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Personalized Online Learning:
Context Driven Massive Open Online Courses

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ABSTRACT

The success of MOOCs (massive open online courses) is rapidly increasing. Most educational institutions are highly interested in these online platforms, which embrace intellectual and educational objectives and provide various opportunities for lifelong learning. However, many limitations, such as learners' diversity and lack of motivation, affected learners' outcomes, which unfortunately raised the dropout rate. Thus, multiple solutions were afforded on MOOC platforms to tackle these common problems. This paper suggests a model outline of a customizable system context-driven massive open online courses that could be implemented in any learning environment, and that goes hand in hand with learners' context to boost their motivation towards learning, and to help identify their learning needs. The paper introduces CD-MOOC following a learner-based approach by employing two types of users' data—long-term and short-term data—assembled from learners' online traces when interacting on the platform. The data help users design their own learning path based on their context and preferences.

KEYWORDS

Adaptive Learning, Context, Learning Platform, Massive Open Online Courses, Personalized, Personalized Learning

1. INTRODUCTION

Knowledge acquisition outside schools has been a major dilemma before the emergence of online courses which introduced a new paradigm of learning. Even though correspondence courses have existed since 1800s for students who didn't have the chance to attend university (Kentnor, 2015), they were never as effective as online learning. A massive open online course (MOOC) is an online learning environment offering an open access to all network users often for free or with lower cost (McAuley et al., 2010). MOOC includes a large group of learners with different backgrounds: level of understanding, age, learning habits and so on, where there exist no variation of online teaching methods behind the screen. Therefore, online content must be designed and adapted according to the educational background of each learner, as an adaptable learning system improves the online

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learning-teaching process (Syed et Nair, 2018). Improvements are made to several learning axes like dissemination methods, which lead to considerable degrees of flexibility than that of traditional classrooms (Giesbers et al., 2013). However, the problems that rise at the MOOC are a direct cause of the high dropout rate caused by lack of users' motivation that stands against successfully completing the courses. Personalisation in learning systems can help increase students' motivation as it can provide an independent learning experience based on learners interests, preferences, backgrounds and abilities.

Studies on adaptive technologies in MOOCs indicated both technical feasibility and educational promise (Rushkin et al., 2017). According to Jonsdottir (2015), adaptive learning is a method that uses software as an intelligent interactive teaching mechanism aiming at installing resources according to learning needs. This mechanism has proven to be unique and essential for each student. Soukkarih et al. (2009) introduced three types of adaptation; Content adaptation, service adaptation, and Interface adaptation. So, to create an adaptive learning system, one or more of the three types of adaptation must be used in order to be capable of handling some criteria. Azough (2014) pinpointed a number of proprieties that serve to define an adaptive platform including presenting and managing an appropriate educational method for each learner, keeping track of the activities of learners, using models to interpret them, and more importantly analyzing and identifying the preferences and needs of the user.

In the CD-MOOC model, the pieces of information extracted from the users' context include all modifications on the properties of the presented data, several changes on the platform based on the capacities of the device or the network and interface adaptation, and identifying variables, such as individual learning styles, network characteristics, and language. This paper aims at setting up a model for personalizing educational content on an online learning platform considering learners' context in order to reduce the dropout rate by instigating learners' motivation.

2. RELATED WORKS

Notwithstanding that there are several types of learning online platforms, the lack of motivation still represents one of the most remarkable causes, which can ultimately lead to drop out. One of the predicted solutions is using learners' context to personalize the platform settings where user context is a mandatory parameter in the design of learning systems. It required a fundamental analysis of users' needs to use the right context variable, which guarantees adequate learning experience for each learner based on his habits. Therefore, adaptation can be defined as a system's capacity to deal with particular cases and adjust the environment accordingly.

