Developing a Model of WLAN APs and E-learning with Security System to Improve the Technology of Education at Public University of Mali

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Abstract The aim of this study is to develop a technology model as a contribution to the public university of Mali and also to discover the appropriateness of that new technology for the educational process. The contribution of this study is a technology of WLAN APs and Moodle e-learning model deployment remoted, secured, and managed by a RADIUS server model design which was implemented and deployed on Linux server OS. In order to meet this objective, the research and development or R & D method are used. The subjects of the research were students of bachelor study programs in Cheick Zayed Center of Mali. This technology allowed to solve the lack of Wi-Fi network and system interconnection, optimization.

Keywords: WLAN APs, security system, technology of education

1. Introduction

When getting into information and communication technologies (ICT) applications, education is the first and best opportunity to influence economic development. Although the central question is whether and under which conditions improved access to ICT can improve people's individual and collective capacities to better achieve the lifestyle, they are worth [1]. Otherwise, Milkova [2] claimed that the boom of technologies had not spared any country so far or as poor as it is. The understanding of this phenomenon is very promising for the development of several sectors, especially for educational sector. However, ICT must be placed at the service of education to adapt this sector to the change of the world because the integration of ICT as tools offer great potential for education, such as develop skills and foster learning, especially if they are well adapted. In short, Investment in ICTs is an investment in human capital development [3].

The present study concerns the integration of ICT as educational technology in the context of Mali, especially its public university in which ICT integration is inefficiency [4,5]. One of the reasons is the lack/weak of technologies transferring, especially in the educational sector, because of economic and socio-cultural constraints [4].

There are some deficits at the University such as the lack of optimized system, the lack of internet connection in the university areas, and the lack of professional email addresses for students and lecturers. The first Wireless Local Area Network (WLAN) or Wi-Fi deployed by the Government was no longer working [5]. Despite these deficits, there is still a using application online that tracks enrollment in the University which is linked to a website (www.campusmali.ml) which is currently used. That website represents: (1) the showcase of the university because by utilizing it, it is possible to consult all Higher Education and their training and diplomas, (2) and also the only way of pre-registration in the university [5].

After analyzing the data found, the researcher found that it is important to solve the problem of network and also the lack of learning management system in the system which conducted to the following proposed solution. Meanwhile, the study developed a WLAN APs model design and a security management system too, and set-up a model design of E-learning to equip the university with modern technological tools to improve the existing technology.

The research questions leading to the understanding are (1) how to develop the proposed technology? and (2) how this development (or technology) could be appropriate for the educational process at the University of Mali?

2. Literature Review

The learning community in 1998 described E-learning in two ways: (1) the application of Information and

Communication Technologies (ICT) to key institutional functions such as administration, materials development and distribution, course delivery and services such as counseling, prior learning assessment and program planning; and (2) as an organization created through alliances and partnerships to facilitate teaching and learning without itself becoming a direct educational provider [6,7].

Mons, (2006) [8] described the Geo-Information Science and Observation of Earth (ITC) program to provide geo-location services (LBS) to UT campus. The LBS system runs on the existing wireless campus system which provides Wi-Fi Internet access to all one hundred and forty hectares of the university. This study was done to know as a testbed for research and infrastructure activities to develop cases of practical use. The first includes research on wireless LAN positioning techniques, contextual knowledge of ubiquitous data management systems, and data dissemination for LBS and mobile applications. Therefore, their study confirms that it is essential to implement Wi-Fi access points in all the university buildings and students boarding schools.

Wireless networks or Wi-Fi offer manageability, mobility, etc. With its various opportunities, the security risks are increasing. It shows the indispensability of always supporting networks, especially Wi-Fi, with appropriate security measures. The aim is to know what extent this technology will provide a protected environment in terms of confidentiality [9].

Zheng [10] conducted a study about the importance of the security solution for the students' information administration system and proposed to create a security protection mechanism from the classroom network, the class system, and a classroom application. They claimed that the security solution could prevent illegal users from invading the system, ensuring servers security and data privacy, backing up, and restoring the database.

Barbhuiya [11] organized a study titled "Detection of neighbor discovery protocol-based attacks in IPv6 network" explained that the security requirements in colleges education administrative system were firstly analyzed in its current environment before proposing a security defense measure and the corresponding security scheme from the point of view of the external environment and the internal database, in order to meet the current requirements. What required different types of research such as network and database security are applied, and the corresponding systems are designed to effectively eliminate security breaches in these systems and to ensure the security and stability of the system.

