Adaptive E-learning: Adaptation of content according to the continuous evolution of the learner during his training

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ABSTRACT
Higher education has always been based on a traditional education system. All learners have to attend all training courses without taking into consideration human and logistical constraints. This situation leads to major problems of massification, which unfortunately subsequently lead to problems of demotivation or even abandonment of a large number of students.

A solution to these problems resides in introduction of distance learning. The implementation of online courses, such as MOOC (Massive Open Online Courses), and the emergence of educational platforms such as LMS (Learning Management System) or LCMS (Learning Content Management System), have made it possible to introduce the notion of e-learning into Higher education. Nevertheless, if e-learning has left the Stone Age elsewhere, it is still an emerging field in some countries as Morocco where it is far from having reached maturity. Like any new system or proposal, e-learning has its own detractors who need to be more reassured on certain aspects.

In this article, we deal with some major issues related to e-learning platforms, which offer pre-established pedagogical content without really taking into account the particularity or evolution of each learner during the training path. We will therefore talk about a customised or adaptive e-learning. By combining UBA (User Behavior Analytics) and AI (Artificial Intelligence), we will propose during this article an LBA (Learner Behavior Analytics) model based on an a system called SBAN (Score and Behavior ANalytics).

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CCS Concepts
• Applied computing→Education • Computing methodologies→Artificial intelligence • Computing methodologies→Modeling and simulation • Human-centered computing→Collaborative and social computing.

Keywords
Adaptive e-learning; artificial Intelligence; behavior analytics; e-learning; LBA; LMS; MOOC; SBAN; UBA.

1. INTRODUCTION
We are currently living in the air of digitalization. As a result of the great emergence of digital devices such as smartphones and tablets and the evolution of information technology, it is becoming obvious that the use of these tools in the different sectors represents a great opportunity to develop them. All questions related to communication and the management of everyday life involve computer technologies commonly known as Information and Communication Technologies (ICT).

The evolution of ICT and the web in the 1990s revolutionized the global economy through their simplicity and access facility. This revolution has affected many very sensitive areas, in particular education and training. As they have changed profoundly in recent years, with:

- the emergence of educational content management platforms: LMS (Learning Management System) and LCMS (Learning Content Management System);
- the implementation of e-learning platforms: MOOC (Massive Open Online Courses);
- the creation of digital workspaces;
- the explosion of new smart mobile devices such as smartphones and tablets, which have become accessible to all learners.

ICTs have evolved very rapidly in several countries. Their application in Morocco has lagged far behind although Moroccan state has set up several projects to raise awareness in the education system about the use of ICTs, namely the MARWAN project (Morocco Wide Area Network), the GENIE project (Generalisation of ICT in Education 2009-2013) as well as the financing of ICT integration projects in Moroccan educational institutions. This is

still not enough to reach the required and existing cruising speed elsewhere.

The application of ICTs to training has led to the creation of this reality called e-learning. Defined as the fusion between multimedia (sound, image, text) and the Internet (online distribution, interactivity), e-learning becomes for people like a new breath to make up for its shortcomings in terms of educational or competitive needs.

As you know, grey matter represents the main wealth of a country. It also represents a company's major competitive advantage, for parents, as their children's education is the best contribution: "You earn what you learn". Training is therefore becoming a strategic issue to guarantee a good future.

E-learning covers a wide range of pedagogical practices, from the distribution of self-study subjects with quizzes to project groups, personal work, tutoring, coaching, case studies, project implementation and others. The effectiveness of an e-learning solution lies in :

- Saving time
- Cost reduction
- Personalization of training
- The effectiveness of learning
- The multiplication of training themes

2. STATE OF ART

Lifelong learning is one of the major axes for developing human capital and enhancing the employability of workers and the competitiveness of companies. E-learning is one of the pillars of this lifelong learning policy.

Taking a course at any place outside the home institution, at any time on flexible and accessible slots, and on any electronic medium (smartphone, tablets,...), is the principle of open training or distance learning (ODL). This concept was introduced by the first online universities, such as Capella University (Oladoke, 2006) and University of Phoenix Online (White, 1999), which are leading American universities in online training. These universities had already distance education programs that provided correspondence courses. In the 1990s, and with the advent of the Internet, we saw the emergence of many other universities specializing in distance education (Distance Learning), as well as open distance learning (ODL). The Internet has enabled some universities to transform their distance learning programs into online training programs. It was easier for these universities to adopt the "e-learning" concept because they had already mastered the scenarios of distance education pedagogy, and had a strategy for training teacher-researchers (Benraouane, 2011).

