



D-Learning and COVID-19 Crisis: Appraisal of Reactions and Means of Perpetuity

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Abstract

Distance Learning (D-learning), as an alternative educational solution for students who cannot attend in-person classes, has been deployed during the COVID-19 pandemic to deliver the promises promoted long ago by technology and education experts. For many professors and students, the shift was a first as they had to resume their classes fully online despite not being academically competent to do so. This research paper examines the D-learning scenario introduced by Moulay Ismail University (MIU). It is based on the intelligent Association Rules method to identify relations between different variables. The significance of the method lies in its ability to assist in drawing relevant and accurate conclusions for decision-makers on how to rectify and adjust the adopted D-learning model in Morocco and elsewhere. The method also tracks the most probable future rules that govern the behavior of the population under study vis-à-vis D-learning; once these rules are outlined, the training quality can be dramatically improved by adopting better-informed strategies. The study concludes that most recurrent D-learning issues reported by students systematically interrelate with ownership of gadgets and that once specific procedures are implemented, reports concerning the D-learning experience at MIU are likely to be more comforting.

Keywords D-learning · COVID-19 · Intelligent association rules · Kirkpatrick's evaluation model

Background

Following the Moroccan government's decision to impose a complete lockdown to prevent the spread of COVID-19, the ministry of education took steps to ensure the continuation of studies remotely, such as broadcasting TV lectures and courses on a variety of topics covering various fields of knowledge. Conversely, universities strove to become more autonomous by launching their own D-learning portals and social media channels, producing original video podcasts, and providing access to prestigious library databases.

Many schools around the world are likely to continue to use D-learning as a backup plan post the pandemic,

particularly those dealing with large-size classes. So far, the government's official bulletins and communications have embraced reassuring rhetoric about the D-learning model during the lockdown without providing any confirmatory impact evaluation reports [16]. Examining the government's efforts in this regard without a meticulous evaluation of the process and the methodology used may promote groundless unforeseen misperceptions about the effectiveness of D-learning or even misdirect efforts to mend the gaps in the proposed learning scenario [25]). Because it is critical to obtain feedback from students to assess the effectiveness of the experience and identify areas of flaw that obstruct the achievement of optimal results, this study comes as an attempt to provide a preliminary concise evaluation of the D-learning scenario used at Moulay Ismail University's School of Technology. The setting serves as a sample case study that meets the criteria of representation and randomization given that the students descend from various communities and social milieus (urban communities, suburban towns, distant villages, etc.).

The evaluation is based on Kirkpatrick's (1996) four-level impact evaluation model and the Association Rules method. The authors stick to Kirkpatrick's levels of reaction

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and learning and the process is broken down into four sub-rubrics: Accessibility (students' ability to use the resources placed at their disposal in the platform), Autonomy (students' ability to process/digest the course material provided by the faculty), Retention (students' ability to provide constructive feedback and perform well on exams), and Psychological Impact (the student's capacity to cope with the D-learning unique atmosphere). Following, comes the analysis of generated data via the Association Rules method conventionally used in artificial intelligence to validate the study findings, highlight anomalies of the system, and explain relations between variables before applying any recommendations.

The paper is organized as follows: The first section discusses the theoretical framework of the paper, particularly that of the evaluation and analysis models used. The related work section is devoted to the state of the art relative to D-learning (locally and internationally). The methodology section provides rigorous details about the surveyed population, Kirkpatrick's model, and the association rules method. Following, comes the results, discussion, and implementation sections. The study comes to a close with a discussion of the limitations and a conclusion.

Theoretical Framework

Program Evaluation: Donald Kirkpatrick's Four Levels of Evaluation

Donald Kirkpatrick suggests four fundamental levels of evaluation in the Training and Development Journal, and they became the standard for most, if not all, subsequent evaluation models [14]. It was first used in a project to evaluate a supervisory training program, but the model's simplicity, effectiveness, and comprehensiveness make it a good fit for a wide range of study fields, including medicine, higher education, vocational education, blended learning, ICT, and so on [18]. Kirkpatrick had to alter or update the levels' rules regularly due to the ever-changing research on evaluation, however, the four levels (reaction/learning/behavior/evaluation) remained unchanged. Given that each level leads to a more intricate, time-consuming, and information-rich level, the levels are commonly referred to as steps or taxonomy (Kirkpatrick 1996).