According to Marie et al. (2011), there are two perspectives for managing the learning/teaching process; the first is the learner-based approach, and the second is the teacher-based approach. Many research papers have discussed personalized learning and suggested models and architectures that tackled the problem in reference to these two perspectives:

- **Learner-based approach:** This approach aims at collecting all user profile information. Works on this perspective fall into two categories:
  - **The stereotype (Vincent et Grugeon, 2005):** The set of characteristics gathered in a group of learners that serve to determine the group's abilities equal or close to his. However, the problem that often arises in this type is the difficulty to considering the individuality of these learners.
  - **The learner profile:** This approach is specific to each subscriber, it more precisely retains the information extracted from the learners, but it risks falling on incorrect analysis that may lead to invalid findings.
- **Teacher-based approach:** This approach is based on the personalization of the activities at the level of the teacher. Researchers have introduced the learning scenario as a new term, which refers to the description of the unfolding of the learning scene (Pernin et Lejeune, 2004). Therefore, this approach focuses on the activity itself regardless of the resources. Besides, as

many inconveniences may take place, this approach allows creating scenarios based on different criteria held by the teacher.

The most appreciated model in the teacher-based approach is persua2 (Marie et al., 2011). Based on a teacher-centered approach, the persua2 model aims at integrating the process of personalization of learning activities. It allows stakeholders to define the learning scenario and the context of use as well as being informed about the learners to be assigned the most appropriate and engaging activities. The context of use facilitates the way towards pointing out the limitations related to the settings in which the session takes place. Hence, the PERSUA2 model encourages teachers to design teaching sessions adapted to learners' educational goals. Another model inspired by persua2 is persua2mooc (Florian et al., 2015), which represents a personalization within the framework of MOOCs adopting a learner-based approach. Following the same approach the team members of the research introduced in the work of Tanja and Martina (2016) are seeking to utilize the cultural diversity displayed by MOOC subscribers in positively exploiting their differences as a resource for learning. Therefore, they proposed a design that emphasizes a learner-based approach, which is mainly directed towards smoothing the path to collaborative learning. By applying this design, each member will be active and productive throughout the course. In another study, García-Peñalvo et al. (2018) analyze the elements of the two generations of MOOCs: C-MOOC and X-MOOC, in order to suggest a new model that does not require sophisticated technological materials, and that can assist in restoring the initial base of MOOCs, called ahMOOC. It also presents a case study combining the benefits of cMOOC, the organizational benefits of xMOOC, and the personalization of essential learning, taking into account the participants' heterogeneity. The results and perspectives of the case study participants confirm the utility of the model.

Several architectures have been placed on the research ground aiming at the personalization of online learning platforms. Vladoiu et al. (2013) contributed with a hybrid architecture to recommend open courses and educational resources, which combines recommendations from improved cases through user review.

Collaboration plays a crucial role in the teaching-learning processes where Syed et al. (2017) proposed an architecture for developing a Personal Learning Recommendation Systems (PLRS) that support students via a Learning Management System (LMS) to find the most suitable material that can effectively ameliorate students' learning experience. They have also put forward a methodology for building a collaborative dataset via learning management systems (LMS) and educational repositories.

Monsalve et al. (2020) described an architecture of an intelligent and autonomous recommendation system to be implemented in any virtual learning environment intended in order to recommend digital resources efficiently based on several criteria, including using a hybrid algorithm on intelligent paradigms and analyzing the context of the users.

In this section, several works that propose models and architectures of adaptive MOOC systems have been tackled. Each research team offers an adaptive solution depending on the research aims, and all attentions are directed towards finding an all-inclusive solution that can satisfy all parties and would be applicable to all cases, which looks like a hard task to achieve. Therefore, regarding the aforementioned works and taking into account the limitations of the MOOCs, this paper presents a personalized model (CD-MOOC) that adapts to a learner-based approach focusing on containing learners' dropout phenomenon, which proved to be in increase due to the lack of motivation on MOOC platforms.

