

# Virtualization of Data to Improve Pedagogical Approaches the Case of Higher Education in Morocco in the Face of the COVID-19 Pandemic

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**Abstract:** The world in general and the educational community in particular will remember well the COVID-19 pandemic, which forced schools and educational institutions to close their doors and switch abruptly to distance teaching and learning where the success of the pedagogical continuity of the 2019/2020 academic year became a challenge of high importance. Students and teachers, mostly unprepared for the pedagogy supported by digital technology, have experienced great difficulties in assuming a quality pedagogical continuity. To this effect, the experience we are living, due to this pandemic, pushes us to rethink our pedagogical tools and practices as well as our technical devices set up, at a distance learning, via Information and Communication Technologies (ICT). In this context, it seems useful that these pedagogical activities, whatever the tools, techniques and platforms put in place, during this period of pandemic, should be able to be re-verified. To this end, a modelling based on five layers has been proposed, in order to analysis the feedbacks of the different actors participating in the learning process (students, teachers, and administrative agents), and this with the aim of proposing a data virtualization approach to help decision making and to improve the distance learning device and the different activities of the pedagogical approaches.

## 1 INTRODUCTION

The specific context related to the COVID-19 pandemic has necessitated the implementation of a distance learning continuum. In Morocco, several measures have been decided by the Moroccan government to avoid the inexorable advance of the COVID-19 pandemic. Among them, the suspension until further notice of classes in all schools and universities from Monday 16 March 2020 and the launch of a distance learning system allowing professors to ensure pedagogical continuity to students and to organize distance learning courses (Massive Open Online courses (MOOC), Platforms, Forum, chat room, etc...). Thus, the use of ICT was automatic and proved to be the only solution to ensure the continuity of activities without compromising the decisions taken.

The pandemic we are experiencing has brutally switched our face-to-face teaching to distance

learning. Students and teachers, mostly unprepared for digitally supported pedagogy, have found it very difficult to provide quality pedagogical continuity. According to several studies (Louiz, 2020, Hantem, 2020, Villiot-Leclercq, 2020, Zorn, Feffer, Bauer & Dillenseger, 2020), these difficulties are not inherent characteristics of digital technology, but of the urgency with which educational teams (trainers, teachers, administrative and pedagogical managers) have had to deal.

Human history is full of examples of brutal phenomena that have struck mankind (earthquakes, wars, cholera or the plague, etc.). These disasters often give rise to new reflections on the means to be deployed to avoid them or to mitigate their repercussions.

Today, the experience acquired during this pandemic should enable us to rethink our traditional operation approaches based exclusively on face-to-face teaching and our capacity to adapt to change, and should lead us to continue our reflection by

progressively testing these teaching tools which will eventually modify the "classic" organization of our teaching systems.

To this end, the major problematic related to this research is to show how to make good use of these tools and technological platforms, in order to meet the expectations of autonomy, commitment and motivation of students on the one hand, and to guarantee a level of requirement corresponding to the needs of a quality teaching.

The main objective of this paper is to propose a technical architecture composed of five layers, allowing to analyse the feed data from the different platforms related to the courses implemented during this pandemic period, in order to propose a data virtualization approach aiming at improving the distance learning device.

## 2 STATE OF THE ART

### 2.1 Role of Evaluation in the Teaching/Learning Process

Whether in face-to-face or distance learning, the evaluation of the teaching/learning process is an operation that makes it possible to gather relevant and precise information that consists of establishing a quality diagnosis for decision-making (Georges & Pansu, 2011). It is indeed a diagnosis that must be carried out in order to provide tools to the various actors in the teaching/learning process, to identify the needs of students, to help them reflect on their own learning processes and also to guide teachers and trainers in remedying any difficulties. This is what the end of Legendre's definition suggests: "To evaluate is to understand, to shed light on the action so as to be able to decide correctly what to do next".

The main purpose of evaluation is to support learners through the analysis of feedback. It is in this perspective that the field of education has long been attracted to this concept.

### 2.2 The Feedback

Feedback, is an educational practice implemented, consciously or unconsciously, by all teachers. For the teacher, it is a matter of providing "feedback on a learner's achievement behaviour" (Legendre, 1993), they also specify that achievement behaviour is similar to the result but also to the action to be taken. In an even more holistic approach, (Hattie & Timperley, 2007) present feedback as information provided by a source, not necessarily external

(teacher, booklet, parent or even oneself), on aspects of a person's performance. Thus, feedbacks can take various forms "feedback is conceptualized as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding. A teacher or parent can provide corrective information, a peer can provide an alternative strategy, a book can provide information to clarify ideas, a parent can provide encouragement, and a learner can look up the answer to evaluate the correctness of a response" (Hattie & Timperley, 2007).