1. Reaction: Kirkpatrick also refers to it as a "measure of consumer satisfaction" (Kirkpatrick 1996). According to him, a customer is anyone who participates in a training course, regardless of whether it was paid for or not, and whether it was voluntary or required by an organization. Although the model was created almost 60 years ago, Kirkpatrick uses a bottom-up approach to evaluation

because he feels that positive trainee reactions are vital for trainers and those who create public programs.

2. Learning: This stage assesses the success or failure of the inputs, and the influence they had on the learners at one, or more, of three levels: knowledge, skills, or attitudes. Certain programs focus on improving one of these skills, such as languages or engineering, while others, such as motivation and communication courses, might use integrative ways to improve two or even three skills. To be on the safe side, the evaluator must explicitly define their objectives.
3. Behavior: This step is referred to as the transfer of training. It examines if the training has influenced the learner's behavior at work or school in the way that the institution or organization anticipated after the learner completed a specific program. Kirkpatrick, as mentioned previously in this section, points out that institutions that conduct evaluations are more likely to forgo behavior and outcomes evaluations; nevertheless, some institutes skip the first two levels entirely to focus on behavior assessment from the start. He disapproves of the approach and even refers to it as a "major blunder," because a program's failure to deliver at the level of behavior does not automatically imply that it failed at the level of reaction and learning.
4. Results: This step assesses the final findings as well as the training's impact on learners and institutions. Profit increases, better quality goods, higher graduation rates, cost reductions, reinforcement of desired behaviors and beliefs, reduced drop-out rates, and so on are all examples of optimal outcomes. It is critical to recognize that outcomes like these are the reason why some training programs exist, so it is critical to clearly state the evaluation objectives. [14].

Kirkpatrick's Model Vs. E-learning Evaluation Model

Being futuristic and innovative study fields, Instructional Technology (IT), E-learning, and D-learning have recently drawn the attention of scholars who enriched the academic field with books, articles, reviews, etc. One, thus, cannot help asking: Are the conventional evaluation approaches and methods applicable to this newly established arena of research? How can an approach or a model that was first elaborated in the 1950s or even earlier provide a credited platform to judge the worthiness of a technology-based learning model?

William Horton (2001), for whom Donald Kirkpatrick has occasionally expressed his admiration and appreciation, confidently answers that the four-level framework applies quite well in this prospect. Although the argument may seem naïve and primitive, Horton (2001) asserts that the purpose of the evaluation is getting to the results rather

than being concerned with the means; what matters the most is achieving the results regardless of the mechanisms “*Since we are measuring results rather than mechanisms, we can use this framework to evaluate e-learning as we do to evaluate other forms of learning.*” (Horton 2006, p.36). Hence, he projects Kirkpatrick’s model to the E-learning model he proposes as shown below (Fig. 1), and adapts each level’s objectives to the new needs.

Scanlon et al. (2000) introduced a framework that summarizes 25 years of experience in technology evaluation at the Open University in the United Kingdom. The CIAO framework is tri-dimensional: Context, Interactions, and Outcomes. At the context level, the evaluation answers why, how, and where technology is used within the course. The interaction evaluation investigates how students interact with their peers and their teachers. The outcomes evaluation, eventually, Table 1 examines and inspects any changes (cognitive, behavioral...) that took place after using technology.

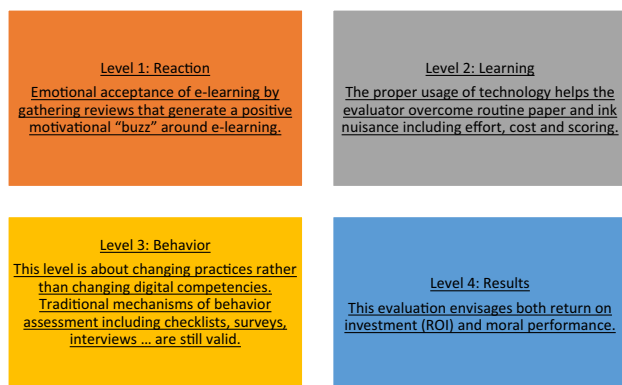


Fig. 1 Projection of Kirkpatrick’s model on the E-learning model

Table 1 CIAO framework

	Context	Interactions	Outcomes
Rationale	To evaluate technology, we must first understand its goals and the environment in which it is used	Observing students and collecting process data helps us learn why and how a certain component works as well as whether it actually works	It is indeed challenging to credit learning results to technology when it is just one component of a complicated course. It is critical to track both cognitive and emotional learning outcomes (such as changes in perceptions and attitudes)
Data	Designers’ and course teams’ aims Policy documents and meeting records	Records of student interactions Student diaries Online logs	Measures of learning Changes in students’ attitudes and perceptions
Methods	Interviews with technology program designers and course team members Analysis of policy documents	Observation Diaries Video/audio and computer recording	Interviews Questionnaires Tests