According to Thüs [12], nowadays, with the technological advances in various fields such as telecommunications or education, are affected and are no longer limited to the classroom. Thus, M-learning occurs as a learning method that uses mobile learning. M-learning is a type of learning that uses mobile devices such as digital cell phones, tablets, and laptops.

The system uses Wi-Fi networks and offers many services to improve the educational process and makes M-learning a complete system. Cavus & Al-Momani [13] clearly evoked the indispensability of technology integration in the process of improvement and management of education through Wi-Fi networks. Cavus & Al-Momani [13], again, mentioned that wireless networks cover large

areas and make the service accessible to the users. It is known that teachers, students and educational organizations such as universities, vocational schools, institutes or anyone looking for E-learning adapted to their needs do much research.

Pal [14] conducted a study of mobile learning or M-Learning in University Campus Scenario - Design and Implementation Issues in which they evoked that the rapid development of mobile communication technologies is leading a new M-learning. The demand for personalized learning via mobile devices creates a new paradigm in education system. The advantages and characteristics of mobile learning extend its applicability to distance learning and additional support for classroom-based learning. The document in which the authors presented a conceptual model for the implementation of m-learning the university discussed the need, challenges, and opportunities to use m-learning in the university as a support for conventional learning.

Afandi [6] provided a theoretical explanation for the adoption of Distance Education and described innovation as an idea, practice or new object for an individual. Potential users are influenced by an innovation based on five perceived attributes: (1) Relative advantage - considered in terms of time, cost, efficiency, convenience, quality or results, social prestige, and compared to what innovation replaces, (2) compatibility - which refers to the alignment with past values, practices, needs, past experiences and social norms, (3) complexity - which refers to perceptions which innovation is perceived as difficult to understand, learn and use, (4) trialability - which concerns the possibility of experimenting and reducing uncertainty and learning by doing before adopting, and (5) observability - which refers to the visibility of the results of adoption, which stimulates discussion, interest, and participation.

3. Research Method

3.1. Conceptual Framework

The framework designing of this study is to: (1) implement a model of wireless Access Points which covers all the campus area and could be interconnected to another campus (if need be) to allow students and lecturers for accessing to internet; (2) implement a security system to prevent any abusive access which could damage the data of the university, i.e. those students, teachers, and administration; (3) implement an E-learning system as a model of LMS for the University which is secured by the implemented security system. In short, WLAN APs and E-learning model are implemented under the remoting of the deployed security system.