The multiple definitions of this concept seem to agree on the importance of collecting data on learning, and on the value of analysing the data collected. It is also one of the most important factors influencing learning in different contexts (Hattie & Timperley, 2007, Hattie & Gan, 2011).

Admittedly, the concept of feedback is simple at first glance. However, the work on this topic is as numerous as the definitions attached to it, so the literature classifies feedback into simple and complex. According to (Hattie & Timperley, 2007), simple feedback has limitations. Although they promote learning and self-regulation, they do not give learners the information they need to understand how to achieve the goal. For complex feedback, some studies show that positive valuing of abilities, i.e. focusing on the person and his/her abilities, provides the student with psychological rewards that result in increased motivation (Anderson, Manoogian & Reznick, 1976) and ultimately help to develop the targeted ability.

It is then considered that, thanks to feedback, the teacher gives the learner tools that will enable him/her to understand all aspects of his/her learning, whether they are notional, methodological or socio-affective. Thus, learners will be accompanied in overcoming learning obstacles and the teacher will be able to prevent the said obstacles by adapting his or her teaching practices and accompanying them towards an active and continuous use of the tools (Ben Romdhane, 2013).

It is therefore necessary, thanks to the analysis of the data provided by the various digital platforms used during this period of pandemic (source of data) and thanks to big data (means of structuring), and to the application of means and techniques of consolidation and data processing, to be able to set up an effective and relevant feedback, helping to promote the learning of learners, The role of information and communication technologies (ICT) in the development of the Moroccan university should be emphasised as an important, if not essential, factor in the personalisation of learning and remediation

(Michelet, 2006), and in the fight against academic failure, among others.

Several technological devices are useful in this perspective: data analysis, big data, data virtualization and many others have become essential components of decision support technologies that gather and analyse data for faster and more efficient strategic and operational decision-making in an organisation.

### 2.3 Data Virtualization

Effective data analysis is a very essential component in the decision's making process for any type of organization. These decisions need to be relevant and fast. Today's educational environment is constantly changing and the COVID19 pandemic has accelerated this change. With the excessive use of exchanges via digital tools and platforms, a large volume of data is generated through them. This data can be a key to the real change desired by institutions and schools.

Data virtualization is a modern technique that creates a layer of abstraction between the data used and the data retrieved from many different applications and distributed across different storage locations (Muniswamaiah & Agerwala, 2019).

So far, data virtualization has brought several features to big data to help organizations adopt and process big data more easily.

Through data virtualization, users can virtually access various data sources, aggregate and combine to form virtual views that can then be exposed as APIs (Application Programming Interfaces) to support multiple formats such as SQL (Structured Query Language). This abstraction provides greater agility and a shorter data integration life cycle. Thus, data virtualization can be a critical component of decision making.

In the following sections, we present in detail the overall technical architecture of the proposed solution, based on the extraction of data from learners' and teachers' feedbacks using the data virtualization technique.

## 3 MOROCCAN HIGHER EDUCATION FACES THE CHALLENGE OF COVID-19

### 3.1 Distance Learning and Decision Support Platforms in Morocco

In recent years, Moroccan university has undergone a new dynamic aimed at improving the performance

and quality of higher education, in particular through the implementation of measures (emergency programme) that place the learner at the centre of educational action and integrate ICT into the world of teaching and education, within the framework of the national strategy.

To this end, the Moroccan education system has been the subject of several reforms and upgrading programmes such as the Education Reform (Law 0100) and the Emergence Project of 2005. Also, it launches several projects dedicated to ICT and their integration in learning and training: The "MARWAN" Network (MAROC Wide Area Network), the Moroccan Virtual Campus (CVM), and so on.

These projects have been consolidated by the strengthening of the technical infrastructure of Internet access in Morocco (Today, about 65% of Moroccans have access to the Internet, 86% of them use it every day, mainly to access social networks, which have a penetration rate of 47%, according to the ANRT report and the Digital Report by We Are Social and Hootsuite), which has facilitated access to Web 2.0 and its services with communicative and collaborative aspects, and to digital social networks, especially by young learners, as part of their exchanges.

