A Novel e-Learning Model Management System Based on Business Intelligence Tools and WSN Technology

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Abstract: Nowadays, Learning Management Systems are considered as the best solution for different institutions to provide efficient and flexible learning processes. Furthermore, the use of e-learning model as an alternative training support in academic and professional didactics, allows different institutions (enterprise, universities, schools…) to reduce learning investments cost and improve performances and users flexibility. However, these e-learning platforms have shown plenty of limitations, especially in terms of efficient learners tracking and monitoring, which affect the progression of e-learning use. Consequently, we aim in this paper to propose a novel approach of e-learning architecture, which mergers both Learning Management Systems (LMS) and Learning Management Environment (LME), by the integration of an Intelligent Sensing System (ISS), into a global e-learning system. The aim of our proposed model is to perform high efficiency e-learning system progressing current LMS and completing traditional academic and professional training.

Keywords: Business Intelligence (BI), e-learning, Learning Management Environment (LME), Learning Management System (LMS), Psychological Environment, Wireless Sensor Networks (WSN).

Introduction

The new student generation is increasingly interested in the use of information and communication technologies, especially in the learning area. E-learning presents the best solution to meet the needs and constraints of learners in terms of flexibility, autonomy, offering a variety of features for collaboration and communication. Furthermore, e-learning platforms allow to different institutions to reduce the learning investment cost and overcome a lot of logistics issues, such as preparing and providing suitable classrooms or conference rooms and necessary learning and training equipments.

Despite of all offered functionalities that facilitate learning, those systems show some limits when it comes to learners behavior monitoring. Furthermore, we believe that the success of any learning process is highly dependent on the degree of continuous monitoring and on high visibility of learner's activities [1], in order to evaluate them and to predict the possible actions to enhance learning performance using the different available tools. In addition, it is proved [2, 3, 4] that the human cognitive and tasking performance is depending on the learning environment. A messy and teddy work/learning environment affects on the motivation, the concentration (conscientiousness criteria) and the performance [5].

Consequently, to address this problematic, we proposed in our model the use of an Intelligent Sensing System (ISS) able to combine both of e-learning and learning environment system, LMS and LME, which are inherently complementary. Our ISS architecture is based on a WSN technology and BI tools. WSN enables to collect more representative data about the learning environment (presence and noise criteria), and BI tools allow to gather data from LMS and LME about learners behavior, and convert it in a suitable format (graphs and statistics) for learners profiles analysis. Thus, we aim to create a virtual learning system simulates the classical learning process and overcomes its limits. The challenges we are facing are, on one hand, to project and model the classical leaning practices such as the assiduity, the interactivity, and recreation/break. On the other hand, we have to provide a suitable environment able to enhance the motivation and to increase the cognitive performance.

In the first section of this paper, we give an overview of the different e-learning use and we introduce our new e-learning model. The second section describes the advantages and limits of e-learning tools. Then we discuss, in the third section, its integration within different institutions (i.e. enterprises, universities) to the leaning process. The fourth section will be dedicated to describe the suggested novel e-learning model, and to introduce the architecture of our proposed system, seen as an Intelligent Sensing System, subject of the fifth section, where we discuss the different technologies contributing on the implementation of this system that are WSN technology and BI tools. Finally, in the sixth section we conclude with a summary of the undertaken work and the contributions of our proposed system.

II.   E-Learning Tools Advantages And Limits

The new generation of learners shows a great commitment to the use of Information and Communication Technology (ICT) in different aspects of their lives [6], especially in their learning. E-learning platforms such as Moodle [7], Sakai [8], and Dokeos [9], come to meet the need of a solution adapted to the various constraints of the learner, allowing him to learn alone, on his own pace, and to overcome his different knowledge weaknesses by giving him self-confidence.

Thus, e-learning tools offer a rich work environment and panoply of features:

- Flexibility; learning tools allows an easy and location free access, what can be considered as an important advantage. (there are some systems more severe concerning this point depending on the learning context)

- Self-learning, and autonomy in the learning process and in research of information

- Communication and Collaboration tools (sharing of ideas and knowledge).

- E-learning platforms are intended for a public of users with different levels of knowledge and varied skills.

- Therefore, we have to present content relevant to their needs and constraints (time, place ...).