Figure 1 describes the process by which the user can access to the wireless access points in order to the E-learning system at the public university of Mali. Every user should, first, login his/her username and password to access the WLAN APs connectivity, and second, login his/her E-learning account to access to the e-class. The lecturer can directly access his/her class but student should input his/her enrolment key, provided by lecturer, to access to the e-class.
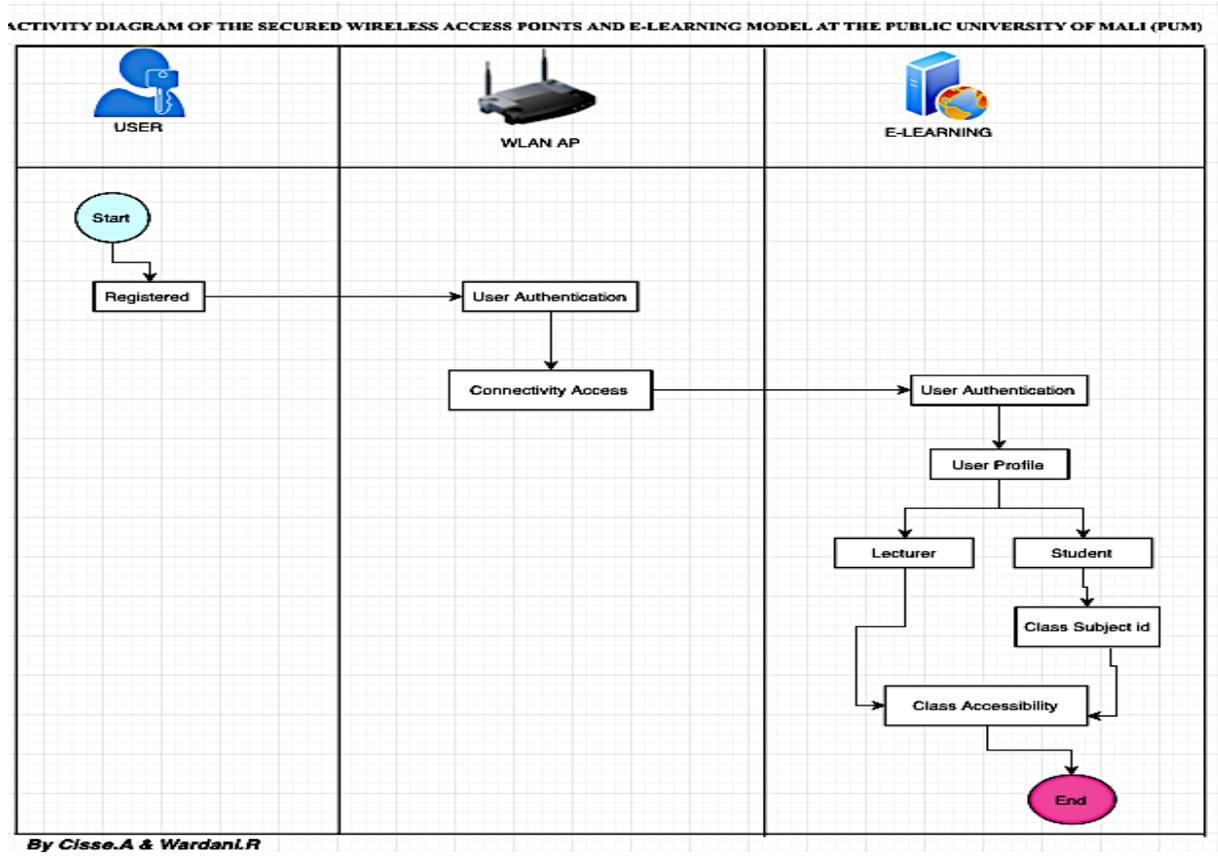
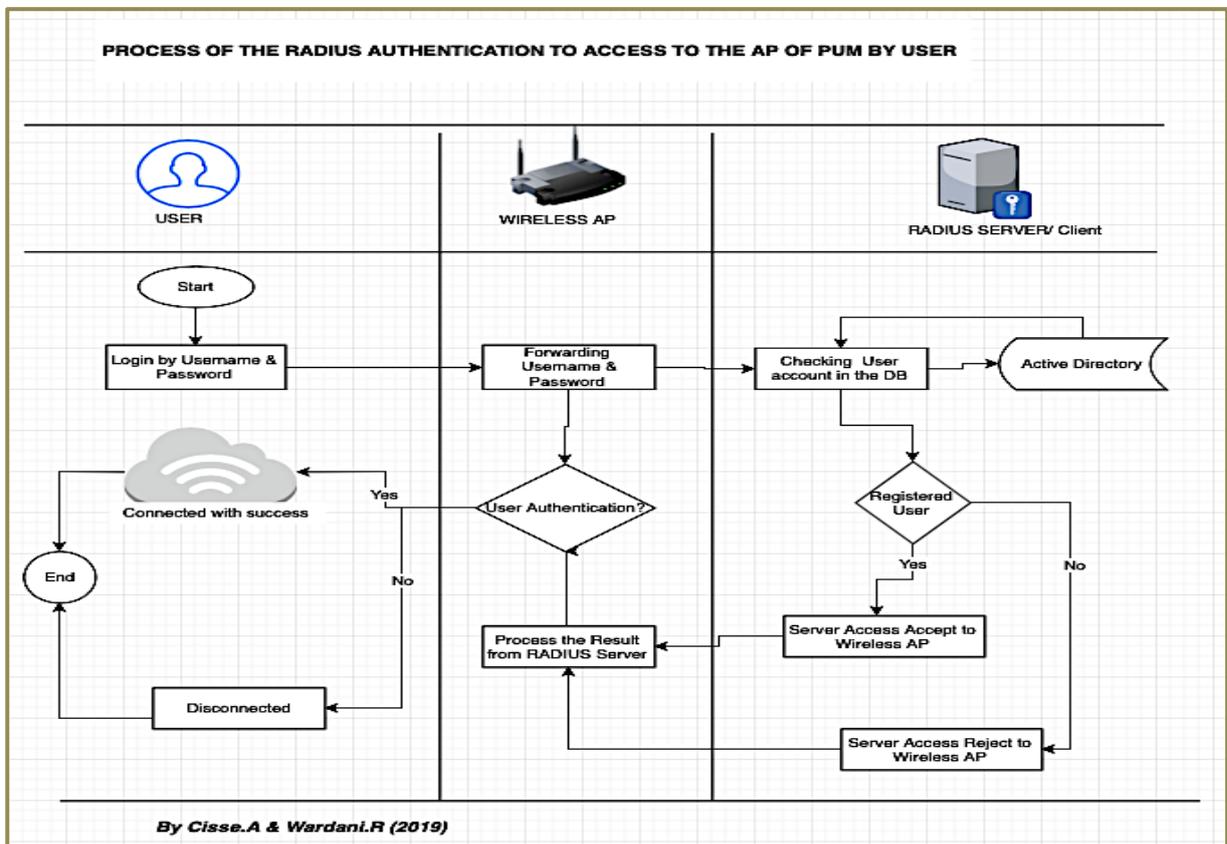Developed by Cisse.A and Wardani.R