3. METHODS

In order to reach the research goal, the paper recommends the following steps: First, it is necessary to highlight the essential characteristics to design the MOOC platforms. Since the model is based on the learners' approach, it is paramount to present the different learners' categories and adjust the

Table 1. MOOC platforms features

MOOC Platform					
Login	**Edit profile**	**Register**	**Follow the course**	**Evaluation**	**Evaluate with others**
via smartphone via tablet via computer	Change the name change the password	Search for course Register in one or multiple MOOC	Watch video Read text	Answer the quizzes Answer the exams	Exchanges information Use social media Use forum

system's behaviour towards each one of them. Then, in order to memorize all learners' information, the system offers the traceability module, which aims at saving learner's tracks on the platform. Finally, the integration of a real-time context module reveals the architecture of the whole system.

3.1. MOOC Platforms Features

The aims of feather collection is to conserve MOOC functionality and extract what links to the learners' context. After elaborating the most popular educative platform (Edx[1], Coursera[2]), functionality was extracted in Table 1.

After having several functionalities introduced in some of MOOC platforms distinguished, we manage to choose the more exciting functionalities in the implementation phase of CD-MOOC:

- **Edit profile:** This task is critical in personalization as it is seen as an act of practicing personalization. Moreover, this implementation is based on the automatic change of platform language and user preferences based on the learners' context.
- **Receive and send mail:** In case of dropout, it is quite possible that the user has missed the course or has forgotten to access it for a week or more, periodically sending Mails will bring learners closer to the platforms and help them remember the reason in which they start the MOOC at the beginning.
- **Evaluate with others:** This is a significant feature that distinguishes MOOC from other online courses, finding an interaction class always helps learners attach themselves to MOOCs.

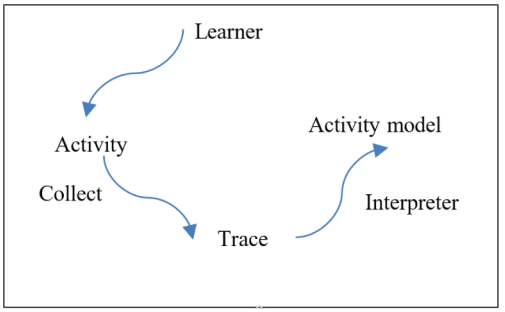
3.2. Traceability Module

To correctly distinguish learners' preferences and analyze their behavior, it is necessary to manage their traces. Every single click will be saved in the database to evaluate learners' progress and motivation rate. Champin et al. (2013) delivered a traceability module that allows to collect the necessary information about a trace. The module used in this paper is inspired by (Champin et al., 2013). The definition of traceability concept was presented as follows:

What: Identify the actions
Which: Identify the resource
Who: Identify the learner ID
When: Identify the time
How: In which way learners use the resource (e.g., how much time he repeats a sequence)
Since where: Identify the last consultation

Each activity done by a learner will be saved in the database and interpreted by conditional rules (e.g., if (the previous login was four days ago), send a reminder e-mail)).

Figure 1. From activity to activity model



To benefit from this concept in the trace model, we must first think of the analysis process. The goal is to organize the activities and convert them into an activity model that allows the system to decide which modifications to be made on the user's profile or which reaction to be executed, as shown in Figure 1.

3.3. User Profile

This research aims at personalizing MOOC based on learners approaches using two axes: The first concerns MOOC consultation, the second focuses on each learner progression during the course; in the two cases, a primary information section will be interrogated. The student filled out the primary information collected from the first interaction between learners and the platform during registration (e.g., name, age, school level).

3.3.1. MOOC Consultation

The learners in a MOOC can be classified into several categories; to emphasize them, we take a store's custormers as a sample. In any store, owners and workers are looking to satisfy customers to turn them into a sustainable one. However, we may find several types of clients: those who buy from time to time, those who take pictures of different items, those who never buy anything at all and do the trick in the store, and finally, the best category that always buys from the same store.

Taking inspiration from this example, learners, therefore, belong to one of these four categories:

- Inactive: enrolled in the platform but never connects, the system does not realize this type of learners until they reach a certain threshold, in this case, the system sends an e-mail in which it proposes a list of choices for answering the question: what problems are encountered on the platform? the collected answers help to improve learners' experience.
- Active: learners who pass the MOOC while actively participating in the forum.
- Less frequent: learners who frequent the MOOC less and less, a motivational e-mail is often sent (e.g., the exciting news is revealed, join us), during their consultation, the system offers the best possible educational scenario.
- Learners' that simply just use resources.