However, this means that the learner in such an environment requires more monitoring and evaluation of his performance and behavior. This will surely lead us to the need to classify and compare these learners by evaluation criteria that need to be identified. This can be applied by several variables, including:

- Notion of Attendance on an LMS platform (frequency and dates of connection)

- Level of interactivity / Raise hands

- Number of assignments / exercises conducted

- Respect of Submission deadlines of assignments / exercises

III.   Integration Of E Learning Tools Within Different Institutions' Learning Process

LMS are one of the tools that provide a new vision about learning and help different institutions to overcome several weaknesses of the classical learning system such as distance and availability. In this section, we discuss the benefits of using e-learning platforms in two different systems: for enterprises and academic use.

A. Professional use

Open source e-learning tools are increasingly being used in enterprises educational curricula, for different purposes (Learning, Trainings, Certifications….), instead of using the classical tools of training. This choice is based on the great need to reduce the learning investments cost as well as the optimization of energy.

Taking the example of different scenarios a company can follow to accomplish their learning process:

1)   Scenario 1: A company aims to organize certification sessions for their employees within the company. In this case they should bring them professional trainers, prepare the necessary training spaces (offices, conference rooms…).
2)   Scenario 2: A company aims to organize Certification sessions for their employees. For this reason they will send them to a foreign training institution specialized in employees training and certification.
Both of the first and the second scenario represent the classical learning process within organizations and enterprises. This system leads to a serious loss of money and energy.

Consequently, we can see clearly that the integration of a new system more flexible and adapted to the company and employee needs and constraints is needed.

This area of application is more critical and exposes more constraints that affect the evaluating criteria. For instance, the flexibility brought by the e-learning that refers to the concept of any-time/any-where [10], is not valid for all systems. There are many enterprises that would not allow their employees to leave the company or their office during training days. In this case, we give more importance to the criteria Attendance, in the opposite of some e-learning systems (i.e. educational systems), where they can give the importance to the Level of interactivity Criteria for example.

Although integrating open source e-learning platforms in enterprises will certainly resolve a lot of learning and training issues, they will be always the need to improve the learning process performance. This goal cannot be achieved without following a clear evaluation model or establishing control measures and monitoring strategy to analyze learners' behavior through this system.

B. Academic use

Nowadays, e-learning platforms are widely used by universities and other research-based and educational institutions, to offer their educational material benefiting from their advantages such as work "any-time, anywhere", collaborative tools, support different styles and profiles of learning, and respect the learner' specific constraints.

If you are a working student, a foreign student, a student suffering from an illness, handicap or disabilities impeding his mobility, a house wife wishing to continue her study in parallel with taking care of her family, a student looking for a collaboration program between his university and other institutions or foreign universities, undergraduate students wishing to be certified on one of the fields he study, then e-learning programs present the best solution for you to complete your study and ameliorate your skills. No matter what your profile is, we share all the right to an education and learning system with an optimal and suitable leaning environment adapted to our needs.

In addition, the use of e-learning programs can contribute on the resolution of several problems. In fact, recently Moroccan universities and schools, and a lot of others over the world, are suffering from overloaded lecture halls and classrooms due to the increase in the number of students. Such environment does not provide the proper learning conditions. To enhance the learning performance and resolve this problem, e-learning can help those institutions to provide parallel virtual classes able to reduce this pressure on universities to provide appropriate human and material resources responding to those critical constraints. Furthermore, likely to the enterprise use of e-learning platforms, universities can use it to train their staff. Consequently, e-learning helps to reduce learning and training costs for the academic use as well as in the enterprise use.

IV. Proposed E-Learning Model

We are proposing a new system that allows overcoming different problems that institutions encounter with e-learning tools. As a result, our suggested system, integrate the ISS model which, combines WSN technology and BI, in addition to the adopted e-learning platform. Therefore, we aim to make the virtual learning process more realistic and close to the classical learning.

To achieve a successful projection of the traditional learning and training process, we have to build an intelligent system able to provide a continuous supervision of learners' behavior, and monitoring of learners behavior and activities.

Consequently, we have to focus on the learning environment conditions and their effects on the learning and tasking performance. Thus, we analyze the effects of different types and levels of sounds we can find in a working/learning environment, i.e. speech, phones ringtones, people walking, music, etc… The evaluation can be conducted according to multiple criteria, such as "loudness of sound", and "sound pressure level" [11].

