Lab that is going to be an efficient alternative of real laboratory experimentations. The next chapter presents a Web 2.0 experimental online E-Learning including remote laboratories.

III. WEB 2.0 EXPERIMENTAL ONLINE E-LEARNING INCLUDING REMOTE LABORATORIES

Web 2.0 is set on integrated technologies all in one. According to Forrester [3] web 2.0 is a framework which composed by different components, those components play the fundamental role to execute applications such as Flash, XML, Ajax etc. The most popular web 2.0 applications are: wikis, social networks, blogs, RSS, tags etc.

These applications help users create and share contents easier than it used to be. Web 2.0 technologies develop the vision of how the work is done. Ajax is one of the most popular Web 2.0 applications, it is the richest media technique used to develop Web 2.0 web sites; it stands for Asynchronous JavaScript and XML [4].

AJAX is a combination of Asynchronous JavaScript and XML. Ajax is a new technique for making higher, faster, and more interactive internet applications with the integration of XML, HTML, CSS, and Java Script. Ajax uses 3 elements: XHTML for content, CSS for presentation, beside with Document Object Model and JavaScript for displaying a dynamic content. Using AJAX, when a user confirms his request, JavaScript makes a request to the server, interpret the results, and modify the current screen. The user would never know that anything was even transmitted to the server. So the user can continue to use the application while the client program requests information from the server in the background.