Based on the learners' traces, each of them will be classified in a category by following the stereotype approach principle.

3.3.2. Learner Progression

The second step concerning the MOOC personalization is learner progression during the course. The learners' improvement level is based on the learners' traces; each of them will be placed in a section. CD-MOOC model offers the following four categories:

- **Result between 0%-40% in the quiz:** The learners in this situation are obliged to review the video.
- **Result between 41%-70% in the quiz:** The learners in this situation are invited to read an enclosed document to support the video's information.
- **Result between 71%-90% in the quiz:** An explanation of the unanswered or poorly-answered questions is introduced.
- **Result between 91-100% in the quiz:** Redirected to forums to answer and make enquiries.

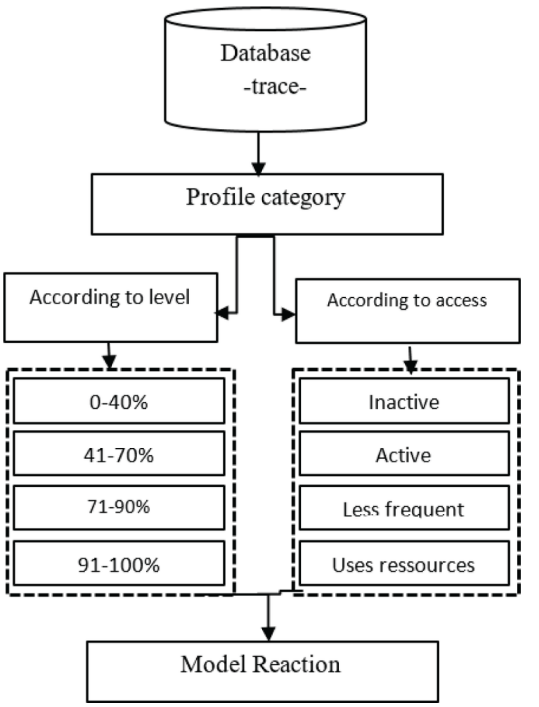
The provided percentage is calculated according to the appreciation of Algerian high school degrees.

To determine for each learner the category in which he belongs, it is crucial to exploit the traces (e.g., number of times in which it consults the resources, the forum). The user profile model is displayed in Figure 2.

3.3.3. Real-Time Context Structure

When the learner connects to the platform, many data might change from the previous access, such as internet speed, user device, and system language. For a better result, the system includes a real-time context structure whose values change according to each user's connection; this information is essential as they add more knowledge to the learner who is the guide in the personalization system. The learner's profile contains relatively durable and stable information, allowing the medium and the

Figure 2. User profile model



long term to be characterized. The real-time context holds data relative to the short term, calculated on the fly for every connexion.

The real-time context combines two parts: the system gathers information on:

1. **Environmental Context:** This section focuses on the MOOC environment, the time oflearner's session, and the number of connected learners at a given moment.
2. **User Context:** Consists of two types of data obtained during connection:
   a. The different data obtained from learners' connected devices (e.g., internet speed, battery life, operating system and so on);
   b. Time Availability: the user is required to specify the duration in which he can remain active. During this period, the system will offer him the best possible scenarios to achieve the sessions' goal.

Hence, learners will be characterized according to two levels: the first is a real-time context that presents changeable data, and the second presents durable information about this learner.

3.3.4. CD-MOOC Operating Process

CD-MOOC operating process represents a set of instructions that are connected to achieve efficiency and quality results. This model follows a learner-based approach and was inspired by the persua2mooc model (Florian et al., 2015).