Figure 1. Conceptual Framework

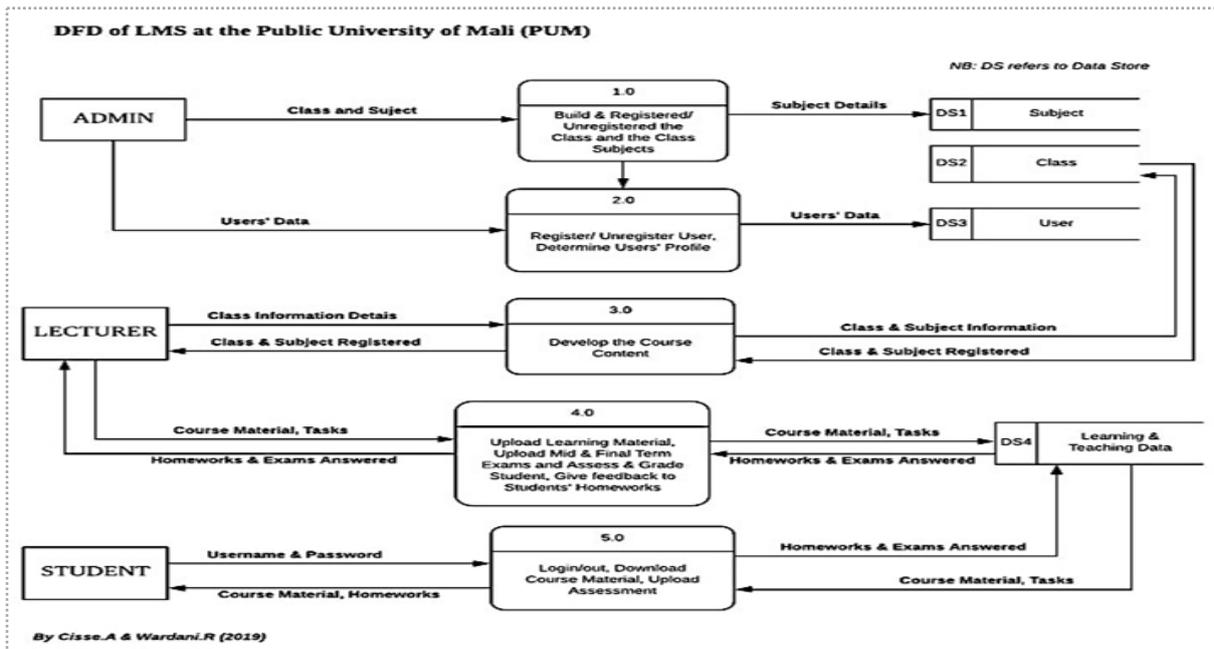**Figure 2.A.** Activity Diagram of the RADIUS-Server/Client and Users

Figure 2.B. DFD of the LMS at the Public University of Mali

3.2. The Model of Development

To develop that model, we used Linux Server as OS in which we configured: (1) VirtualBox to implement the Radius Server as security and management model and to set-up the Moodle with its database as the E-learning model; and (2) WinBox to setting-up the access points routers with Radius client for the WLAN APs implementation. Thus, every user should be created and authenticated by the RADIUS server before he/she can log in to the system which provides the privilege of each user.

Figure 2.A.: The creation of users' accounts, the determination of users' profiles, the bandwidth management, the remoting, and the security of all the systems are possible through the RADIUS-Server/Client. On the other hand, the wireless access points users should log in the username and password, which are forwarded by the APs system to the RADIUS server for checking. If the information given by user is correct, he/she could access the network. Otherwise, he/she will be rejected by the system.

LMS consists of student, lecturer, admin and the data stores (DS). The DS constituted of web server, database server, LMS servers. The DFD of the LMS is described as Figure 2.B.

a. Administrator (Admin): the admin builds, registers/unregisters the class and the class subjects, registers/ unregisters the users, determines the users' profile.
b. Lecturer: The lecturer develops the course content, uploads the course materials such as books, articles, videos, develops homework and the exams assessments, and then grades the students. He organizes forum discussions with students to allow them to ask questions over the classroom.
c. Student: Students can access the e-learning platform by login and logout, download the course material provided by the lecturer, upload the assessments and participate in the forum of discussion organized by the lecturer to allow both student and lecturer to

interact together. It helps the student to fill his gaps to get back to level.
d. The data store constituted of servers which include: the webserver which dispenses web pages as it is requested, the database server to provide database services to other computer programs, the RADIUS server through with users' accounts are created, managed remoted and secured in the e-learning system and LMS server which provides study programs, documents, information, and other services to the students.

