

IMPROVING E-LEARNING WITHIN ORGANIZATIONS USING MACHINE LEARNING

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ABSTRACT

This article discusses the issue of improving the occurrence of E-learning professional training within organizations to provide guidance for improving staff efficiency using machine learning. The proposed methodology is based on the statistical learning of a model of evolution of qualifications from available information considered and observations of practices within organizations. The main originality consists in representing the evolution of careers through the specific process of vocational training within companies. This representation will be used in particular to group the types of activities into similar behaviors and to construct a common model for each of the behaviors identified. We then implement a method of automatic learning of a model of evolution of skills using distance professional training (e-learning). This model makes it possible to provide a predictor of the occurrence of the need to set up professional training in e-learning over a given future period and therefore to give advice for training freely at any time and from any place for employees.

Keywords: *Machine Learning, E-Learning, Prediction, Organisations Improving.*

1. INTRODUCTION

In a universe of extraordinary change in knowledge, technologies, cultures and worlds that meet and intersect or competition and increasingly extreme in which knowledge is the heart of development, new specific mechanisms in training /learning. Appeared thanks to technology and the explosion of the Internet, a new mode of distance learning has surfaced. Online training allows a multitude of new possibilities, especially in fields and sectors that may be limited by various constraints. In other words, it opens up new avenues for learning in general, it corresponds to the use of computer technologies which help learners to improve their performance and knowledge through the exchange of necessary information, which allows total autonomy of users. Learning is therefore flexible and faster, e-Learning has developed and already appear the first generations of students who have done all of their training in this way. It covers a large part of the situations of daily life, professional and media.

The main purpose of this learning is to organize the training and facilitate the task for teachers and learners as well as facilitate the search, the obtaining and the transmission of knowledge to understand and respond, to express oneself by giving opinions, would encourage the learning to communicate with others. Today, we operate in an economic environment based on innovation. For the company, the adaptability of employees and their ability to acquire new skills are a major challenge. Through this article, we will discuss the effectiveness of e-learning training to meet this challenge[1]. Whether for the company or for the employee, this learning method has many advantages. It is in this perspective that we have developed this article since we have discovered that there is a close relationship between improving the performance of organizations using e-learning by referring to in-depth analyzes based on machine learning technique. Machine Learning or automatic learning is a scientific field, and more specifically a subcategory of artificial intelligence. It consists of letting algorithms discover “patterns”, namely recurring patterns, in data sets. This data can be

numbers, words, images, statistics. Anything that can be stored digitally can serve as data for Machine Learning. By detecting patterns in this data, algorithms learn and improve their performance in performing a specific task. The research presented in this article is organized around three axes, first, we introduce the concepts related to our subject. We will then present the materials and methods, then we will model these series of yields by estimating the intensity using computer tools and the available data.

2. MATERIALS AND METHODS:

Today, e-learning is one of the most adaptable methods for companies, and an alternative that makes it possible to overcome the limits of traditional training while ensuring good efficiency [2]. Artificial Intelligence (AI) was defined early on by one of its founding fathers, Martin Minsky, as "the science of making machines do things that would require intelligence if they were made by men. While most of this definition remains true today, modern computer scientists go one step further and define AI as a system that can perceive its environment and take action to maximize the chances of achieving its goals. Additionally, it is a system with the ability to interpret and analyze data in a way that it learns and adapts as it goes. Among the tools of artificial intelligence we find Big Data, Data Mining, Machine learning ... ect[3].

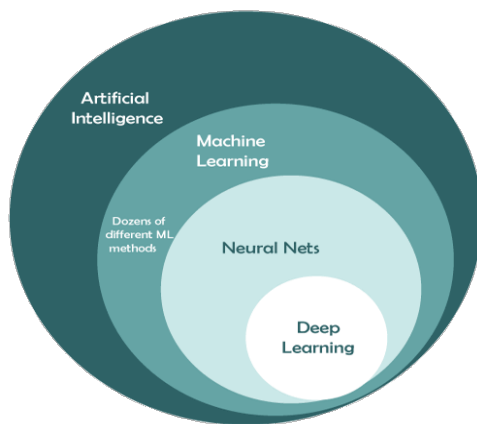


Figure 1: Artificial Intelligence Structure

In this study we will use the Machine learning technique to Analyze the available data in order to quantify the importance and the requirement of implementing e-learning training within organizations in order to improve the performance of the organization , to improve staff qualifications and above all to optimize all available resources .