Platforms (e.g. blogs, virtual classrooms, forums, social networks, e-mailing and virtual data storage spaces, etc.), make it possible to promote collaborative work, manage projects, courses and discussions and constitute spaces for interaction and exchange of ideas, with others, on a specific theme, without geographical or temporal constraints, where each person participates at his or her own pace (Fourgous, 2011).

Also, in addition to face-to-face teaching, most Moroccan universities currently advocate distance learning in order to keep up with the mutation that the world is undergoing. In this sense, several universities have embarked on projects to create Massive Online Open Courses known by the abbreviation "MOOC" to encourage hybrid training. For example, there is the initiative of Cadi Ayyad University of Marrakech with its UCA MOOC model implemented since 2013, Hassan II University and Ibn Zohr University of Agadir and Mohamed V University of Rabat with MOOC models as diversified and whose effectiveness has been proven and many others.

The integration of ICT into the daily functioning of the classroom thus offers learners opportunities likely to promote, among other things, the personalisation of learning and remediation (Michelet, 2006), thus constituting an asset in the

fight against failure and the promotion of success and motivation. These technologies, as (Barrette, 2007) states, facilitate communication and exchange as well as the transformation of information into meaningful knowledge.

They are also very valuable in the context of tutoring which can be done at a distance learning. Indeed, during e-learning, the learner can benefit from personalised support, which can allow him to learn without the gaze of his peers, he will benefit from adapted advice that allows him to be guided in his learning and supported in his efforts. E-learning therefore has the particularity of creating a link between in-school and out-of-school time, thus devoting more time to learners who need it. Thus, when the relationship is asynchronous or automatic feedback, it also allows the learner to choose the time and place of their learning (Fourgous, 2011).

In brief, technologies have a real impact on learning, motivation, success, etc..., but it is still necessary to develop the art of teaching with them. As Lameul said: "there are no good or bad technologies but more or less good pedagogies using technologies" (Lameul, 2008). The role of the school or university is first and foremost to show learners how to make good use of information and communication technologies and, above all, to provide a favourable context for their exploitation. Of course, without ignoring the digital divide between students, which is extremely visible in the emergency that we are experiencing in these difficult times.

### 3.2 Measures Taken in Response to the COVID-19 Pandemic

Following the declaration of the state of health emergency in Morocco in March 2020, the Ministry of National Education, Vocational Training, Higher Education and Scientific Research has decided to urgently stop face-to-face courses in the various public and private universities and switch to online teaching.

To this effect, a lot of efforts have been made by the different actors of teaching and education in order to overcome this health crisis of COVID-19. To ensure this change to a fully distance education, during the period of containment, many projects have been undertaken at the level of the supervising ministry (by broadcasting the contents of the different cycles of education in the national channels), and others at the level of all institutions of higher education and Moroccan universities.

Each institution, and university has set up, according to its own human, technical and financial

means, as well as its strategies, digital tools allowing its students to access distance learning courses either via Massive Online Open Courses (MOOC), and/or via exchange spaces and collaborative work platforms, either paid or free via web services.

It should be noted that a significant number of teachers and pedagogical actors have mobilized to make this transition a success, through the mobilization of several initiatives aimed at providing students with quality training. Several virtual classes have been created using platforms such as: Google Classroom, Zoom, Google Meet, Skype, Microsoft Teams and many others.

These tools have proven their success in providing teachers and students with high quality collaborative spaces, given their ease of use, their rich functionality (such as screen sharing, file sharing, instant messaging and meeting recording), their effectiveness in terms of actively detecting anyone speaking in a group, their flexibility of use via different types of devices (PC, lap top, Smartphone, Tablet, etc.. .) and their surprising capacity to gather a large number of participants in the same meeting room and also have a better quality of audio and video flow.

Other applications have been mobilized during this unprecedented period, in order to facilitate and/or strengthen communication between: Teachers/students, Administration/students and students/students, such as WhatsApp, Facebook, emails and solutions for storing and sharing large files, such as Google Drive.

A lot of efforts have been made to save the 2019/2020 academic year during the lockdown and after the lockdown, but unfortunately despite the efforts made, several difficulties have been noted (Akhasbi, Belghini, Riyami, Benitto & Gouttaya, 2021) and they are summarized as follows:

- Numerical fraction among students;
- Instability and overload experienced by Internet connections during the lockdown period;
- Overload and bombardment of students with digital resources (Akhasbi, Belghini, Riyami, Benitto & Gouttaya, 2021);
- Lack of support and training for students and teachers not familiar with ICT in teaching practices (Akhasbi, Belghini, Riyami, Benitto & Gouttaya, 2021) (Riyami, Mansouri & Poirier, 2019);
- Difficulties in adapting to this new mode of distance work, sometimes involving several channels of communication, sharing and work (email, WhatsApp, virtual classes, etc.)