3.3. Procedures of the Development

The researcher used a theory called ADDIE (Analysis, Design, Development, Implementation, and Evaluation). After analyzing the research background, the researcher designed the model of development. The researcher started to develop the model design implemented to become the product of the research. The participants filled questionnaire which represents the instrument through which data is collected and analyzed for evaluating of the developed product.

3.4. Try-out Design of the Product

3.4.1. Design of the Try-out

For the test, the E-learning system and the Radius are hosted in Google Cloud Platform, in order to be accessed by the participants from anywhere, as shown below Figure 3.

The implemented product (E-learning and Radius-server) hosted in rented VPS called Google Cloud Platform.

Through the hosting of the E-learning system, it can be accessed by users everywhere. The fact the Radius-server is hosted in the cloud allows the admin to remote the user's accounts everywhere he/she can get internet access. Then, users can access to the WLAN AP of the university and the E-learning system through their accounts delivered by the admin.
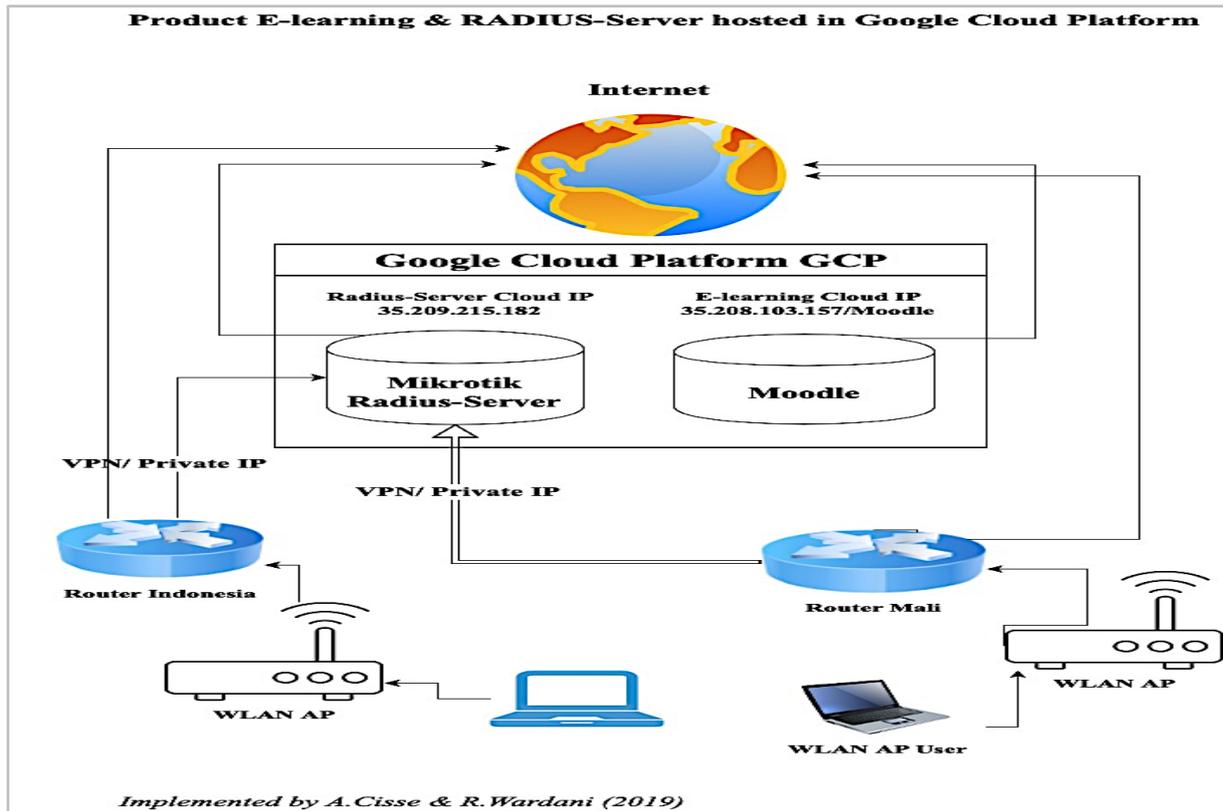
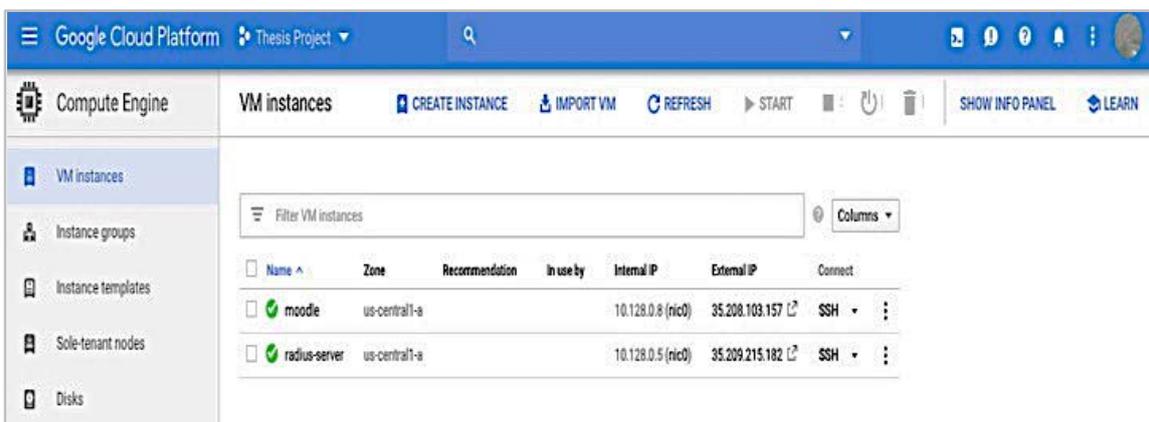**Figure 3.A.** Architecture Design of the Product in GCP