3. CONCEPTUAL SPACE OF E-LEARNING:

"Online" training, known as "e-learning", is "the use of new multimedia Internet technologies to improve the quality of learning by facilitating access to resources and services, on the other hand, exchanges and remote collaboration" (European Commission, 2001). E-learning is part of information and communication technologies for education (ICTE) and allows non-face-to-face activities to be carried out. This is most often the use of computers or mobile devices (smartphones, tablets, PDAs, etc.) connected to the Internet [4]. E-learning is especially suitable for developing cognitive skills, and, with specific methods, interpersonal skills. E-learning training can be self-study (digital learning courseware) or facilitated (chronological syllabus).

Facilitators have a major role in planning activities and facilitating training activities with participants[5]. They use two groups of communication tools:

- a. Asynchronous tools (independent of time) which correspond to the use of emails, discussion forums, wikis and other shared tools: publishing, blogs, webcasting.
- b. Synchronous (real-time) tools that correspond to live contact times through instant messaging, polls, interactive whiteboards or screen sharing, application sharing tools, audio conferencing and video, live webcasting.

E-learning can be structured according to a course linking different sessions or be personalized according to the profile of the participant.

With the advent of the Internet, E-learning, this new digitalized teaching method, is taking an increasingly important place in our education system. Behind this technological and modern side, however, hides a much older story than it seems. It all started in 1728 when a certain Caleb Phillips placed an advertisement for correspondence courses in the Boston Gazette, a major American weekly [6]. By offering himself this advertising insert, Sir Phillips did not imagine that he was coming to mark the beginning of distance learning. The development of the paper press being at that time in full swing, correspondence courses developed rapidly[7].

At first, it was mainly individuals who offered training or tutoring, but schools and certain renowned establishments were also beginning to take an interest in this phenomenon. A phenomenon that would grow until 1858 when the University of London became the first major institution to award diplomas to students who had completed their training at a distance[8].

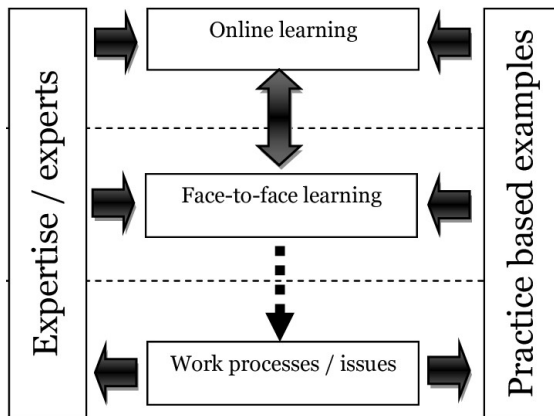


Figure 2: Integration Of Distance Education In Organizations

Distance education being, by its nature, intimately linked to the development of the media, it was necessary to wait until the end of the 1940s to see the next notable development appear. It is the advent of radio and television that shakes up the system in motion. With these two extremely powerful means of mass communication, it is now possible to follow courses recorded and rebroadcast through the hertzian waves. This is the first time that the lessons no longer need to be distributed entirely on paper. From the 1980s, the last and perhaps the greatest revolution in the history of online education took place: its computer development[9]. The generalized access to personal computers allows the emergence of new practices. Learning software is emerging and it is becoming possible to interact directly with a keyboard and mouse. The arrival of the internet and e-mails allow direct communication between learners and teachers.

Today these means of communication have not finished developing and web 4.0 offers very interesting new possibilities. We have entered a connectivity area where information becomes available to the student with a single click and at any time[10].