Today we are able to say that the ODL's deal has begun to prove its worth as several dedicated solutions and platforms have emerged, which allow to manage e-learning distance learning with many guarantees. They make it possible to reach an interesting level in terms of content and pedagogy. This allows us to say that e-learning is progressing at a fast pace.

In addition, several concepts can be associated with e-learning:

- The quality of learning (revolutionizing the pedagogical approach)
- Collaboration (digital collaboration, remote collaboration)
- The notion of interactivity, as well as that of community (knowledge communities)
- The notion of competence, knowledge and know-how, capacity...
- Self-training (pilot training) and the notion of support
- The company and the economic dimension (new economy, global economy)

Nevertheless, a deeper reading and analysis leads us to say that e-learning is still an emerging field, particularly in Morocco. If it has left the Stone Age elsewhere, it is still far from having reached maturity in the field. On the other hand, there are many e-learning initiatives, which is very reassuring for the next years.

3. RESEARCH ISSUES

During the last decade, the difficulties related to the basic education system (primary, secondary and high school) and especially higher education have had a major impact on Moroccan political life, which has seen a succession of new reforms, without being able to achieve the objectives expected to reform and advance this strategic sector which represents the backbone of any country.

This leads us to reaffirm that the current situation of our Moroccan education system requires a profound modernization and improvement in terms of pedagogy and methodology. Several contributions and research studies (Botturi et al, 2006), (Gavignet, 1991) and (Ouari, 2011) have confirmed that the design phase of pedagogical scenarios is essential for the success of any reliable learning system. This phase requires very special attention to be able to build compliant, scalable and adaptive learning platforms.

The majority of existing e-learning platforms offer a wide range of interesting functionalities that allow the learner to benefit from a very high level of training quality (availability of courses/tutorials, support,...). However, like any system, there are still some handicaps that, once solved, will allow e-learning and these platforms in particular to become a strategic choice for education in Morocco.

We will mention two major issues as a priority. The first one is related to the pedagogical aspect while the second one is related to the credibility and security aspect.

With regard to the pedagogical part, most of the proposed solutions are based on the learner's initial profile, while the learner's profile may change and evolve after starting the training, which means an ignorance of the evolution of the learner's cognitive abilities. Hence the need to take into account this possible evolution of the learner during his training path on the platform.

Normally a traditional learning system is considered as a static system that limits the learner's profile to data which doesn't change over time. The idea we want to set up proposes a dynamic and adaptive approach. It will be based on the excavation of data transcribing the learners' behavior during their training path and presence on learning platforms. This offers thus new perspectives to discover new factors of influence, but also to be able to apply readjustments and adjustments based on the learners' behavior in order to propose and guide them towards a more appropriate content that matches their profiles.

The second aspect is related to the credibility and security of the system. There is one aspect that is extremely important for the success and which unfortunately remains very poorly addressed in current standards: the identification and recognition of learners during the test and examination phases. How can we be sure that the learner concerned is the right person who takes his exams without any help? How can we be sure the day of the test that it is the learner himself and not an expert who is taking the test for him? The resolution of this problem will make it possible to convince

several critics of e-learning so that they will adhere too to the e-learning.

The difficulty of this task comes not only from the fact that it requires in-depth reflection but also from the fact that it represents a decisive element to encourage and facilitate the integration of e-learning solutions within our Moroccan universities. The challenge is therefore to find and propose ideas and techniques to address these issues, which remain a real obstacle to the ultimate success of this type of project within our institutions.

Our research is an attempt to evaluate different learning and testing situations (classroom and distance training) with Moroccan university learners (public and private) in order to identify and track down all possible scenarios.

The objective is to identify and propose valid approaches and solutions to ensure the identification of the learner and to provide some recommendations to the LMS's editors (Learning Management System) for consideration on future versions and thus facilitate the integration of e-learning in Moroccan higher education.

4. ANALYSIS AND PROPOSALS

These are obviously two major issues that will answer a large number of questions about these solutions, which are and will continue to be part of the digital transformation of Moroccan higher education.

Several research studies have been carried out in the field of e-learning with very positive results but there is still a lot of work to be done in order to continue to develop existing systems and thus to encourage their integration.