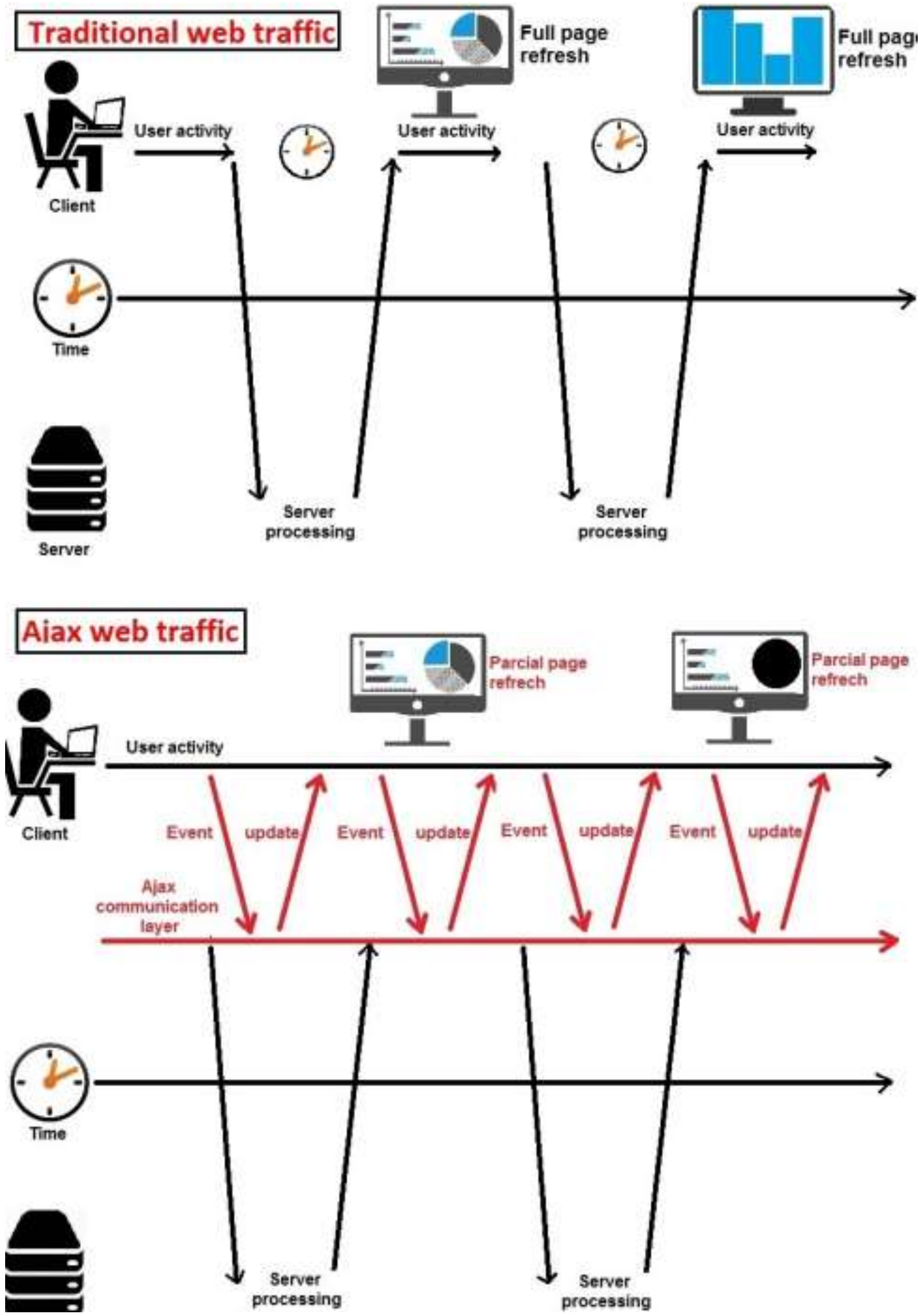

Figure 1. Traditional and Ajax web traffic

Using Web 2.0 technologies to develop a remote laboratory is a new concept. Our proposed framework comprised of 3 main elements (Figure 2):

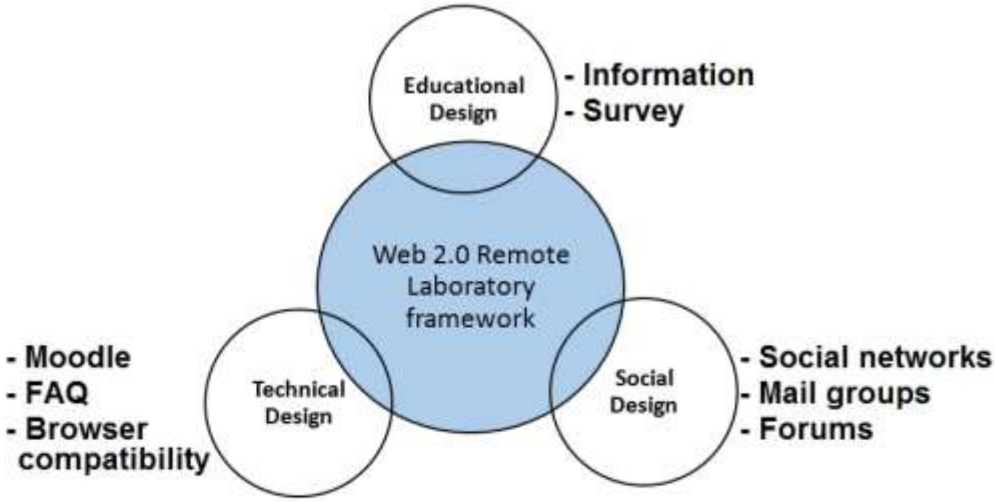

Figure 2. Remote Laboratory Pedagogical, Technical and Social Design

1) Educational or Pedagogical Design

To create a Remote Lab with education support, we should always answer to the present question: do existed Remote Labs add a worth to education terms in engineering education? To evaluate the education effectiveness of Remote Labs, a set of procedures are provided such as: (1) A general introduction for every course introducing to the learner a brief set of necessary theoretical info. (2) An open survey on the topic before and after the experimentation for concepts which need to be considered within the future. (3) Interviews with students and teachers concerning learning with and without Remote Labs.

2) Technical Design

The Remote Lab is integrated within the online Moodle platform; it's designed for each students, tutors and teachers, thus complexity level is really low, fast and simple to use. The Remote Lab is a web 2.0 based platform, thus it's accessible via a web browser, and it’s tested and worked for several web browsers and in completely different screen resolutions. Moreover, the platform design and code are well structured for easy maintenance or for adding new online experimentations and courses. Moreover, we have a tendency to expect create Frequently Asked Questions (FAQ) in Moodle to indicate the way to conduct an online experimentation technically. The project team discusses the problem huge of traffic on the website, thus we use the Moodle Organizer tool to arrange for every cluster the access to the Remote Lab platform.

3) Social Design

Learning life cycle doesn't finish after understanding the course and conducting the experimentation, conversations between learners would be encouraged to help solving issues. Moreover, knowledge management typically refers to how organizations produce, retain, and share information [5]. For this reason we tend to use Moodle forum for discussion and social network pages for sharing exercises and solutions.

It is currently clear the objective of our research; we present the full the online remote lab overview in the next chapter.