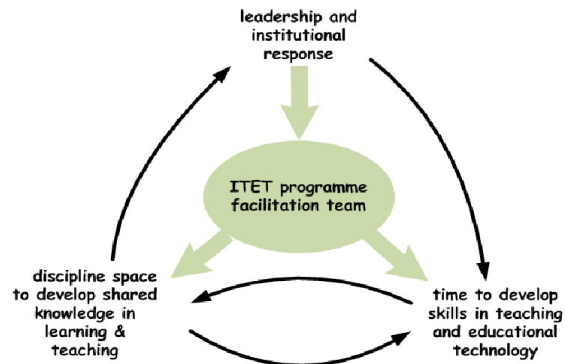


Figure 3: E-Learning Adoption In An Organization

Regarding the brakes of e-learning in organizations, we mainly have five:

- a. Cultural obstacles: According to the AFINEF study, for 45% of respondents, the main obstacle to e-learning is cultural. This training medium grants more autonomy and freedom to the learner, but the latter must be individually involved in his learning. This upheaval of roles in which the learner becomes an actor in his learning and in which the manager can follow the evolution of the achievements, requires the learner to be more involved in his training. Thus, the employee in training cannot skip sections of the e-learning course because his knowledge is constantly assessed. The training departments must therefore have a communication budget to ensure that employees adhere to this permanent education.
- b. Budgetary obstacles: The main motivation of companies for setting up an e-learning training platform is to reduce and optimize costs. In the 2015 e-learning barometer, this criterion comes first for 63% of the companies surveyed. However, to implement an e-learning system, it is necessary to plan an investment phase that is not always compatible with a strategy of immediate reduction of training costs.

- c. Bad previous experiences: LMS platforms are constantly evolving to adapt to the new needs of training departments, to meet the challenges of digital and individualization. However, it is necessary to seduce and convince employees who have "undergone" massive training, sometimes poor in pedagogy and interactivity. Thus, "default & without personalization" e-learning content is over. On the other hand, the new generation of LMS platform makes it possible to develop interactivity and adapt training materials and themes to the needs of each individual.
- d. Technical obstacles: The multiplicity of tools used during e-learning training, interactive videos, rapid learning, social learning, serious range, mobile learning, are not always compatible with the infrastructure of companies. Some face technical obstacles due to a certain obsolescence of hardware and computer networks or real shortcomings in terms of digital transformation.
- e. Organizational and managerial barriers: It is not necessarily easy to find time to study and take training at your workplace. Closed offices are becoming rare and open space platforms or coworking areas do not encourage learners to start training in peace. In addition, the manager is not always involved in the training program and he may object to an employee physically present at his office devoting himself to an activity other than his job. To avoid this situation, some companies have made training rooms available so that the employee can access their training during dedicated times and in good conditions. However, this choice requires financial means and premises available for this space dedicated to professional training.

The presence of these brakes does not limit the rise of e-learning in the training offers of companies and even less the decision to fundamentally renovate the teaching methods. Indeed, e-learning has many advantages in the eyes of managers: optimization of training costs, improvement of the quality and efficiency of training and dissemination of training on a larger scale[11].

4. TRAINING IN ORGANIZATIONS:

The company is today in a world: less and less secure (context of crisis and increased risk-taking, dependence on international fluctuations, competition, sudden changes, rapid repercussions of economic or environmental phenomena on the economy of a country and therefore, in the long term, on the company) [12], less and less stable (technological evolution, evolution of expectations, movements of capital, etc.) and increasingly complex (high technologies, administration, taking into account unforeseen phenomena, legislative context, etc.).