Source: Adapted from Scanlon, E. et al. Educ. Technol. Soc., 3(4), 101–107, 2000

Association Rules Models

Today, Association Rules are adopted in many domains such as web browsing, intrusion detection, and bioinformatics. They are used to identify connections between two or more variables to reveal the hypothetical likelihood to obtain similar results and connections in the future. Their significance resides in their ability to locate anomalies and direct the decision-makers toward better practices should some parameters be reset accordingly.

In this work, we use the apriori association rule to uncover the rules that control our D-learning phenomena. To this end, we discuss the different possible levels of confidence in the investigated rules.

The area of association models is considered a part of the unsupervised symbolic learning approaches used in the field of data mining [1].

Apriori Algorithm

The best-known association rule algorithm is the Apriori algorithm. [6] and the first one incorporates pruning operations to handle the growing number of candidate itemsets. The process of the algorithm takes three steps:

- Generating sets of items;
- Calculating the frequency of item sets;
- Keeping the sets of items with minimal support, which represent the sets of frequent items.

In the Apriori algorithm, the calculation of the supports and the generation of the rules are very time-consuming.

Related Work

D-learning research during the COVID-19 pandemic is still running strong in many areas of the world, and it is likely to make up a new field of study [8]. It may take some time to form a thorough crystal-clear judgment about this once-in-a-lifetime encounter. Meanwhile, a lot of research publications have attempted to convey viewpoints from various perspectives.

In a recent study, Photopoulos et al. [22] collected quantitative and qualitative data from 336 students. The surveyed students reported increased involvement and learning within the in-person classes. Senior students who had face-to-face relationships before the pandemic expressed their ability to communicate remotely, whereas first-year students struggled the hardest to build relationships remotely. Kwee [15], however, focused on teachers by investigating the incentives and the deterrents that impact language instructors' online teaching decisions. The research is based on three questions that should provide pertinent data on what teachers think of online education, what motivates them to continue teaching remotely, and what challenges force them to give up these courses. The multinational study is based on the Social Cognitive Career Theory and Interpretative Phenomenological Analysis to study language instructors' experiences. Better time management and a favorable learning environment are the key reasons to continue giving distance language courses, but personal ideas on education and "negative" teaching outcome expectations may interrupt the process. These impressions and personal views, which we consider qualitative by nature, are among the reasons why we are calling, in this paper, for an embracement of empirical and scientifically proven approaches to deal with issues in the field of humanities and social sciences.

Gonzalez et al. [10] investigate the impacts of COVID-19 confinement on the auto-learning performance of students in higher education (Spain). They evaluate the changes in exams before and after the pandemic by placing students into two groups: a control group from pre-pandemic years and an experimental group whose education was affected because of confinement. COVID-19 confinement, according to the study, has a considerable positive effect on students' performance. We, however, find this finding a bit challenging to other studies in the literature. For instance, The influence of the COVID-19 lockdown on the Sultanate of Oman's school system is highlighted by Osman [20] who, through an analytical account of higher education's Emergency Remote Teaching Plan ERTF, describes how the experience has altered negatively the teaching and learning landscape.

Scull et al. [24] explore Australia's response to the rising COVID-19 challenges in education, and how

an Australian institution used several innovative online solutions for its students and teachers. The conversion allows for both synchronous and asynchronous learning. The purpose of this article is to look into the aspects that contributed to pre-service teachers having high levels of contact, namely through interviews with academics. Scull et al. offer a variety of suggestions and key lessons that may aid others seeking methods to implement high-quality teacher education programs during and after COVID-19, according to the authors.

Nenko et al. [19] surveyed the effectiveness of D-learning in Ukrainian universities. The study investigates the material used, the adopted approaches, and the successes and lacunas that characterize the process. The findings are meant to provide pertinent data to Ukrainian institutes, decision-makers, and stakeholders on D-learning tools, activities, duration, and influencing factors that affect distance learning (skills, internet speed, emotions). The challenges were also addressed by Belay [5] who particularly focused on the educational inequalities of students living in rural areas in Ethiopia that contribute to keeping them lagging behind their peers in urban milieus. The author affirms that the shortage of materials and electricity, lack of monitoring by teachers, and the inability to give remote assistance to special needs students contributed to widening the gap between Ethiopian students in rural and urban areas [26] were particularly focused on the students' acceptance of D-learning as an alternative to in-person classes in Indonesia. The study concludes that the sample population $N = 750$ has a good deal of reluctance to accept remote classes as a substitute for their in-person classes due to the technical and psychological challenges they endured during the lockdown.