IV. THE ONLINE REMOTE LAB

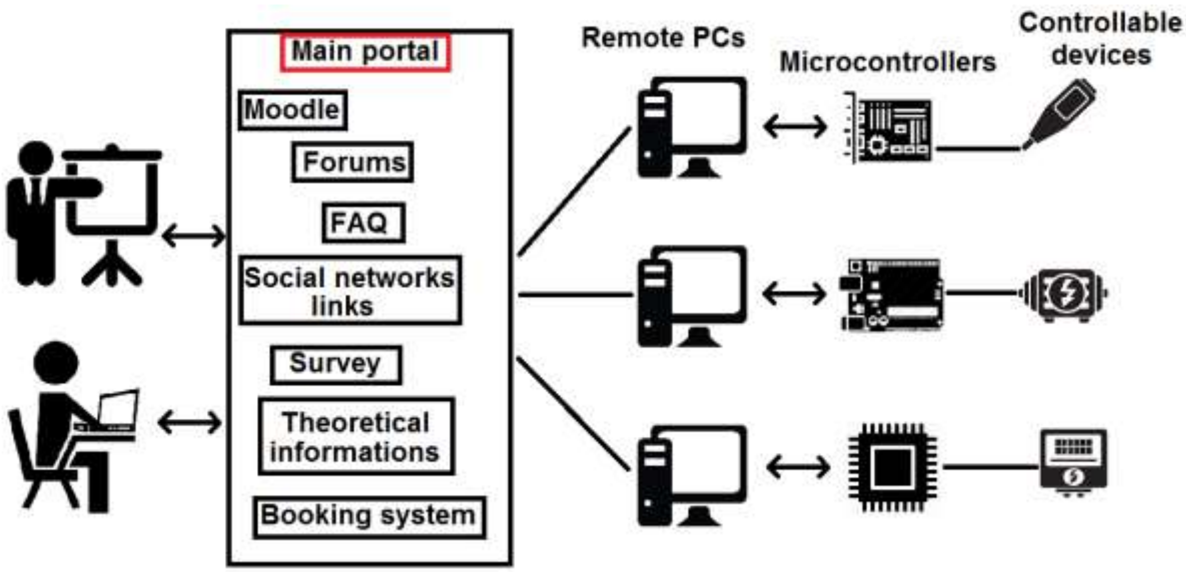

Figure 3. High-level Architecture of Our Remote lab System

Our high level architecture is shown in Figure 3. The architecture consists of a server which holds all learning resources, such as the booking system, forums, theoretical information etc. The server links to a number of remote PCs and contains a booking system so that the experimentations can be booked by teachers or students.

Our remote lab is based on an embedded system using an electronic interface and a computer program to control a device of measurement (sensor) in real time via internet [6] [7]. The communication with the physical phenomenon is done by a sensor (inductive or ultrasonic) which is a device for measuring physical or chemical variables, transforms them into signals to interpret, make a decision and start the data acquisition phase.

It is also possible to create the remote laboratory in a scalable way by creating new links to new servers and services. Figure 4 shows a cloud-based E-learning infrastructure in electronics. The development of the system was informed by a requirements survey [8].

Cloud computing technologies offers several advantages have attracted much attention and investment from industry and academy as much as the E-Learning research community. A number of researches [9], [10][11] have analyzed the benefits of the remote learning that can be gained by integrating cloud computing technologies into learning such as low cost, increased reliability, improved performance, more secured and instant software update [12][13]. Fernandez et al. [14] proposed the concept of "E-Learning in the Cloud" as Education Software-as-a-Service which attempts to exploit the values of cloud computing to education. CloudIA [15] is a framework designed for the learners to develop their own Java Servlet environment for experimentation.