Figure 4: Training Process In An Organization

All these constraints oblige the company that wants to remain efficient, profitable and competitive, to fully take into account the human factor, a real challenge for strategy and development. The Business Leader can assume that all people who are engaged in an organization have the skills necessary for the exercise of their function, at least at a basic level of "starting professional" [13]. For the company, training means Adapting its human resources to technological, organizational and regulatory changes in the market and thus increasing its competitiveness, Avoiding the risk of unemployability of its employees and thus being more agile on the occasion of reversals of economic trends, Bringing in new ideas, original methods and techniques and thus innovating and taking a step ahead, Allowing each of its employees to better master the skills of their profession and thus be more comfortable in their work, more confident,

more motivated... Sharing skills and ways of doing things between employees and thus creating a more united work collective, Recognizing the value of its human resources by offering everyone the opportunity to develop and progress, Authenticate the skills of its employees, "qualify" them and thus guarantee its customers proof of the quality of its resources. human resources[14], Comply with the new requirements in terms of HR development: obligation to adapt and maintain employment and obligation that two of these three criteria be met within the 6-year interval (training followed and/or acquisition of certification through training or VAE and/or salary or professional progression).

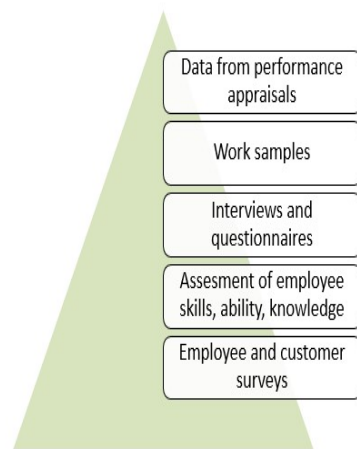


Figure 5: Levels Of Training Needs Analysis In Elearning

Also, in a socio-economic context that makes training a challenge for careers and employability, e-learning tries to respond to the new missions of training: to support people throughout their lives. professional by offering them the opportunity to train, enrich themselves and specialize. If in companies, the effects of e-learning are still timid, the fact remains that many companies have already begun to integrate training directly into the work environment of employees by providing them with various assistance devices. (fault or error diagnosis documents, operating mode manuals, etc.). Some of these devices are already available online (online help, tutorials, decision support systems, etc.) [15]. We bet that it is by integrating more and more training into the exercise of the profession itself that e-learning will experience its most beautiful developments in business. It is a set of actions, means, techniques and planned support by means of which employees are encouraged to improve their knowledge, their behaviors, their attitudes and their abilities and their mental capacity, necessary both to achieve the

objectives of the organization and personal or social objectives, to adapt to their environment and to adequately accomplish their current and future tasks[16]. Training involves teaching an employee the knowledge and skills necessary to perform their day-to-day duties. Vocational training is generally adopted for people already exercising a professional activity, and wishing to increase their skills[17].

Other names for training: Individual development, Improvement, Retraining, Apprenticeship, Training;

Regarding the objectives of training, with the rapid evolution of the environment and professions, undertaking training actions is now an indisputable necessity. The evolution of professions therefore requires an effort to develop the technical skills of the sales organization and even mentalities. The objectives must be defined according to the strategies of the organization. The GR department proposes objectives that take into account existing constraints, in particular the financial resources available for training. Without clear objectives, the training program will be difficult to establish and decisions will be made under pressure that will make no sense[18]. The main objectives targeted during in-company training are: To ensure the adequacy between the capacities and knowledge of the employees, To adapt the employees to well-defined tasks and to job changes, To maintain a degree of competence necessary for the progress of the organization, Improve the status of employees through advancement in the organization, Promote the efficiency of all new employees through better use of materials and equipment and a reduction in accidents and departures, Contribute to the expansion program and the HR acquisition policy, Generates better behavior at work and fosters positive attitudes that reduce costs and production losses as well as improve the quality and quantity of products, Increase self-esteem in each employee, Helping to develop prevention and protection of employees in specific situations, Helping the unemployed to integrate more easily into new organizations, Improve the oral expressions of employees and make them lose their stress when they make a professional presentation, Promote interpersonal relations and the analysis of organizational situations, Adapt to the requirements of the ever-changing environment[19], Develop the judgment skills of the trainees, Carry out state projects in order to solve problems, Create a feeling of belonging among employees towards their organization and promote a better perception of the workplace, Help with the integration of right person

in the right place at the right time, Give employees the opportunity to acquire a general knowledge or to maintain it or even to perfect it[20].