Proceeding from the input elements (Database and Real-time context), the system will categorize all learners according to the user profile model and real-time context structure, calculating the learners' progress, MOOC consultations, and the different contexts variable. In order to edit each time users' profile based on conditional assignment rules: if condition, and then reaction. In this way, the CD-MOOC system builds a valid educational scenario for each learner. These rules can be altered by the platform administrator based on a request from the trainers, Figure 3. For each learner

Figure 3. CD-MOOC operating process

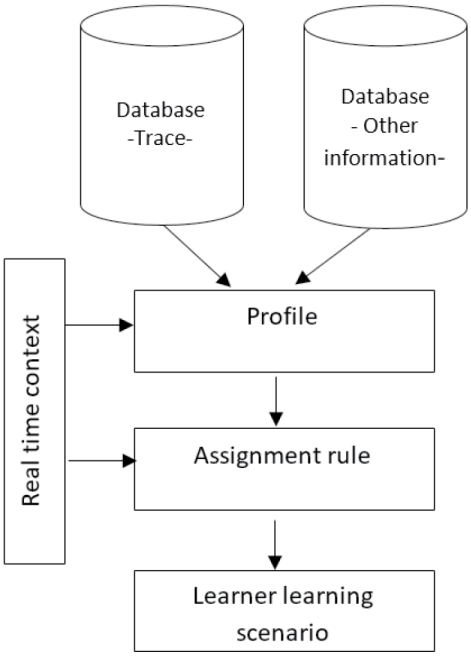
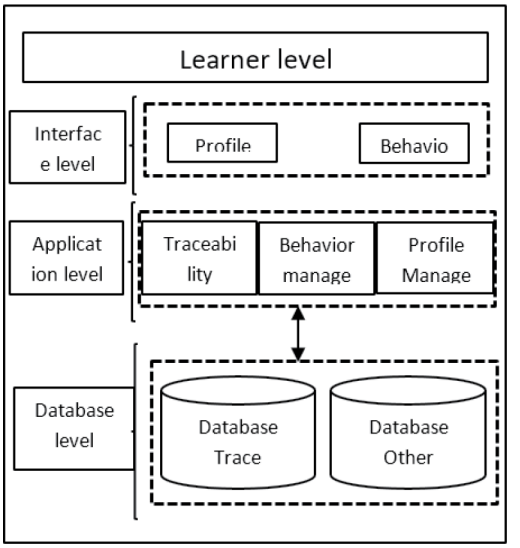


Figure 4. Architecture of the CD-MOOC model



category, an algorithm will be applied; it takes as input the traces, the profile information, and the context variable value and delivers the rules that suit this type of user as a final output. The profile can also be edited by the learner.

3.3.5. CD-MOOC Architecture

The architecture of CD-MOOC Figure 4, is based on four principle levels. The first level emphasizes the user who will eventually be the learner; he will only transmit his required information at this level. The second level concerns the user interface, which presents the interaction unity between the learner and the platform. At this level, the system regroups the traceability module Figure 5, behavior module Figure 6, and profile module Figure 7, concerning a particular user. The previous three models change regularly based on the application level, that allowed to deal with the management of the data extracted from the user's behavior and its context. The last one is the data storage level that circulates in the system.

Each learner during his first contact with the platform, in which CD-MOOC is integrated (registration), fills out a form. This form contains a long-term data that will be stored in the database. He then looks for a MOOC to enroll; the behavior of this learner is tracked to help him attend his objectives on the one hand and assure he never lose motivation on the other hand. The learner's category changes depending on its purpose, behavior, and other data collected during connection labeled short-term data. Finally, for each learning unit, the conditional rules are applied to the learner's results to guarantee the success of the MOOC and the fulfillment of the learner's objectives.

4. BEHAVIOUR OF CD-MOOC SYSTEM

This section described the CD-MOOC process in detail. Since MOOC is a learning domain, and this domain combines several actors, we will focus on learners in a particular way in this description since the present work is intended to improve their learning experience and motivation. It is mainly supposed to create a new academic course by the educator, the user register in a MOOC where the educational objective meets his needs.