Within the framework of our theme, several tracks will be analyzed, among which we distinguish the following:

One of the possibilities for the recognition and authentication of learners may be through the analysis of the behaviors of users and entities UEBA (User and Entity Behavior Analytics) or simply through the analysis UBA (User Behavior Analytics), which is limited to the analysis of people's behaviors. The UBA or UEBA (figure 1) is a domain of artificial intelligence that makes it possible to detect hostile actions (attacks, frauds, influence ...) thanks to the unusual nature of the events observed, by appending them to a signature-based operation. This approach could answer simultaneously two problems with this thesis, namely:

- Combine AI (artificial intelligence) for the proposal of pedagogical content in adaptation with each profile
- Identification and access control of the learner during tests and examinations

Work has been carried out on similar projects related to information systems, such as the protection of an IS (information systems) by artificial intelligence.

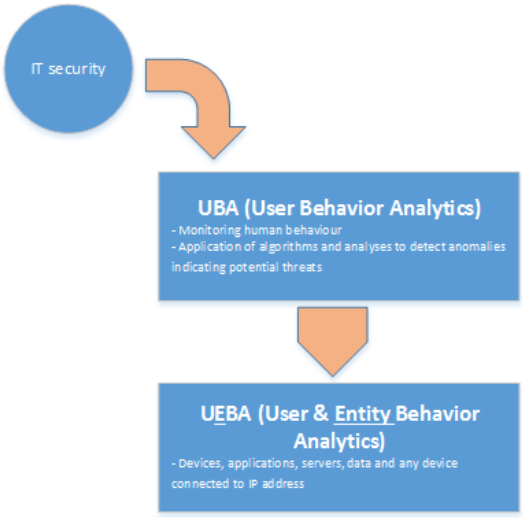

Figure 1. Difference between UBA and UEBA

UBA (User Behavior Analytics) has appeared with credit cards to detect abnormal cardholder behavior. It used user behavior patterns to detect fraud, such as the use of credit cards in strange places, suspicious purchases, etc.

UBA solutions examine human Behavior models, and then apply algorithms and statistical analysis to detect anomalies from these models, anomalies indicating potential risks or threats.

The system is based on the following four steps:

1) Data collection: Collect all data that may be relevant from all possible sources.
2) Data standardization and storage: Extract and store relevant information in a common and centralized manner.
3) Data analysis: Analyze the data to identify abnormal behavior compared to expected behavior
4) Alert/notification: Alert and report any abnormal behavior.

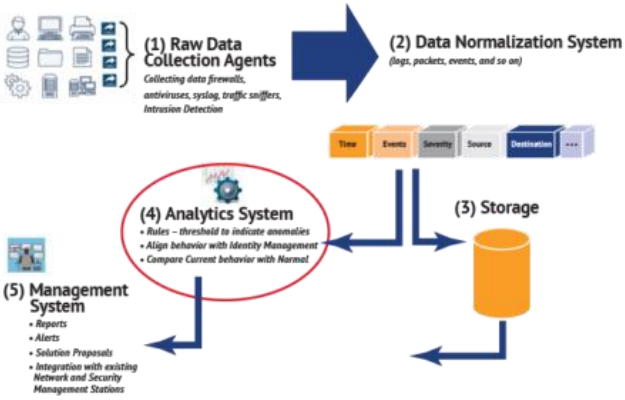

Figure 2. UBA operating diagram

5. LEARNER BÉHAVIOR ANALYTICS (LBA)

To develop an effective solution, an appropriate environment is required. Such an environment should represent the most realistic situation.

We therefore propose a solution for analyzing learners' behavior called "LBA" (Learner Behavior Analytics), which is based on a mechanism we have named SBAN "Score & Behavior ANalytics", which reassesses and reorients the learner throughout his training path on an e-learning platform and which we detail in the following section.

The figure below (figure 3) represents the proposed LBA's model (Learner Behavior Analytics), which is based on enriching an e-learning platform with other components as:

- Machine Learning
- SBAN module (Score & Behavior ANalytics)

Once the learner is connected to the LMS platform, our system will collect the data received from this platform and generated by the learner in order to normalize them before transferring them to our Machine Learning, which will in turn keep and store only the useful data. This data will be always examined by our SBAN module, which will use the score obtained or the learner's behavior to reassess and redirect the learner to the appropriate profile. These scenarios are more detailed in figures 5 and 6.

Four intelligent modules compose our system LBA:

1) "LMS" module: Connection and path of the learner on the LMS platform
2) "Filter" module: Collection and standardization of data received by the LMS module
3) "Analyzer" module: Analysis and storage of useful data
4) "SBAN" module: reorient and reassess the learner's profile according to results and choices.