5. THE DIFFERENT MODES OF IN-COMPANY TRAINING:

Vocational training is an initiative that is becoming more and more important within the framework of the company. Indeed, it becomes an essential pillar in the development of companies and their adaptation to changes in organizations and the market. It concerns business leaders, employees and professionals exercising their functions in multiple fields. Vocational training concerns all parties, therefore both the employer and the employee[21].



Figure 6: The Importance Of Training And Development In The Workplace

There are basically two types of training:

5.1 Face-to-face training

At this level we distinguish between two types, group face-to-face training and private face-to-face training. Face-to-face group training: A group of trainees are gathered in a place to follow their training. Generally these trainings take place in the big cities for reasons of accessibility for the trainees. The training organization or company must be transparent about the number of participants in the training. Two training formulas exist: Small group learning (less than 10 people): this formula favors interactivity and exchanges between the trainer and his trainees. However, its cost may be a little higher. Large group learning (up to 30 participants): this formula, on the other hand, has a lower cost. It is characterized by being much more anonymous than small group learning. Private face-to-face training This type of training is generally chosen by real estate professionals[22].

This private learning method allows the trainee to better assimilate the training and to correctly master the basics. Entrepreneurs often tend to choose this type of training because it turns out to be more suited to their needs; fast, precise

and effective training. Over an equivalent period, private face-to-face training is much more in-depth than face-to-face group training.

5.2 Online training (e-learning)

Learning via the internet or using technology is a method that consists of teaching training using a computerized platform (Learning management system LMS). The main advantage of this type of training is that it allows staff to follow their learning at their own pace and according to their availability. The LMS platform offers a specific interactivity that facilitates the assimilation of information. It is designed in a light-writing style and based instead on simplified schematics and diagrams.

Like any managerial action, vocational training seeks to provide the company with added value insofar as any training action is intended to be a learning path aimed at instilling in learners a set of skills and know-how. The Internet offers an opening on the outside: the network opens the walls of the class to a whole world which sometimes informs, which also often floods. It can be seen as a way to create new situations where the learner can elaborate meaning. Thus thinking about the use of the Internet means imagining a learning activity that integrates ICT as one of its facets. Since we cannot oblige the student (extrinsic motivation), we must imagine situations that mobilize the motivational forces that the Internet conceals, while registering them in the direction of the learning objectives to arouse an intrinsic motivation. ICT allow the teacher to renew himself, to rethink his teaching, to discover new tools, to update and enrich the content of his course, to experiment with new avenues, to compare his experiences with other teachers (there are many websites for teachers with activity banks, offering exchange and discussion forums, and displaying class achievements). He can either use ready-made tools (software or activities), or develop his own content. The implementation of online training is not, at least not only, technically determined. In a few years, the Personnel function is transformed into a Human Resources function. The name change is a change of perspective and practices. The traditional conception of personnel perceived as a source of costs that must be minimized gives way to the perception of personnel considered as a resource whose use must be optimized[23]. Also, the function has taken on a strategic dimension. Consequently, the HRD must now put in place a strategic management of human resources. Training, as a major lever for the

development of this capital, then becomes a subject of interest beyond simple intellectual and social discourse. It is and is becoming a competitive issue. But to serve the company even better, it must live up to its ambitions: speed, flexibility, efficiency, profitability. To deal with it, the traditional system conditioned by the unity of time, space and place is ineffective. E-Learning is therefore a conquering and essential concept[24]. However, it has certain limits, which force companies to ask themselves the right questions before embarking on this innovative approach. It appears much more as a social situation of skills development, resulting both from the technological determinism of the new devices, the cognitive models implemented, the learning content, the educational experience acquired, the individual and collective strategies of the actors (learners and trainers) and operational strategies based on what individuals think of what they are learning or have to learn. Thus, setting up virtual training cannot be reduced to a simple transfer of knowledge from a sophisticated machine to human individuals. This is a complex process, which shows that individuals seized by such a movement develop specific strategies for appropriating the tool and inventing a new relationship to their own education[25].