(Akhasbi, Belghini, Riyami, Benitto & Gouttaya, 2021) (Riyami, Mansouri & Poirier, 2016);

- Lack of interaction and commitment from students and sometimes from some teachers (Akhasbi, Belghini, Riyami, Benitto & Gouttaya, 2021) (Riyami, Mansouri & Poirier, 1019);
- Problems related to how to evaluate students and ensure equal opportunities (Riyami, Mansouri & Poirier, 2017);
- Etc.

It should be added that the quality of the Internet access network may be judged not to be in conformity with the expectations of the participants (teachers/students), particularly during the period of confinement when these elements remain indispensable for a good follow-up of the distance courses.

To counteract these handicaps, the idea of this research work is to propose an architecture based on means of collecting, consolidating, integrating, homogenising and analysing the data exchanged (feedbacks), through the different tools and distance learning platforms implemented during the crisis period, in order to propose a list of recommendations that will allow, on the one hand, to anticipate new periods of distance teaching/learning imposed by a new similar event (Re-confinement again) and, on the other hand, to propose improvements to the technological approaches adopted.

## 4 PROPOSED APPROACH

The reliability of distance learning is based on two elements that are equally important: the teacher and the platform. The latter is one of the important factors for successful distance learning. Also, the mastery of this tool is compulsory, the student and the teacher must know all the parameters of the platform in order to ensure a good course. The platform also allows time management for those who have constraints. For this, a careful and targeted analysis of the data exchanged in the different platforms mobilised during this period of crisis is very important.

In this perspective, the proposed approach facilitates the extraction and collection of feedback, the structuring, consolidation and storage of relevant data in data warehouses, and finally ensures their analysis, in order to help decision-makers make the right decisions (to improve, remedy or change), at the right time and in the right place (Kalelkar, Churi, & Kalelkar, 2014).

The architecture of the proposed solution is composed of five main layers, the following figure gives an overview of the different tools, techniques, and main elements involved in the processing and virtualization of data related to the feedback of the different actors of the teaching/learning process (teachers, trainers, learners and administrative teams).

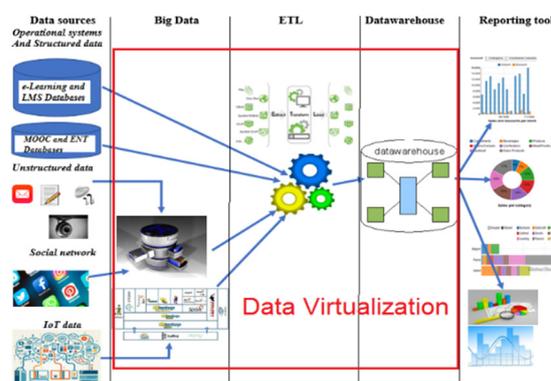


Figure 1: Architecture of the data virtualization we propose.

The distance learning platforms that are used by universities and higher education institutions in Morocco during this period of COVID 19 propagation contain a lot of information and data. These feedbacks are related to teaching materials, discussions between teachers/students and students/students, the different teaching activities implemented, as well as the history and traces of monitoring and evaluation of learners. All these data constitute what is known as big data, "big" because of its enormous unstructured volume which must be exploited in a simple and efficient way.

The approach we propose aims at collecting and analysing this feedback in order to propose recommendations for improvement and innovation of teaching approaches and practices, according to the needs and expectations of learners, encapsulated in their feedback (Kalelkar, Churi, & Kalelkar, 2014) (Janković, Mladenović, Mladenović, Vesković & Glavić, 2018).

Our approach is composed of the following five main layers:

### 4.1 Layer 1: Data Sources

Learner feedback data are the basic data sources for our analysis approach. These data sources come from the databases of distance learning platforms used by universities and higher education institutions such as ENT (Environnement Numérique de Travail), MOOCs, e-Learning systems, on the one hand, and

from data coming from social networks, files, emails, videos, etc. on the other hand (Siddhant, 2021).