Plenty of works have been performed in the literature in order to satisfy mentioned problems in working environments and overcome their weakness [10]. The Environmental Psychology based researches proved the following findings [3, 4]:

- Intermittent noise is more disruptive than a continuous schedule (consistent with the observations of Broadbent 1978, Poulton 1979, and Loeb 1986).

- Acute and continuous noise adversely affects vigilance and comprehension.

- For resource-demanding cognitive tasks, speech noise affects more strongly the performance.

- Accuracy should be more susceptible than speed to noise effects has been confirmed (According to Poulton's 1981).

- Music results are equivocal. Music may facilitate performance involving high levels of concentration and attention. Conversely, music has also been shown to be as distracting as noise during comprehension tasks.

- Fast music tempo increases the speed at which one completes a specific task. However, a fast music tempo also increases the number of mistakes during that task.

- Music is distracting towards peripheral stimuli during frustrating. Thus, music can reduce stress and mild aggression. However, the distracting nature may impede simple vigilance performance during these situations.

- A moderate level of music is optimal for activities requiring careful attention and concentration because it closely resembles one's comfort level. However, the determination of a moderate level is subjective to the listener.

These results underscore the need to address the issue of how to enhance restorative qualities within the noisy environments of a learning environment [12], and to define the optimal learning conditions that will be controlled by the implemented ISS, able to complete the existing LMS and learning processes limitations in terms of monitoring and supervision and define the optimal learning conditions to provide a proper environment for the different learners' profiles.

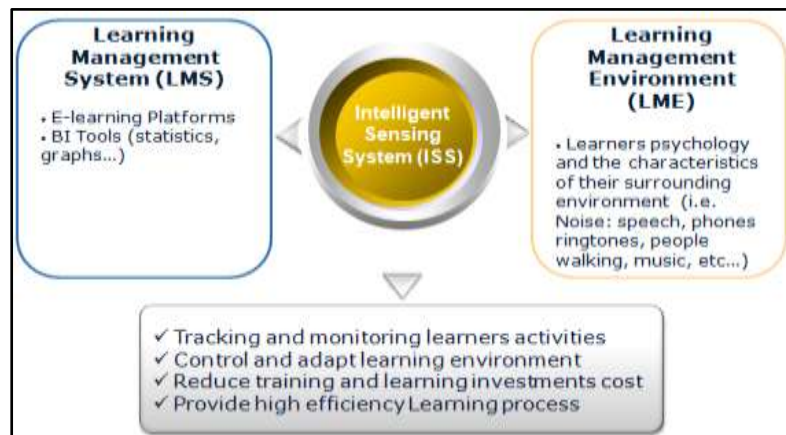The following Schema summarizes our suggested system.

Firure 1: Intelligent Sensing System (ISS)

In the next section, we describe the various components of our system ISS.

V.   Intelligent Sensing System (ISS)

Our proposed system, figure 2, is a novel model of e-Learning Management System. The particularity of our suggested system is the alliance between two major technologies: WSN technology and BI tools to provide, to the tutors and supervisors, the proper information about learners' behaviours (LMS), and their learning environment (LME). The term LME refers to learners' psychology and the characteristics of their surrounding environment (i.e. Noise: speech, phones, ringtones, people walking, music...).
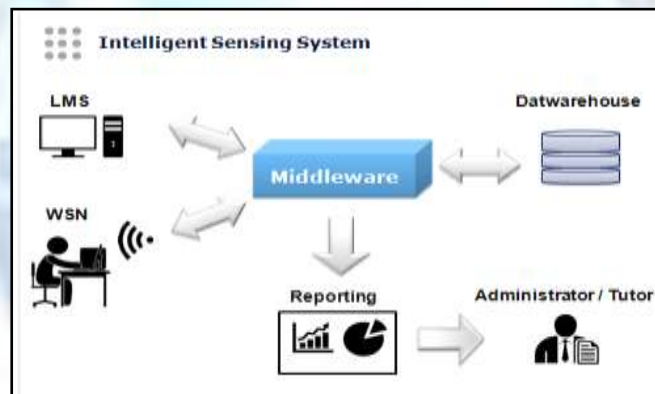

Figure 2. Intelligent Sensing System (ISS) architecture

(A) WSN

 "Sensor networks are the key to gathering the information needed by smart and ubiquitous environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems, automation, education, or elsewhere.