Figure 3.B. Moodle and Radius-Server hosted in GCP

3.4.2. The subject of the Try-out

Students of bachelor study programs were the subjects of the research in Cheick Zayed Center of Mali. They are enrolled in different study programs at the University. They are in the first year of study and all of them have a computer for attending the try-out.

3.4.3. Technique and Instrument of the Data Collection

For the research instrument, the researcher used an online questionnaire (Google Forms) for the data collection. A Google form questionnaire was sent to the students in Mali for data collection purposes.

The researcher used Research and Development (R&D) method because this research aims to implement a new additional technology to reinforce the existing one.

4. Result and Discussion

4.1. E-Learning

Figure 4.A. shows the user interface of the E-learning system implemented using Moodle in which we developed some course categories.

In Figure 4.B., the user can access the e-learning system by login his/her username and password.

Through the implemented E-learning system,

- The students, lecturers, admin, and academic staff can access to the LMS through secured Wi-Fi.
- The students can access the e-learning platform.
- The lecturer can set and edit the courses.
- The lecturer can set up the resources in e-learning.
- The lecturer can upload assessment and make an assessment in e-learning.

- The lecturer gives quiz in e-learning.

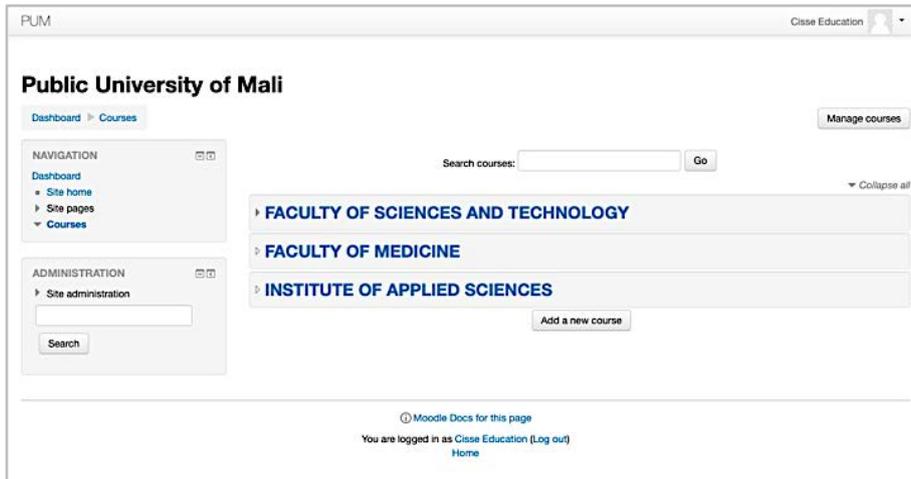- Lecturers and Students can interact in the forum.