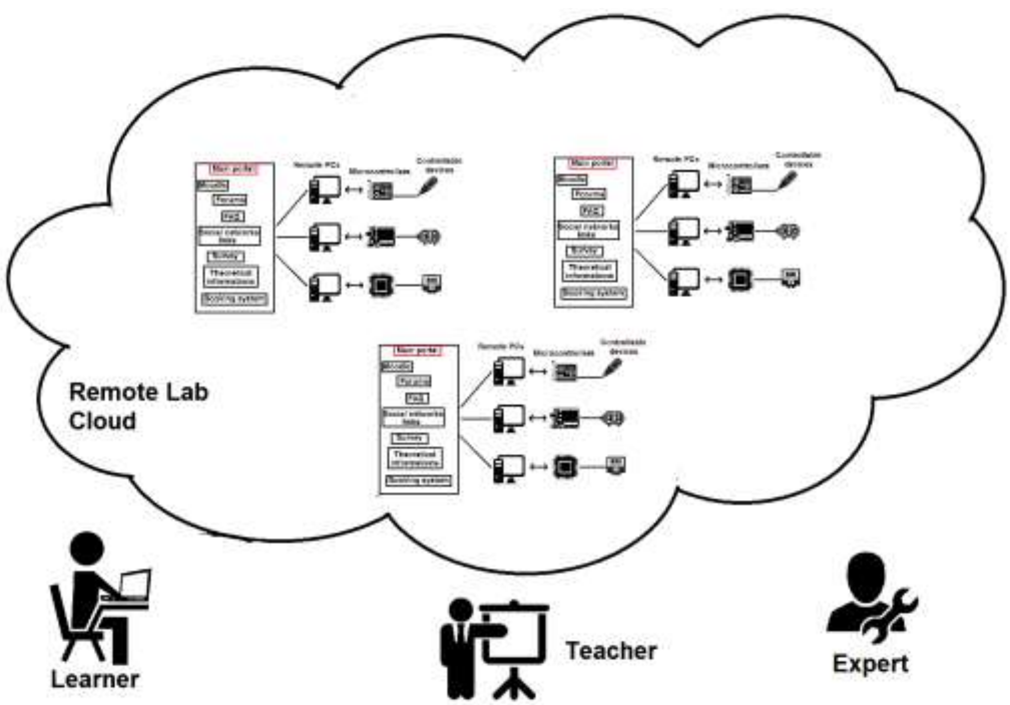

Figure 4. Cloud-based E-learning infrastructure in electronics

Cloud computing improves E-Learning processes in virtual e-universities [16] with completely different operation models and extremely interoperable ICT services to extend service reliability and reduction of price. The BlueSky [17] Architecture contains variety of cloud-based E-

Learning services to supply economical resource management by having the ability to pre-schedule and pre-allocate resources for the high-demand applications before requests.

From the previous reports, several analyses on the benefits and disadvantages of cloud computing and E-Learning frameworks have been found within the literature [18], however lack elaborated descriptions on the activity of modeling E-Learning and cloud computing. Some researchers reported the results of their implemented cloud-based E-Learning system [19], and elaborate analyses of effectiveness of E-Learning cloud computing with real case studies haven't been found. It’s very difficult at this stage to judge the advantages of cloud computing on E-Learning. Our proposed architecture is the first system and platform that uses cloud computing to create a community-based, dynamic electronics E-Learning system (Figure 4.).

1) The structured layered architecture

The following part presents the 3 layers architecture of the Remote lab, we elaborate the functional and organizational characteristics of each layer as shown in figure 5.

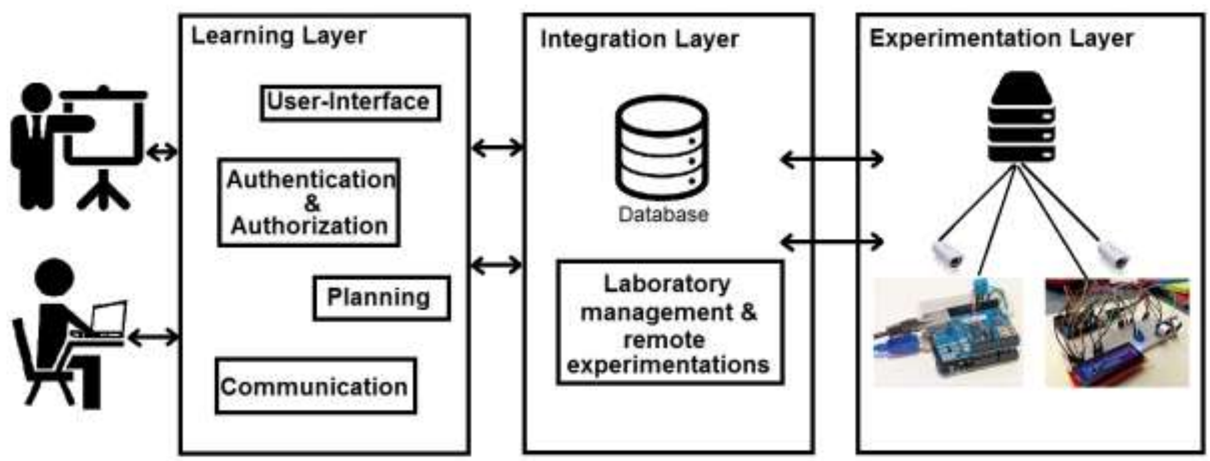

Figure 5. The three layers architecture of the remote laboratory

Our proposals offer the following benefits to the learning Layer: (1) it ignores the technical details of instrumentation devices of Remote Labs. (2) It associates an abstract view to the laboratory elements in order to exploit them in a clear way. (3) It provides a User-Interface of learning, conception, and observance online experimentation. (4) The location of the Remote Lab isn't necessary for the learning Layer.