As far as the Moroccan context, Ouahabi et al. [21] assert that it is possible for distance learning to replace face-to-face training during crises. Because the current pandemic may not be the last, scientifically and statistically speaking, Ouahabi et al. also recommend adopting a blended model where effective quality distance training complements face-to-face training. [4] maintain the same optimistic tone as they argue that although distance learning is still making early 'baby steps' in Morocco deranged by issues related problems related to infrastructure, training, content, and evaluation, it managed to provoke the teaching communities' interest in Information and Communication Technologies (ICTs) for educational purposes. They also claim that D-learning has fostered the learning-by-doing model which encourages students to become more autonomous.

Asserraji [3] adopts a different view as she sheds light on the problems of remote teaching during the COVID-19 pandemic from the professors' perspective. Her study, which surveys Moroccan public and private university academics concludes that remote teaching is difficult and ineffective owing to the faculty's poor familiarity with the

learning management systems LMS in addition to the time and effort they put into the process. Jebbour [13] proposes three implications for implementation. First, remote language instruction is only possible when educational institutions provide computers and unlimited high-speed internet connection for faculty and students. Second, ICT must be incorporated into the study programs to familiarize instructors and students with the use of technology for educational purposes. Third, teachers are to receive pedagogical training in synchronous and asynchronous online instruction.

Following the greatest "online movement" in the history of education, the [28] highlighted the spike in demand for D-learning technology, notably online learning platforms. Limited staff training, insufficient bandwidth, and a lack of planning, according to the WEF, may result in a poor user experience that is "unconducive to continued development." However, there is a considerable likelihood that a new hybrid educational paradigm will emerge with major advantages (WEF, 2020). The disparities in access to hardware and the internet that exist between communities (sometimes within the same country) are difficult to ignore; however, studies have shown that students' retention capacity increases (25–60 percent) when taking online courses compared to classroom courses, according to the World Economic Forum. The statistic might be rationalized by the fact that D-learning allows for more autonomy and a more personalized learning pace [2]. These pedagogical and economic benefits, according to the World Economic Forum, indicate that this new education model has the potential to be adopted permanently rather than temporarily.

All of the above-listed studies with their divergent scopes of examination and analysis do concur that the forced transition to D-learning that we are experiencing today was certain to happen sooner or later and is unavoidable. Some governments anticipated the need to invest in infrastructure and hence engaged and prepared ahead of time; others waited until the demand for change became urgent and coercive. However, these studies limited themselves in the act of reporting what teachers and students advocate or think about D-learning without devising credible association rules that should help decision-makers take widely accepted decisions. Although many of the concurrent studies are drafted by authors affiliated with mathematics departments, we did not come across any study that uses the association rules method to analyze generated data.

Methodology

The evaluation of distance learning in Morocco, forced by the COVID-19 pandemic, is significant, but may not offer a thorough final decision on the entire teaching approach. The importance stems from the fact that it identifies areas of

weakness that must be addressed as well as areas of strength that must be exploited. As a result, the authors want to limit the assessment to Kirkpatrick's first two stages, namely reaction and learning [14]. Besides the widely acknowledged credibility of the evaluation model, it provides a credible concise framework for the evaluation process that can be verified elsewhere and serve as reference data for future studies. The reaction level considers the availability of sufficient content, appropriate learning environment, students' interactions with peers and instructors, and the students' overall personal assessment of the experience. At this level, positive feedback does not always imply that the learning process was effective and successful. The students' performance and intake are measured at the following level (learning). When the compelling need for D-learning courses is over, the third and fourth levels (behavior and outcomes) can be examined.

The study adopts a mixed-method approach with more emphasis on the quantitative aspect. A couple of items are to be answered via direct answers to provide non-metric data that can justify or explain the outcomes.

The survey is divided into four rubrics. Kirkpatrick's first level (reaction) would be addressed in terms of accessibility, autonomy, and psychological impact, while Kirkpatrick's second level (learning) would be addressed in the retention rubric.