A WSN consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion, or pollutants and to cooperatively pass their data through the network to a main location. Wireless sensors are networked and scalable, consume very little power, are smart and software programmable, capable of fast data acquisition, reliable and accurate over the long term, cost little to purchase and install, and require no real maintenance [13]. They generally consist of a base station (or "gateway") that can communicate with a number of wireless sensors via a radio link. Data is collected at the wireless sensor node, compressed, and transmitted to the gateway directly or, if required, uses other wireless sensor nodes to forward data to the gateway. The transmitted data is then presented to the system by the gateway connection."[14]

Data that are collected from the adopted learning tool, give, among others, information about learners' performance, time of response and his different activities. However, another level that we see is very important in learners' behavior study, which is monitoring learner's interaction with their outside environment, especially their physical presence. Consequently, using WSN we can capture and analyse data about learner's presence, noise and motion. Noting that in the scope of this research, we base our study on learners' presence in the learning environment and the degree of noise.

(B) BI Tools

BI intervenes in our suggested system by the use of various technologies, mentioning OLAP (On Line Analytical Processing), ETL (Extract, Transform, and Load), Reporting and Statistics.

Figure 2 illustrates BI architecture. In the first place, the ETL process has one main task, which is extracting data from both LMS (learners' behavior) and LME (noise and presence), and transforming them into the adequate format. Then, the data collected will be stored into a Data Warehouse under a star schema in the form of dimension and fact tables based on the system business requirement. Finally, Analysis and Reporting tools will be provided to ensure statistics and graphs, able to transform the gathered data into a human readable for decision making.
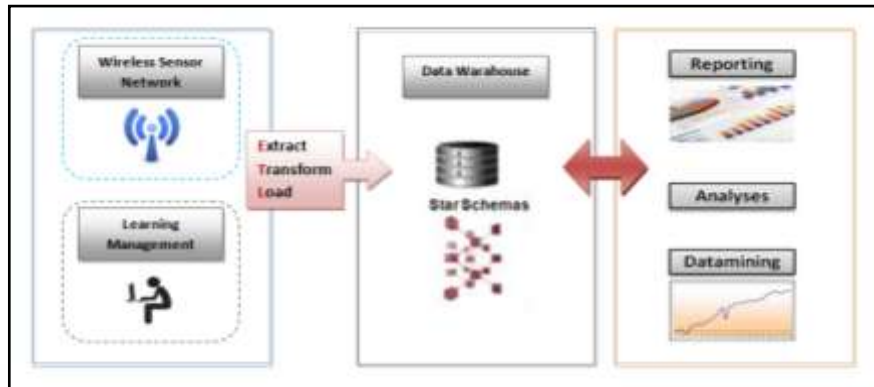

Figure 3. BI architecture

To implement ISS architecture we proceed as follows:

- Choose LMS and BI solution (benchmark existing solutions). For this purpose, a group of high qualified students is chosen to implement an e-learning platform that will be used to several case studies to test the validity of our proposed system.

- Prepare questions about learners' behavior we want to be answered.

- Design our Information model based on the Dimensional Schema.

- Program the ETL Process in charge of extracting, transforming and loading data from the LMS and LME.

- Transform the data format from the chosen LMS DB and LME DB to Fact tables (i.e. Course Activity, Virtual Classroom…) and Dimension Tables (i.e. Date, Learners, Session, Courses).

- Prepare the analytical tools, such as: Dashboards, Scorecards, and Dynamic Reporting tools.

Finally, the tutors can evaluate the effectiveness of a course and adapt its structure and content to the learners' level, to respond to their needs and to fit their learning style. In addition they can evaluate the learners relying on several variables deduced from the data gathered, such us the "attendance" and "interactivity" (and others variables as suggested on section 2).

Conclusion/Results

Wireless sensor networks include a wide range of potential applications to improve the quality of teaching and learning in a ubiquitous environment. WSNs become an evolving technology that acts as the ultimate interface between the learners and the context, enhancing the interactivity and improving the acquisition or collection of learner's contextual information in ubiquitous learning [14].

Firstly we gather information concerning learners' activities from e-learning platform. In addition, WSN system provides information about learners' physical environment such us noise level. Then, BI system identifies evaluation indicators and offers statistics and reporting tools. Our system provides a clear and detailed picture about the learning performance, the time budget used up by each learner and his activities.

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