The Experimentation layer provides an interface of distinctive and homogenized operation for any experimentation object. Thus, it homogenizes and simplifies the instrumentation tools whereas keeping the independence of the online learning environments.

The Integration layer forms the core of the architecture; as a result, it implements all the intelligence and also the complexity of laboratory management, resources and experimentations on these laboratories. This layer provides clear communication between the learning and experimentation layers.

2) Remote laboratory of Sultan Moulay Slimane University

In this part we present our web 2.0 based remote lab that provided to the use for the engineering students and teachers in the field of electronics and sensors, it was developed at the Sultan Moulay Slimane University, Polydisciplinary faculty. It aims to offer to engineering students and learners a second solution to conduct experimentation without being in a local lab. We used the learning environment Moodle as a platform to manage the teaching devices and courses as well as learners' progresses. Moodle includes user management and privileges for each user.

Only registered users can access to the remote lab platform. All registrations are free and it is possible to create an account or demand registration to Moodle administrator. Beside, Moodle learning platform contains the courses and the scenarios for all the remote experimentations.

2.1. First Access to the Sultan Moulay Slimane University Platform

First Access to the Sultan Moulay Slimane University (FAUSMS) is a web platform that we developed to help new students on the first access to the university, and it contains practical information, pre-registration, Placement text etc. it is secured to protect both data from the institutions of the university and student’s information. The registration via FAUSMS is indispensable for administrative access to the university faculties. The platform is accessible via internet from any computer or Smartphone etc. the followed table presents the number of students’ registered via FAUSMS in the polydisciplinary faculty Beni mellal in September 2016.

Table 1: Number of students pre-registered to the FAUSMS platform in 2016

	Number of students	**% of students**
Economics and Management	* 1594	* 42,5%
Life Sciences	* 872	* 23%

Physics Sciences	* 530	* 14,5%
Private Law (French section)	* 485	* 12%
Chemistry Sciences	* 129	* 3,5%
Applied Mathematics	* 81	* 2,5%
Computer Mathematics	* 67	* 2%

Table 1 shows that about 45.5% of students are future engineers and they all used the FAUSMS platform to access to the Polydisciplinary Faculty, which permits us to conclude that students are familiar with online tools. Introducing online remote labs into learning is the next step to evolve distance learning in Moroccan universities.

2.2. Remote Laboratory Architecture and Principle of Operation

Our remote Lab is composed of 2 perimeters: web perimeter and the perimeter of the institution or the local faculty network. In the local network perimeter, two web servers are established; the first contains Moodle learning platform that represents the university data centre, where all data are stored. The second contains the User Interface platform of the Remote Lab that allows students to manipulate the experimentations remotely. Moreover, we have established several practical works; each one has its own web camera, which shows the device while manipulating the experimentation. Furthermore, we use Arduino board as it is a popular, low-coast, high-documented and open source microcontroller, and connected to inexpensive sensors to measure physical or chemical variables (Figure 6.).