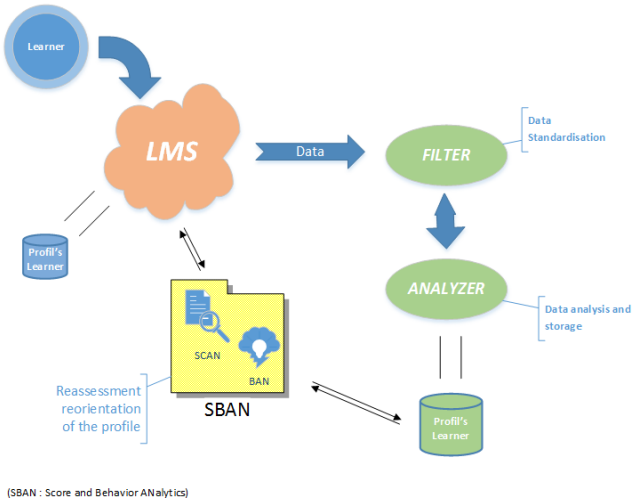

Figure 3. LBA Model (Learner Behavior Analytics)

6. SCORE AND BEHAVIOR ANALYTICS

The SBAN (Score and Behavior ANalytics) module (Figure 4) consists of two components.

6.1 SCAN component

SCAN component (SCore ANalytics) is the first component that supports the real learner's level. It allows a continuous evaluation of the learner's level based on a reference table (table 1) that allows each learner to be assigned a level based on the score obtained after a SCAN during his training path. The basic idea is to define for each level a threshold in the form of an interval that must be respected in order to maintain the same level and thus keep the same learning profile.

This SCAN component will allow the continuous analysis of the score obtained by the learner during a course in order to launch alarm bells if a score is detected outside the expected interval.

This can be explained in two ways:

- either we are faced with a learner who was initially under classified or who has evolved during his training path (SCAN>Y)
- either we are in front of a learner who has been upgraded at the beginning (SCAN <X)

In both cases, the SCAN module will allow our system to redirect and readjust the profile of the learner.

Table 1. SCAN[1] reference table

Cases	Evaluations	Actions
Normal learner	if X< SCAN <Y	Keep the same route
Underclassified Learner	if SCAN (CH[2] (n)) >Y	Change of route [CH Passage (n+1)]
Upgraded learner	if SCAN (CH (n)) <X	Change of route [resume CH (n-1)]

6.2 BAN component

BAN component (Behavior ANalytics) is a component focuses more on the learner's behavior throughout his training path. It is about studying and detecting any unusual behavior of the learner during his training path: response time, quality of responses, clicks, progress, etc.

This component is based on learner's behavior models to detect unusual actions by the learner. As soon as he makes an unexpected decision or action, our component will sound an alarm on the system in order to redirect and straighten the learner towards the path that corresponds better to this type of profile. It is a question of using the artificial intelligence of our system, which will be able to identify and assign the appropriate profile based on pre-established models.

Figure 4 summarizes the operation of the SBAN module which will have as input a starting profile (P), but as output either another

[1] SCAN : SCore ANalytics

[2] CH : chapter

profile (P') or keep the same incoming profile (P) as output in case of a normal leaner (non-evolving learner).

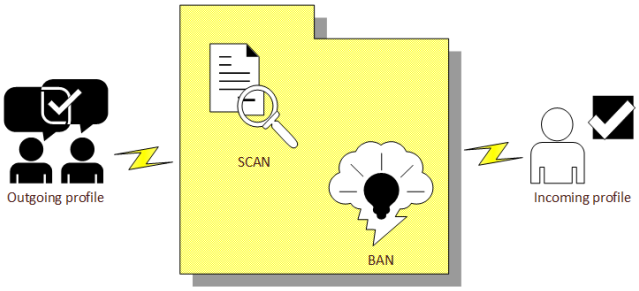

Figure 4. SBAN module (Score and Behavior ANalytics)

7. ADAPTIVE E-LEARNING

We are therefore talking about an "adaptive e-learning", a vision oriented results, while putting the learner's evolution at the heart of the process.

Adaptive e-learning can be schematized by the two variants below.

A first variant called "progressive" (figure 5) which deals with an undervalued and under-ranked learner profile in relation to his abilities and skills. These are learners with a certain intellectual level and higher skills than what is required for such a training path. Even if LMS's platforms generally offer an initial test to evaluate the learner's level, the learner could, for some reasons (poor evaluation, lack of concentration, disinterest, etc.), be assigned an undervalued profile below his abilities. In a traditional system, he would have to undergo the rules and go through a good number of courses before reaching the course corresponding to his true level.