6. MACHINE LEARNING :

Machine Learning can be defined as an artificial intelligence technology that allows machines to learn without having been previously programmed specifically for this purpose. Machine Learning is explicitly tied to Big Data, as to learn and grow, computers need streams of data to analyze, to train on. As a result, Machine Learning, essentially derived from Big Data, needs the latter precisely to function. Machine Learning and Big Data are therefore interdependent. Still confusing for many people, Machine Learning is a modern science for discovering repetitions (patterns) in one or more data streams and making predictions based on statistics[26].

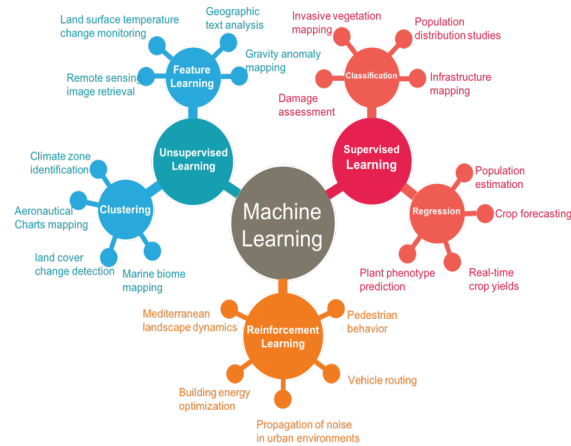


Figure 6: Machine Learning Structure

Clearly, Machine Learning is based on data mining, allowing pattern recognition to provide predictive analysis. The first Machine Learning algorithms are not new, since some were designed as early as 1950, the best known of them being the Perceptron. Machine Learning reveals its full potential in situations where insights (trends) must be identified from large sets of diverse and varied data, called Big Data[27]. To analyze such volumes of data, Machine Learning is much more efficient in terms of speed and accuracy than other traditional methodologies. Machine Learning is really the ideal science to take advantage of Big Data and its opportunities. This technology is indeed able to extract valuable data from huge sources of complex information, without having to call on humans. Entirely driven by data, Machine Learning is therefore perfectly suited to the complexity of Big Data, from which it is truly inseparable. Where traditional analytical tools often come up against a maximum volume of data that can be analyzed, Machine Learning on the contrary reveals its full potential when the sources of data are growing, allowing it to learn and refine insights with ever-increasing accuracy. Simply put, the more data there is, the more powerful machines equipped with machine learning can uncover patterns buried in that data much more effectively than human intelligence can.

There are different types of machine learning algorithms. Generally, they can be divided into two categories: supervised and unsupervised. In the case of supervised learning, the data used for training is already “tagged”. Therefore, the Machine Learning model already knows what to look for (pattern, element, etc.) in this data. At the end of the training, the trained model will be able to find the same elements on unlabeled data. Among the

supervised algorithms, there are classification algorithms (non-numerical predictions) and regression algorithms (numerical predictions). Depending on the problem to be solved, one of these two archetypes will be used[28]. Unsupervised learning, on the contrary, involves training the model on unlabeled data. The machine goes through the data without any clues, and tries to discover recurring patterns or trends. This approach is commonly used in certain fields, such as cybersecurity[29]. Among the unsupervised models, we distinguish clustering algorithms (to find groups of similar objects), association (to find links between objects) and dimensional reduction (to choose or extract features) [30]. A third approach is reinforcement learning. In this case, the algorithm learns by trying again and again to achieve a specific goal. He can try all kinds of techniques to achieve this. The model is rewarded if it gets close to the goal, or penalized if it fails.