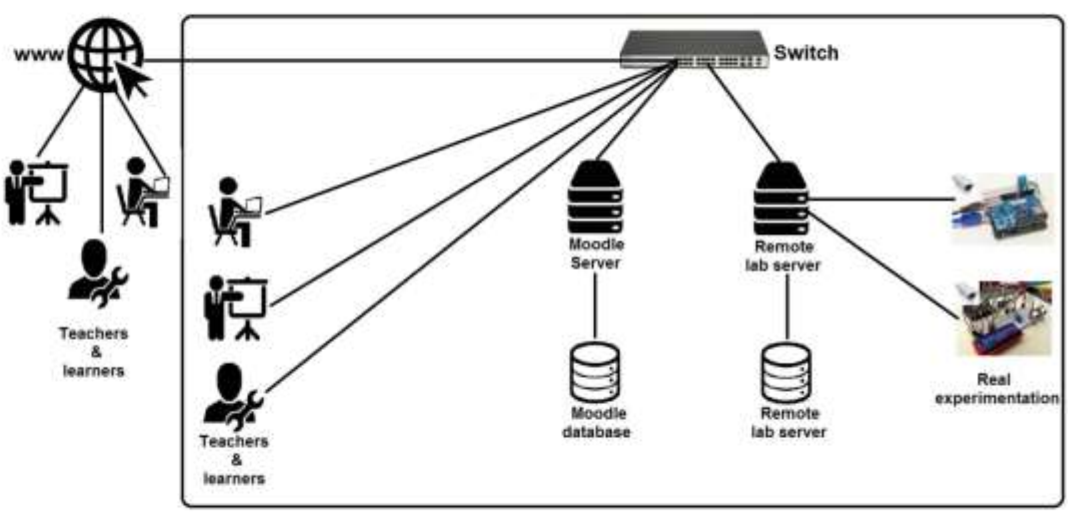

Figure 6. Remote Laboratory Architecture, Technology and Tools

The Remote lab platform consists of a database system, a scheduling and booking service (Moodle Organizer), it is integrated for the reservation of dates of remote experimentation implementation. This tool organizes access to the devices such as only one user can manipulate a remote device at the booking date and time, the scheduling service in the system can automatically allocate and lock the resources to the client who booked. The main goal of this Booking System is to control access to remote experimentations. (Figure 7.).

Figure 7. Remote laboratory booking tool (Moodle Organizer)

2.3. An example of a remote experimentation

In this section, we will review an example of a remote experimentation scenario, features and functions.

First of all and after login to the platform, a list of reservations is shown in the screen, the list contains all information necessary and a link that lead to the remote experimentation page. The remote laboratory web page provides the possibility to change input parameters, interact and analyze the result with the experimentation. The experimentation manipulating page allows the student to realize the first schema of experimentation virtually, insert various electronic components as shown in figure 8. (1). In the section (2), the web camera shows the real reactions of the real experimentation. This example shows a motor wheel robot that is moving forward and backward, calculates the distance between the motor and the distance sensor. All results are shown in section (3).