## 4.2 Layer 2: Big Data

The second layer of our approach aims at structuring the unstructured source data from different sources such as social networks, emails, files, etc. This layer consolidates the unstructured data and makes it structured through predefined algorithms and programs integrated in Big Data platforms such as Hadoop and Map Reduce. This layer consolidates the unstructured data and makes it structured through predefined algorithms and programs integrated in Big Data platforms such as Hadoop and Map Reduce (Singh & Manisha, 2019).

## 4.3 Layer 3: Consolidation, Homogenisation, Adaptation, and Integration through ETL

This layer offers functions for extracting data from different database management systems (internal or external), transforming this data relating to learner feedback (homogenisation, filtering, calculation) and loading it into the data warehouse. It guarantees the relocation of the calculation load and a better availability of sources. It is at this level that the first software layer of the decision-making environment appears, namely the ETL (Extract, Transformation and Loading) (Muniswamaiah, Agerwala & Tappert, 2019) (Skripak, Aynazarova, Ukhanova, Tkachenko & Erina, 2020).

## 4.4 Layer 4: Data Warehouse

The fourth layer allows the data to be stored in a warehouse called the Datawarehouse. This warehouse contains data that has already been processed and structured by the ETL, is non-volatile (dated), historical and documented. This data structure is deliberately de-normalised in order to optimise response times when carrying out OLAP (On Line Analysis Process) type analyses, which refers to a multidimensional database (also called a cube or hyper cube) and decision support (Muniswamaiah, Agerwala & Tappert, 2019).

## 4.5 Layer 5: Reporting Technical Tools

Once the learner feedback data is stored, cleaned, consolidated and accessible, it can be used and exploited by the final decision-makers. Depending on the needs, different types of extraction and

exploitation tools will be considered. Multidimensional analysis consists of modelling data along several axes. In our situation the ideal axes are: motivation, availability of learning materials, quality of videos, support of learners, accessibility of learning content and many other axes can be defined. The OLAP cube designates the analytical technology that applies to this representation model and allows indicators to be analysed (degree of satisfaction, degree of accessibility, importance, degree of involvement, etc.) and explored along several axes or dimensions. The choice of OLAP architecture will influence all the components of the BI system: performance, volume, query time (Muniswamaiah, Agerwala & Tappert, 2019).

The results obtained in this layer are called decision support dashboards. A dashboard is a performance measurement tool that facilitates the management of one or more educational activities within the framework of a progress or improvement process according to the needs and expectations of learners encapsulated in their feedback. The dashboard also helps to reduce uncertainty and facilitates the risk-taking inherent in all decisions. And on the other hand, it is a decision-making tool that stimulates reflection and facilitates communication.

## 5 RECOMMENDATIONS

In this paper, we propose recommendations to help improve the pedagogical device and also the pedagogical activities put on the distance learning platforms. Our recommendations are inspired by the results of the dashboards obtained according to the various multidimensional analyses relating to the axes of the learners' feedbacks, namely:

- Encouraging learner motivation,
- Access to learning materials at any time,
- Harmonisation and structuring of teaching materials,
- Personalisation and educational differentiation,
- Improvement of the quality of teaching activities,
- Exchange and discussion with the teaching team (teachers who own the courses);
- Personalised supervision of learning,
- Implementation of a digital support platform for students to help them identify their difficulties and problems in learning and support them in remedying their shortcomings (Bouaine, Riyami & Loukili, 2020),
- Etc.

The approach we propose is composed of five layers of virtualization of consolidated data that are physically stored in different databases and storage systems. These virtual data are exploited by decision support tools for improving the pedagogical activities and the pedagogical device, so before helping the decision, they first help to analyse the data in order to detect macroscopic information hidden in large volumes of data (Big Data) concerning the learners' feedbacks on the distance learning platforms.

## 6 CONCLUSION

In life, there are always lessons to be learned and experiences that push us towards change. This pandemic has been a real opportunity for all teachers, including those who do not believe in the contribution of technology to teaching and learning, to become interested in or find themselves in need of integrating digital technology into their educational arrangements and especially, to keep in touch with their learners.

Moreover, not all teachers have had the choice, as this is the solution, which seems possible.

Finally, the approach and recommendations that we intend to propose will be based on the gathering and analysing of learners' needs and expectations through their feedback, after consolidation through decision-making tools.

The following step is the experimentation of the proposed architecture in collaboration with a number of Moroccan higher education institutes in view of enriching the list of recommendations and to propose a model of pedagogical approach suitable to ensure quality of distance learning, able to ensure pedagogical continuity even in case of crisis.

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