- **Accessibility:** The rubric looks at whether the students possess ICT devices, can easily access the university's D-learning platform, and how often they use it.
- **Autonomy:** The rubric assesses the students' capacity to maintain self-regulated tasks in the absence of direct supervision from their instructor.
- **Psychological impact:** the rubric looks at whether the D-learning model will be taken as a permanent constituent of future curricula, as well as its role in reducing stress and tension.
- **Retention:** The rubric assesses students' ability to recall material obtained online as well as their confidence in recreating their version of inputs.

136 undergraduates from Moulay Ismail University's School of Technology in Meknes participated in the study. They are majoring in Business and Computer Science, and they come from different parts of the country with divergent social backgrounds. The data collection procedure was completed electronically using Google Forms. The survey followed the rules of anonymity, randomization, representation, and survey goal disclosure.

Post the preliminary evaluation of results, we process the data using the Association Rules model to retrieve and generate solid and confirmatory associations of key variables. This will give data a strong credit and assist in better

comprehending the findings. The method presents invaluable ideas on the likelihood of achieving better or worse results if a parameter or two are altered. The method would serve as a solid background for the recommendations we would eventually propose to reach optimal levels of quality D-learning plans. Piatetsky-Shapiro [23] introduces highly powerful association rules found in databases using a variety of metrics of relevance. Agrawal et al. [1] develop association rules based on the concept of robust relationships to detect product similarities in data gathered on a large scale in the point-of-sale computer systems of supermarket chains.

Results

Following are the retrieved raw results followed by the Association Rules processing of data. Further processing using SPSS's correlation of variables was used to pinpoint any difference in results obtained from the two departments (see discussion section).

Reaction

Accessibility

This rubric addresses a wide range of key conditions for D-learning to be successful. The following factors (see graph 2) shed light on the accessibility to devices, internet, engagement, and platform usability.

According to the report (Fig. 2), 54.5 percent of the sample students reported that access to the university's D-learning platform (FAD) is extremely straightforward, while 25.7% believe it to be rather complicated. Because only 55.9% of students have stable and permanent access to the internet, it is assumed that the reported challenges correlate with accessibility to the internet. Despite the Moroccan internet providers' efforts to supply free access to the ministry of education's platforms "excluding YouTube," the method has little or no effect on higher education institutions

because a large number of lectures are posted to YouTube in video format. Similarly, 51% of students are regular visitors to the platform, 30% are frequent visitors, and 19% are occasional users. The most satisfactory findings in this category are those associated with smart device ownership, with 76.5 percent of students having a laptop, smartphone, or tablet at all times, while only 11.7 percent do not. The 11.8 percent of respondents who said they were "not sure" may have to share a gadget/device at home.

Autonomy

The autonomy rubric assesses the participants' capacity to maintain self-regulated activities and their ability to do so based on their core skills and competencies. It is essential to determine how students deal with learning obstacles including obscurity, confusion, and falling behind their peers when they are "physically separated".

According to Fig. 3, 45.6 percent of students can manage online resources autonomously, while 18.3 percent face some struggles. The remaining 36,1 percent are uncertain, which is fair enough given that most students in the regular classroom may require some assistance before they can comprehend the courses and digest the obstacles. The data shows that students exploit their intuitive auto-learning processes to diversify their learning material, with 72.8 percent checking similar content online. Peer networking is another strategy, with 50.7 percent of students believing they need to stay in touch with their colleagues to obtain assistance, organize, and exchange material. However, 22.1 percent do not believe they needed to. The mediocre amount of regular communication with instructors is one of the most disconcerting findings of the autonomy rubric. Although the institution, particularly the faculty, has put in a lot of work to build up a D-learning approach and compile information in a short amount of time (MAPnews, 2020), information exchange between students and professors would provide a more immense effect. The final question evaluates the participants' willingness to go for the 100% percent online classes