Figure 5. Traceability management module

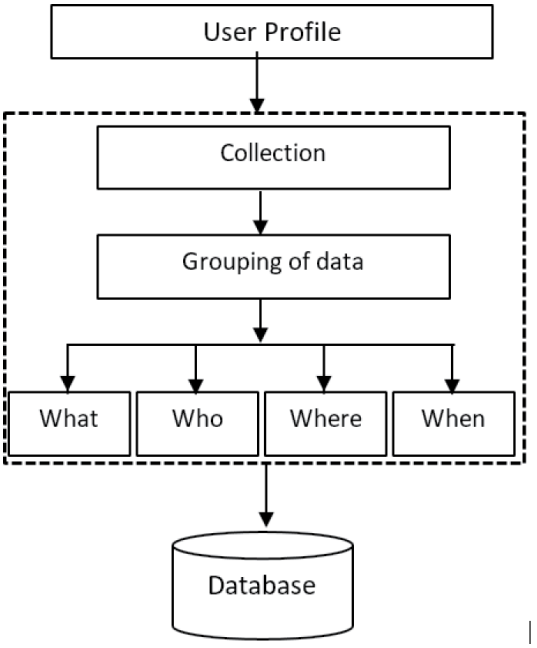
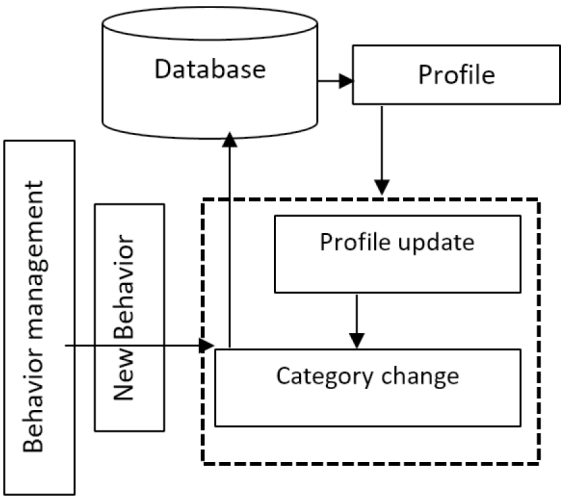


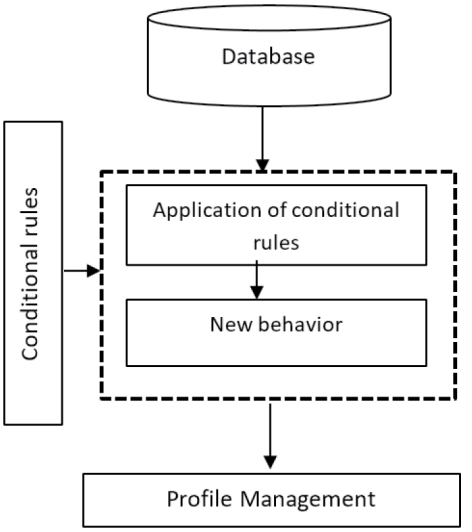
Figure 6. Behavior Management Module



4.1. Adaptive Learning Resources

The learner joins the educational platform using a low internet speed, which does not allow him to appropriately perceive the course video. The CD-MOOC system switches the video by an effective illustrated presentation of the same course. Once the learner connects, the system will examine the connection speed rate, and then decide to offer either the video or the presentation.

Figure 7. Profile Management Module



4.2. Personalized Reminder

In case the MOOC consultation rate of a particular learner frequency decreases in a remarkable way, by following in his footsteps, The CD-MOOC system sends e-mails to notify him about the following events:

- The last connection for a particular learner was four days ago.
- It is the beginning of a sequence (a new week of MOOC).
- End of a sequence missed by this learner.
- End of the MOOC: In that case, the purpose of the e-mail is to extract the learner's opinion as a review of the situation.

4.3. Adaptation According to Learners Level

After solving the quiz, each student will see his result followed by their percentage of grasping what was introduced. This result differs from one learner to another. CD-MOOC system presents different educational paths and scenarios described in the user profile model (Figure 2).

4.4. Adaptation According to Language

When a learner accesses an educational platform with the CD-MOOC system and after choosing a particular MOOC, the first video subtitle will be delivered into the same language used on the learner's device operating system. Moreover, the learner is also allowed to take down video and text notes to be downloaded in a form of a text file.