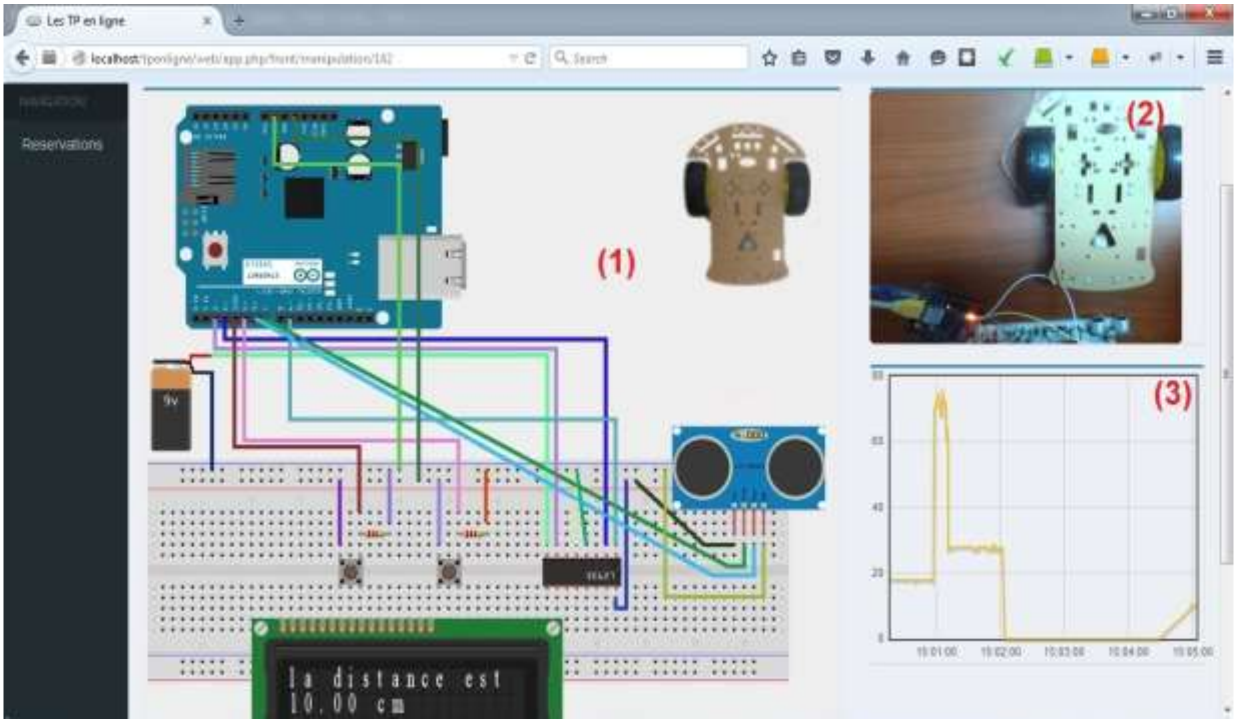

Figure 8. The remote laboratory manipulation page for practical work

One of the most important features of remote experimentation system in education is the system's ease of use [20], as it is strongly influenced the acceptance of the remote labs by learners and teachers. We choose very cheap equipments such as Arduino board, sensors and free software due to the limited financial resources of the institutions. Moreover, the platform is accessible through any web browser. All that users need is a computer connected to the internet, no need of exhaustive software installations.

V. USER EVALUATION AND SURVEY RESULT ANALYSIS

The focus of the user evaluation of our remote laboratory platform is to measure its usability and effectiveness on the teachers' or trainers' teaching styles and students' learning outcomes. Therefore, instead of measuring the system performance, a survey was carried out over 560 students from different institutions of the university to understand the effectiveness of the ICT in higher education.

To do this we have chosen the following topics (Figure 9.):

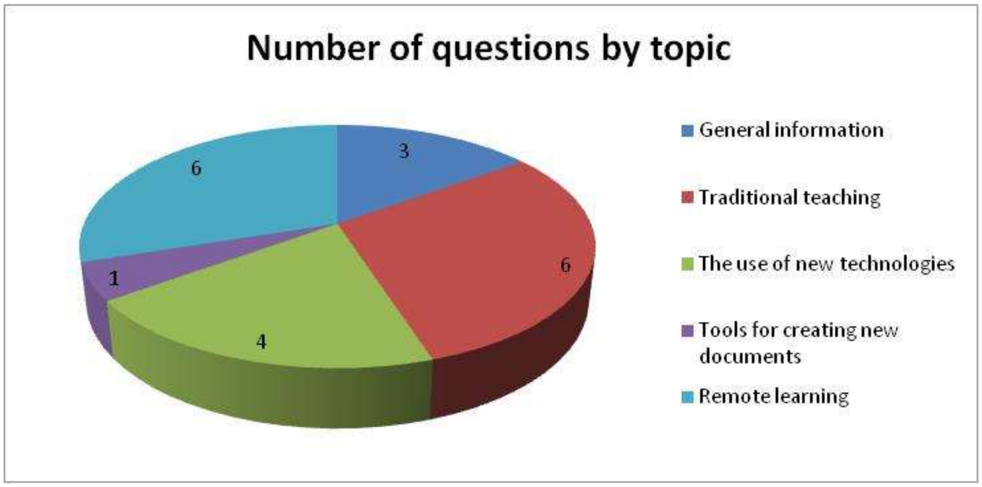

Figure 9. Number of questions by topic

1) General information

75% of the students whom passed the survey are students at the Polydisciplinary faculty; 23% are from the Sciences and Technologies Faculty then 2% from Faculty of Arts and Human Sciences, it is clear that engineering students are interested by the use of a new way of learning. Other ways about age, 66% are between 20 and 25 years old, 9% are higher than 25 years old, while 25% are under 20 years old. About gender 60% are male and 40% are female.

2) Traditional Teaching

(1)Level: 54% are the 3rd year's students, 15% are students from the 1st and the 2nd year, 16% are students of master. (2) Domain: 83% of all are engineering students while 17% are studying languages, law and geography. (3) Presence: The survey shows that 70% are always present at the courses and the directed work and they are satisfied, only 50% are always present in the local lab for manipulating the experimentation and 50% are rarely or never been in a lab. We conclude that the students whom are always in local lab for experimentation only 18% of them are very satisfied or satisfied, that is low percentage and an important detail that it must be considered (Figure 10.)