On a technical level, machine learning is defined as a set of algorithms with the ability to manufacture models without human intervention. It is in particular an improvement made to the machines in order to make them more autonomous by providing them with an analysis capacity. A multitude of data feed this technology allowing it to carry out statistical analyzes aimed at giving a first result. In other words, the information generated by machine learning exists thanks to models and algorithms. Machine learning is already invading the daily life of modern companies, in such a way as to facilitate certain processes and branches. Machine learning can have a big impact in the professional services industry. It can be used to perform and accelerate repetitive tasks, to accurately anticipate workloads and employee needs. Where companies struggle to deploy the right resources to the right projects, Machine Learning can improve speed, quality and efficiency by continuously learning from previous decisions. The professional services sector has always relied heavily on human skills and therefore new technologies have not had as much impact on this sector as in manufacturing companies for example[31]. However, this changes with Machine Learning. Professional services like e-learning, auditing, and call centers are automated because machines can process data faster, resulting in better performance. As a result, jobs within professional services firms are changing, with some jobs disappearing as repetitive tasks are increasingly automated. Jobs that are more subject to human decisions and specific expertise will remain stable[32]. From the literature review, we can say

that e-learning frameworks play a vital role in adapting within organizations, especially for working people[37]. Overall, most learning frameworks do not adapt to learner profiles. Learners have to invest a ton of time before arriving at the learning objective that is perfect with their insight base[38]. Machine learning is a kind of artificial intelligence that gives machines the ability to learn without being expressly personalized it focuses in the situation of improving organizations on the advancement of machine projects that can grow and change when presented with new information.

7. RESULT:

For several years, e-Learning and other terms that are more or less directly associated with it have continued to develop within society and businesses. Its growing presence corresponds to the conjunction of several factors, some of which will be developed below. The two main factors are probably the evolution of technical devices and the evolution of regulatory constraints around training, but other factors also help to explain this evolution. We present in this section the results of an extraction of data on e-learning in Moroccan companies and potential experiences using machine learning tools. In Morocco, it is important to point out that Moroccan companies attach increasing importance to human resources management and staff training. It nevertheless appears that e-Learning is still in an embryonic phase, so for companies that adopt e-learning this will allow them to carry out technological innovations, to develop a greater potential for skills and to improve the performance of the 'business. Large geographically dispersed companies find a real interest in this type of training, which eliminates distances and reduces costs, and many large international companies have already made virtual training modules available to their employees which supplement traditional training; these are mainly large groups and companies in the financial sector. the study to relate only to organizations or companies using e-learning and which were able to share their data.

We used the Cnvr.io tool for processing data from Moroccan companies with the ability to extract data using Machine learning. The results are presented as follows:

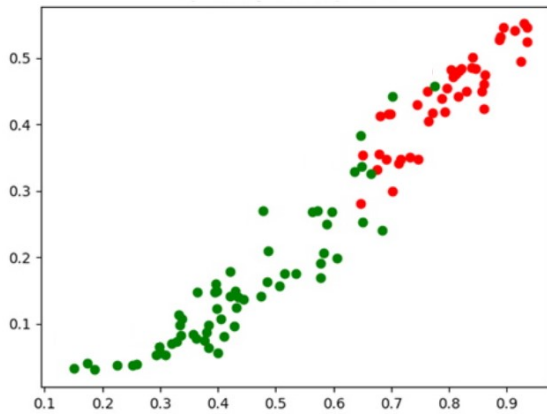


Figure 7: The Impact Of E-Learning On Organizational Performance

From Figure 7, we can say that to stand out from the competition, companies increase their industrial production and improve their services. In this sense, innovation remains a privilege reserved for companies that invest in the training of their employees. E-learning is an infallible way to reconcile work and learning. The majority of companies using e-learning (in red) were able to obtain a higher level of performance than other companies.