4.5. Learners Motivation

As the learners' motivation is of prior importance in this paper, all the previous scenarios are focused on motivation to deliver a good learning adventure and therefore the best experience by exploiting all the available hardware and software resources. According to the MOOC consultation rate, the system automatically generates mailings based on learner's traces. As this process was intended for testing, all the work was in the localhost where in this given part the Test Mail Server Tool is employed. The

latter serves as a complete emulation of the selected mail in order to test the capacity of sending mail in a web application, and it works flawlessly.

5. RESULTS

The CD-MOOC model implementation opted for using web technologies; the work was developed under the WAMPSERVER environment (version 2.2). The PHP language (version 5.4.3) is used to perform the various processing operations on the learners' data with conditional rules. The JavaScript language was favored for the establishment of quizzes and exams. Structured information is presented using JSON (JavaScript Object Notation) as it represents information, without any limitation on the number, which is the same for generating course presentations. Furthermore, to allow better readability on the client-side, the jQuery framework was used. Ajax is used to present better and more efficient results. Requests are made asynchronously, which speeds up the display of results.

5.1. Deployment of CD-MOOC

This paper aims at setting up a model for personalizing educational content on an online learning platform considering learners' context in order to reduce the dropout rate by instigating learners' motivation. Hence, to motivate the learner, two complementary paths should be followed:

- The first concerns personalization based on content through using the information provided by the learner processing his behavior.
- The second emphasizes personalization based on environment where the system's adaptation capacity is examined.

To confirm the proposed model, we created demonstrative profiles representing different learners natures.

5.1.1. Personalization Based on Content

Adaptation according to learners level: This adaptation is available via a Quiz, which a crucial element at the level of the MOOCs. After attending any learning video, the system delivers a Quiz to evaluate the learner's understanding. Learners have different levels, so they cannot learn in the same way or follow the same strategies (Figure 8).

Figure 8. Quiz screenshot

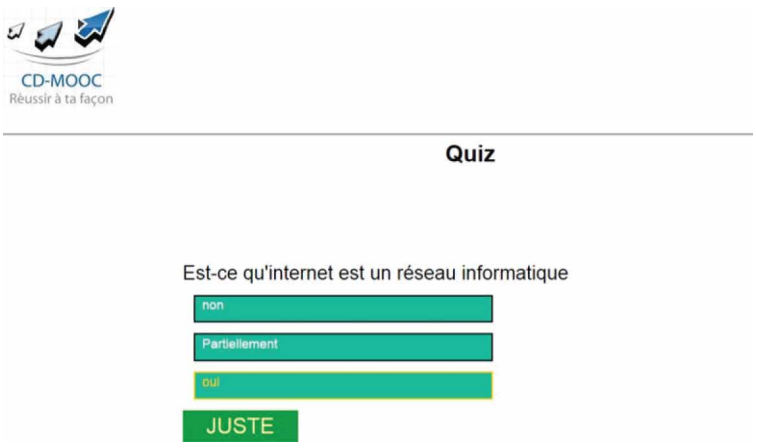
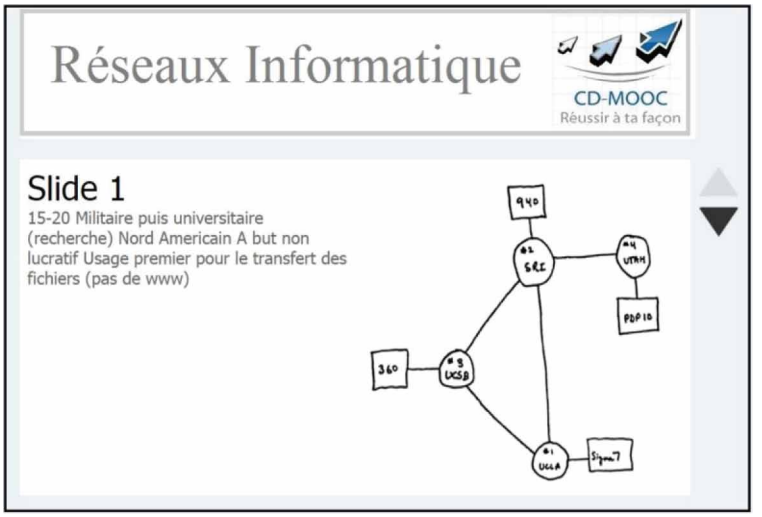