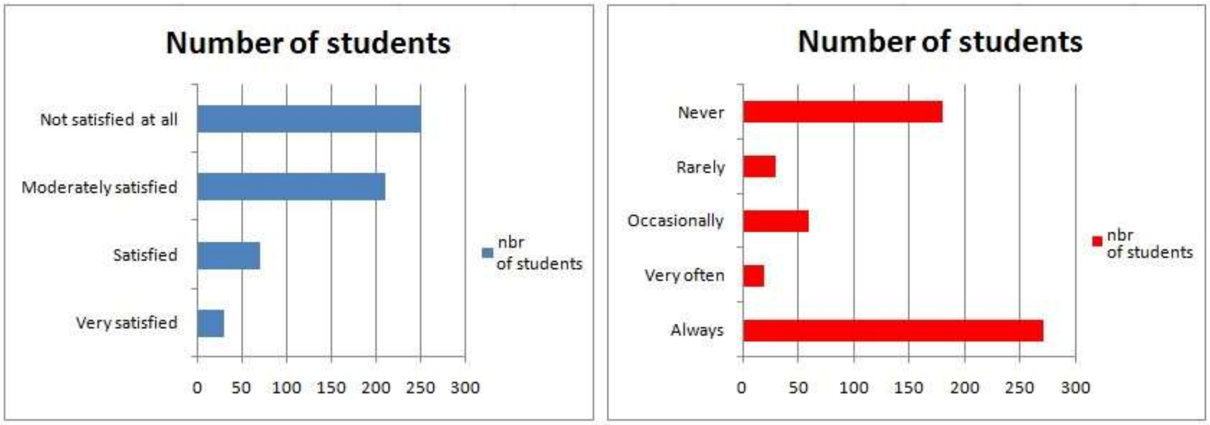

Figure 10. Local lab presence and satisfaction statistics

3) The Use of New Technologies

Our question about the use of computer level knows those numbers: 5% have a low level, 27% medium and 68% have a high and very high level using a computer. The most important that we find 82% of our students had already created a document using a computer. Furthermore, only 2% had never use email services. We state finally that 96% have their own computers. Using these statistics, ca conclude that students are familiarized with the ICT

4) Tools for Creating New Documents

As shown in Figure 11, students are familiarized with the use of office software, an important percentage of students whom use forums, animation, HTML and videoconferences

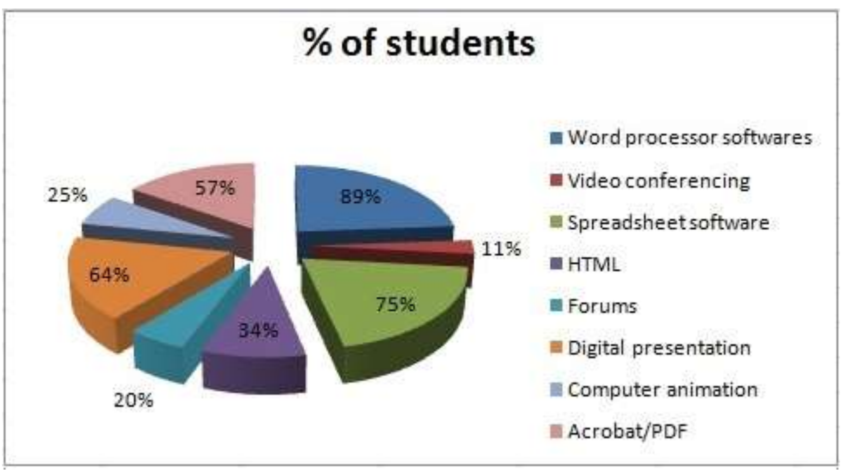

Figure 11. Tools for creating new documents statistics

5) Remote Learning

Three-quarters of students said that they spend more than 2 hours daily in front of a computer. About 34 percent use computers to prepare course, but 66% prefer using classical learning method (paper). 54% of the students communicate with their teachers using ICT. Moreover, we asked our students about having a real remote experimentation instead of being in a local lab, 77% are very interested and motivated about the idea and have this experience. We state that students are generally able for remote learning.

We can conclude that the remote lab has potential to be an effective platform for most learners and teachers, but more attention needs to be paid to the user interface and training so that users can extract the highest benefit from the platform.

VI. CONCLUSION

This project was a chance to put into practice the theoretical information acquired during the learning process. This modest work is seen as a brief introduction within the field of Remote Labs, there's still work to be done, enhancements to be developed, and it should not stop at this level. The web 2.0 based platform is user friendly that will attract and motivate students [21], as well as solving the problem of larger students classes and expensive lab equipment.

Nowadays, small number of Remote Labs has been built in research projects in Moroccan higher education. Our goal is to bring this project to the international level, wherever all the universities collaborate. The future is going to show if our Remote Lab model can achieve success higher education learning.

We can conclude from the analysis of the answers is that students aren't satisfied in conducting experimentation in a local research laboratory. However, most students are familiarized with the ICT. The survey shows that students are able and ready for the new way of learning by the Remote Lab experiences.

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