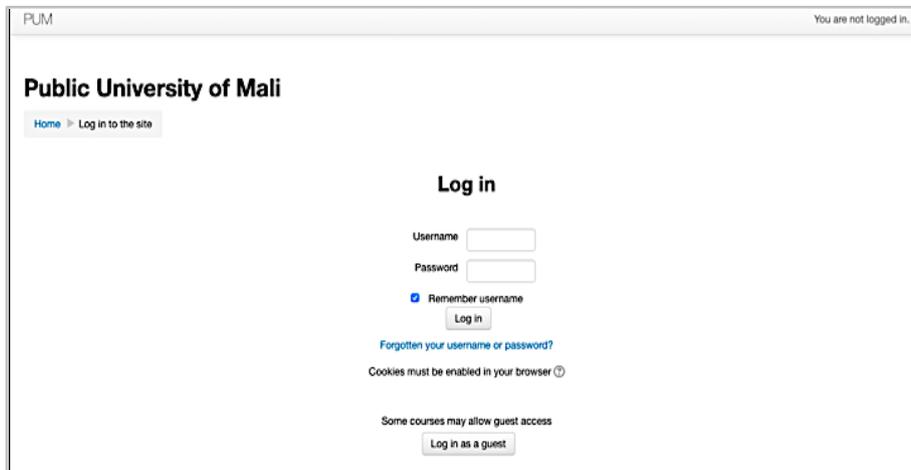**Figure 4.A.** E-learning user interface with courses categories

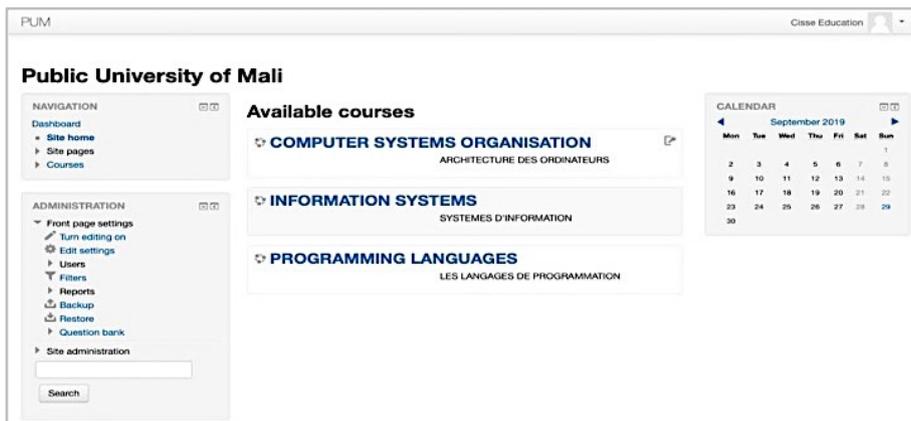**Figure 4.B.** E-learning user interface before login

Figure 4.C. E-learning User interface with some Courses

4.2. Security System

Both the E-learning and the WLAN APs users' accounts are managed (create, register/unregister, delete) by the RADIUS-Server. Without that, the user cannot access to WLAN APs. According to the existing resources in terms of bandwidth, we group users in three categories as High-level-user, medium-user, and small-user to manage as well as the bandwidth. Every user has his/her personal account.