In this case, our model will allow it to adjust his profile through a permanent re-evaluation mechanism based on our behavior analysis module SBAN. This adjustment can be triggered either by the results or by unexpected behaviors of such a profile.

We observe in figure 5 the case of a learner connected to an LMS platform, and who undergoes during his training path an evaluation set to move from one chapter to another. Its path (flawless, response time, number of clicks,...) considered brilliant by the SBAN module will allow it to benefit from a straightening of the profile and thus move to the next level (n+1) without the obligation to validate all the chapters of the previous level (n). This is a Progressive redress.

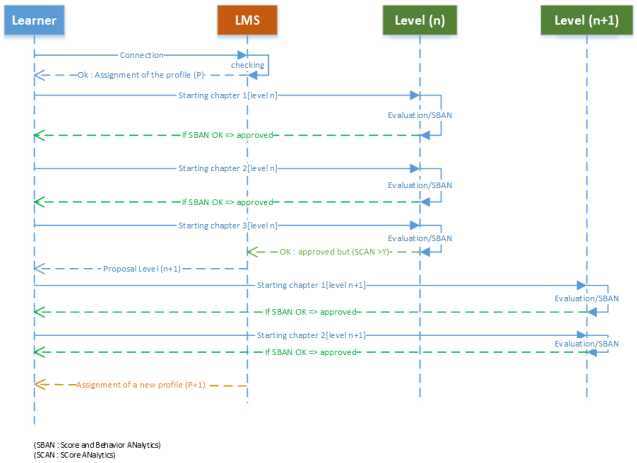

Figure 5. Progressive redress

The second variant is a digressive approach that allows the profile of an overvalued or over-ranked learner to be adjusted to a profile more adapted to his limits and abilities. This implies a change in the learner's path towards a content more appropriate to the learner's real level.

Figure 6 describes the classic case of a learner finding more difficulties than expected during a given course. For a profile of his type for multiple reasons (lack of prerequisites, lack of concentration, stroke of luck during the assessment,...), he will be rectified from a level (n) to a lower level (n-1) allowing him thus to acquire the missing and necessary prerequisites to resume the this level. Even if this scenario is less frequent than the first variant, it can be one of the main reasons for the abundance and disengagement of this category of profile because they have been lost in a level higher than their capacities and limits.

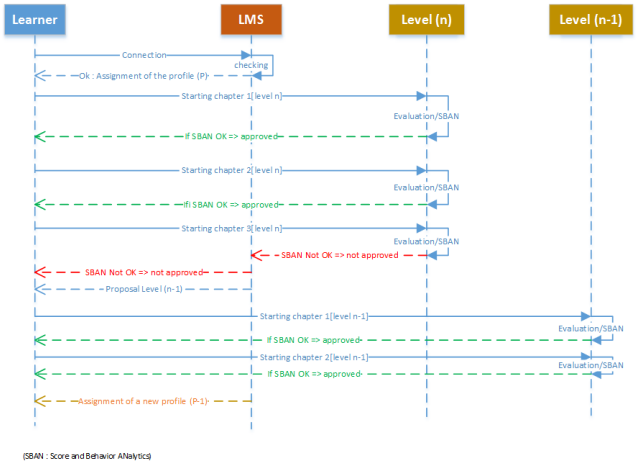

Figure 6. Digressive redress

8. CONCLUSION

During this work, we were able to identify some relevant avenues that will certainly enable us to respond to our problems related to the adaptability of e-learning to the continuous evolution of the learner, but also to the security aspects during tests and evaluations.

We have proposed an LBA model (Learner Behavior Analytics) to analyze the level and behavior of learners. It is collaboration between LMS platforms and artificial intelligence. This will detect unusual actions and responses to events or questions asked, as opposed to behavior based on pre-established paths and profiles.

A module for analyzing learners' results and behavior (SBAN) has been proposed, which will be responsible for continuously monitoring and evaluating the learner's actual level throughout his training path.

We will then seek to detail more these models, proposing an architecture and prototypes that will allow us to better model our future LBA system, which, thanks to artificial intelligence, will be able to present a content more adaptable to the evolving learners profiles. We are therefore talking about adaptive e-learning.

This LBA system will also allow us to identify and recognize the learner during the critical phases of tests and evaluations in order to be sure that we are indeed facing the right learner, and thus respond to the major detractors of e-learning systems.

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