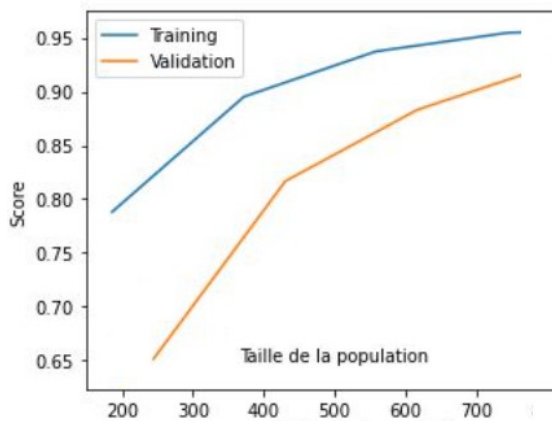


Figure 9: Using The Learning Curve

However, the collection of data required carrying out multiple tests since we were not able to obtain results from all the participants. We were therefore obliged to expand the population to 715 data to extract the maximum amount of information on the basis of a simple random sample composed only of organizations with available data. We plot the Learning Curve, which shows the evolution of the model's score as a function of the number of data. The Learning Curve above, evolves strongly at the beginning then presents an asymptotic character

715 Data. This curve allowed us to know the sufficient number of data to have a model with good predictability. The Learning Curve is obviously largely a function of the data and the complexity of the problem to be solved.

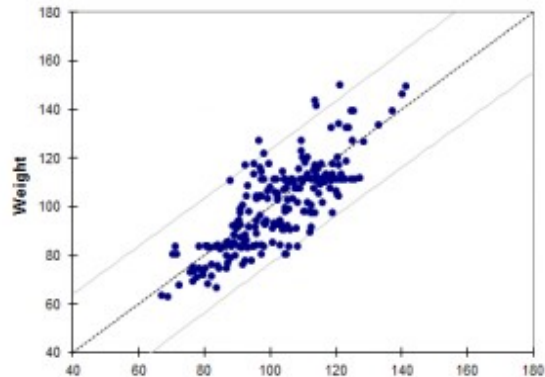


Figure 10: Regression Analysis Relative To Available Data

Between-variable regression is the simplest tool we used to confirm the results. It is indeed Machine Learning, since from existing data, we will model a behavior that will be used to predict data not yet known on this regression line. The figure opposite illustrates the hardness scatter plots and the regression lines (more or less correlated) according to the magnesium content. So following the representation, we can say that the machine learning technique presents a very powerful tool for detecting the influence of e-learning on improving the performance of organizations.

8. CONCLUSION

The world does not seem ready to begin a return to traditional training. Companies that have opted for e-learning are gradually finding their mark and consolidating their initiatives. Most organizations now have online training modules. Many experiments are emerging in the academic world, in areas of increasing complexity. For generalization and success of lifelong training, learning must be adapted to the lifestyle of workers and anyone with difficulties either travel or time management. And it is precisely with the spatio-temporal flexibility of distance learning that makes it possible to arrange learning according to the availability of each other, to respect the rhythm of each. With this Distance Training, companies can

move training activities to the beneficiaries' homes or to the company, but outside of working hours. Thus, both for the company and the employee, it has economic advantages that face-to-face teaching did not have. From the results, we can say that e-learning will have a very important impact on improving the professionalism of organizations, this can directly contribute to improving organizational performance in particular. According to our results, we can see that machine learning is necessary for the processing of data relating to training needs within organizations as it presents an asset for determining the results of training, in particular using e-learning. Finally, e-learning will take place partly remotely but not necessarily totally: the goal is to maximize the advantages of each mode of training delivery, and to minimize their respective disadvantages.

LIMITATIONS OF STUDY AND PROSPECTS

Regarding the limits of this study, we can say that machine learning for e-learning is a very powerful tool but there is no "ultimate" algorithm and model, applicable for all problems, so users must address each new problem with a fresh eye and make sure to test several algorithms in order to solve it, by formulating hypotheses specific to this problem. Another limit is that it often happens to be confronted with very powerful algorithms and models, but too complicated to be used directly. To avoid these situations of intractability, you must not be afraid to perform approximations that allow you to gain in efficiency. In this context, our future research directive will focus on improving the efficiency of e-learning research using Blockchain tools.

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