The user profile can be accessed only by the admin who is allowed to create and manage users' accounts. This admin can be different from the E-learning system's admin who is also the WLAN APs admin. He can remote the system through the RADIUS system included in both the E-learning and the WLAN APs.
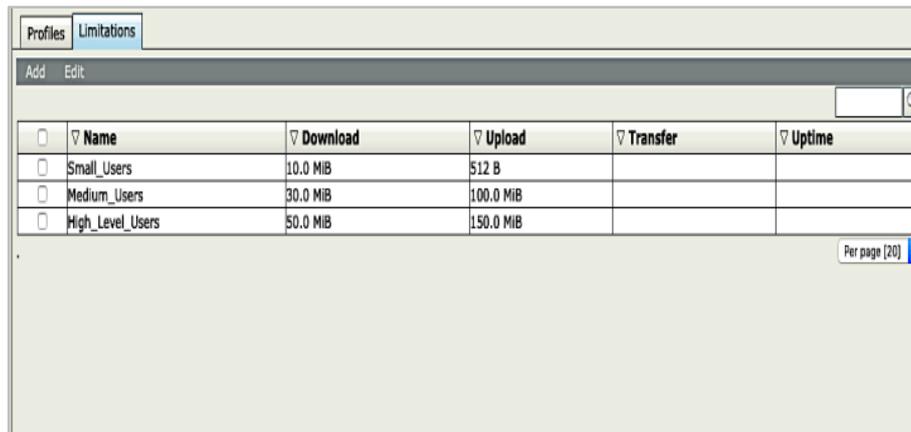
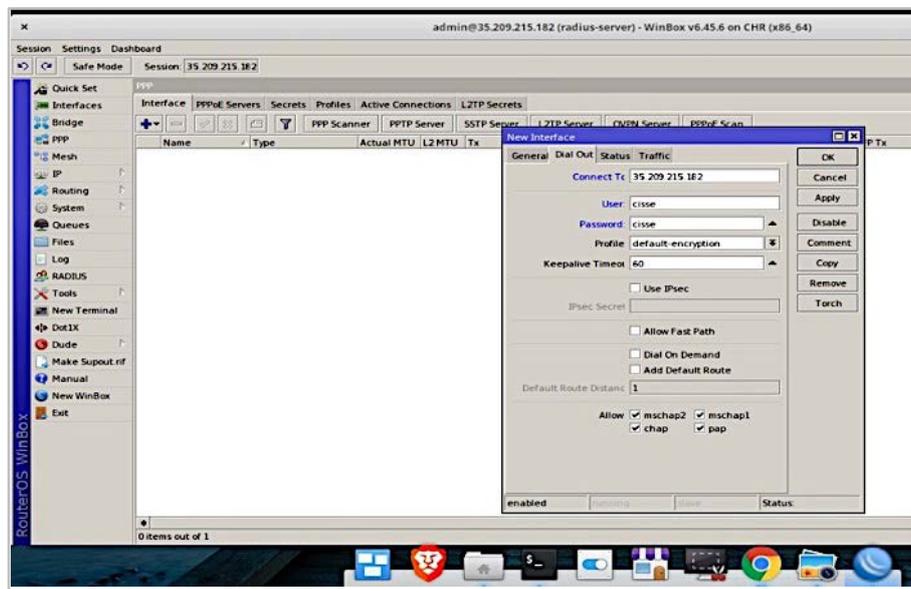**Figure 5.** Userman (Radius) interface (User Profile interface)

Figure 6. Interface to setting up the VPN/ the local routers in the Cloud

4.3. WLAN APs

In Figure 6, it can be seen the hosted external IP address 35.209.215.182 set-up in the local router in order to configure the VPN in the Cloud we used, GCP, in our case.

For the development of this technology, Ubuntu 14.04 is used as OS of the server; Moodle 3.0 is implemented for the E-learning; PHP5 is used to develop the module of the website; for the database, MySQL is used; and Apache for the web-server. Microtic User Management was tentatively deployed for a trial of the Radius Server but FreeRADIUS is recommended. Because of some constraints such as economic [4], the developed E-learning system and the Radius server, it was hosted in rented cloud computing servers or VPS.

The needed access points devices number depends on the geographical extent and the number of users. For example, there is some kind of access points that have capacity to contain one hundred users per device. Meanwhile, for a faculty of one thousand users, it suffices to just install ten kinds of access points that can support a hundred users. Only one access point device is used to remote, manage and control all of the whole systems then each of AP devices contains its own client RADIUS

system. Otherwise, the users' management database which could be downloaded from the manufacturer's website was deployed on the AP used for remoting the others. The other AP devices extent the first one used for remoting the others. If the University managers would extend the area by building other building, they need just to add other AP devices which could be configured by the administrators of the system. Therefore, it is very useful, flexible and high-tech.

Referring to the previous researches, none of them has been interested, at the same time, in the study of wireless points, in the study of online learning and the system security system, networks or information systems and online learning data. Moreover, this study included together with three technologies which are WLAN APs model, Radius server/client security model, E-learning model. However, this study may provide a new contribution to the technology of education, especially in Mali.

This new technology has a positive impact on the social environment because the students have new habits, attitude which they really appreciated. Theoretically, there are several documents about the integration of APs technologies or e-learning systems in education, but the integration of APs model with Security Design and E-

learning together is a new concept. Therefore, this study is a big contribution to the educational sector, especially for Public University of Mali. These technology tools facilitated the learning management and also the system management for the leaders in charge.

5. Conclusion

Through this study, students, researchers, lecturers are a communication World modern. They could access to thousands of documents, books, articles, and they could interact every time, everywhere they go between themselves and with others. Lecturers teach online, share material on their virtual class, score their students through the new system. All the educational systems, including the ministry in charge of higher education are interconnected. For the future research, we must be interested in the lack of professional email addresses and the absence of security system like camera CCTV to secure the installed infrastructures like the students' dormitories. The researcher recommended to the university managers, especially the computer system administrators to follow the systems' updating because it is one of the strengths/weaknesses of the security. If there is a security failure, all the systems could be affected, and its solving could be very costly and difficult.

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