Figure 9. Screenshot of slide 1



Adaptation according to language: This adaptation is available via the learner device OS language. To maintain user motivation, CD-MOOC provides videos with adequate subtitles. We used the Aegisub tool to generate the file.srt containing the subtitles along with the AnyVideo Converter tool to merge the video and its translation.

5.1.2. Personalization Based on Environment

Adaptive learning resources: When the learner joins the educational platform using a low internet speed, the CD-MOOC system switches the video by an effective illustrated presentation of the same course. The idea is to calculate the response time when sending a request to any website. By measuring the speed according to the response of this request, the system decide, to generate the page containing the video or the page containing the presentation based on a threshold (Figure 9) .The information provided in the slides is retained from a slide player presentation (ALAVA, n.d.)

PS: In the prototype, we used videos and presentations that already exist on the internet because the research goal was to personalize the MOOC, not to create it.

6. DISCUSSION

The CD-MOOC system offers an online environment where learners and teachers can meet together to produce a successful pedagogical class session in a personalized method based on the learner approach, all by adapting the environment and the content to learners' preferences and levels. Compared to different works, three criteria were used; recommend different resources with the same efficiency, analyze users' context, and prioritize learner's motivation. This proposed work complies all the comparison characteristics. Once the context is analyzed, the CD-MOOC system recommends adequate resources for learners aligned with their languages, levels, and general preferences. The integration of this model into an educational platform confers significant advantages.

In general, most papers exploit the advantages of users' context in the educational system (Onah & Sinclair, 2015; Monsalve et al., 2020; Florian et al., 2015). (Syed et al., 2017; Syed & Nair, 2018) and the CD-MOOC put forward prioritizes learner motivation; other research prioritizes the MOOC content in their proposal (Marie et al.,2011). Many architectures and models use artificial intelligence techniques to propose personalized content for learners. Switching between video and

illustrated presentation is a significant feature in the CD-MOOC model, which is particular to the nature of some parts of the world, and where the internet connection is very slow. Wu & Turner (2020) discussed the relationship between bandwidth, interaction, and performance and how they can affect the online Courses. Dana et al., (2020) Confirm that there are throughput challenges for rural communities where many students drop out of online classes because of poor Internet access, and the same happened in some developing countries.

Therefore, the challenge we are facing is to fully exploit these technologies as an effective way to support online learning and to keep learners motivated.

7. CONCLUSION

The primary objective of massive open online courses is to spread knowledge amongst internet users on laptops, smartphones, tablets, or any other connected devices. However, it can sometimes display some downsides as people acquire new knowledge neither in the same way nor at the same speed; this is the reason why the use of learner's context allows the MOOC platform to deliver appropriate learning with users needs as the focal point. To sum up the research findings, the presented model (CD-MOOC) enables learners to embark on their learning experience in their own ways by shedding light on the elimination of dropout rate and by boosting learners' motivation, extracting information from users' context, identifying variables to distinct individual learning styles along with collecting traces, login information, network speed, and the connected device type.

As future intentions, it is projected to explore this architecture on an online learning platform. Along with it, the hardware architecture is supposed to be integrated into the personalization of MOOCs. The exploitation of the appropriate technologies gives MOOC a more prominent and affluent class of learners. A more advanced model could always allow significant interaction between learners and teachers, which can, in its turn, make it possible for the learner to achieve his goals and to increase the level of adaptation, carrying within its folds an overwhelming satisfaction from both learners and teachers which thereby marks the success of MOOC.

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ENDNOTES

[1] Edx.org
[2] Coursera.org

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