Fig. 2 Accessibility

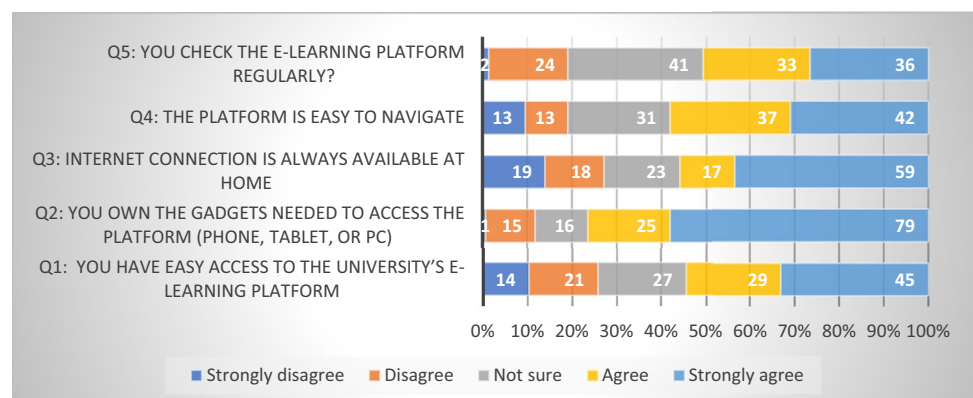
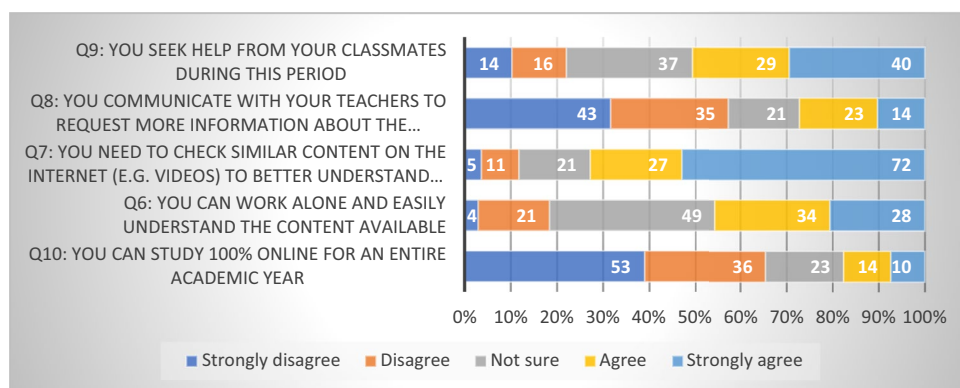


Fig. 3 Autonomy

the following year, and 65.5 percent of participants disapproved of the idea. Only 17.7 percent are not concerned about the transition.

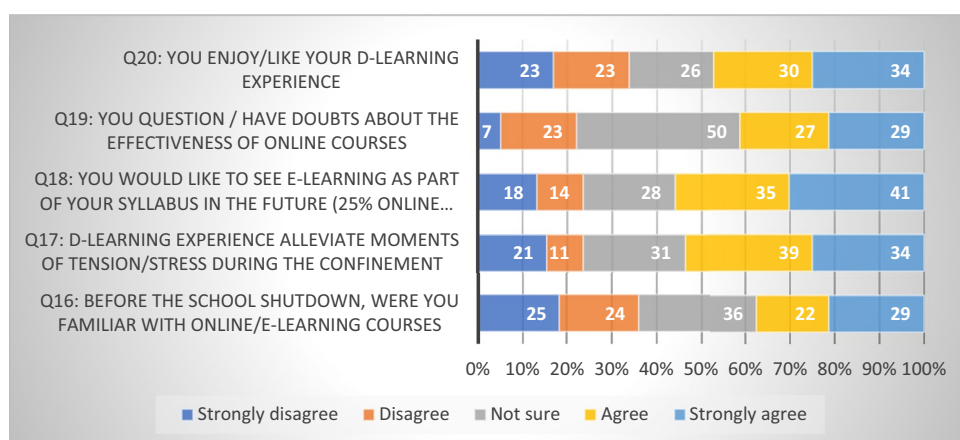
Psychological Impact

The psychological impact investigates the students' acceptance of D-learning, as well as identifying any emotional filters that may exist. Additionally, it determines if any prior D-learning experience or training prior to the pandemic facilitated the whole online shift.

This rubric's first question attempts to Fig. 4 determine if the participants were ready to work online prior to the lockdown. Any prior experience with instructional technology or ICT for educational purposes might minimize emotions of floundering and disorientation. 37.5 percent of participants said they had previously attended D-learning classes, while 36.5 percent said they had not. The remaining indecisive 20.5 percent of the sample implies that they are unsure of their skill sets and are hesitant to declare themselves competent D-learners. 41.2 percent of students refute the idea of making D-learning an

equivalent to the traditional classroom, while 22 percent strongly trust in the technology's usefulness as a substitute. 53.7 percent of surveyed students said working remotely helped them cope with stress and anxiety during the lockdown. 23.5 percent think it did not since, as they explain, they have connectivity limitations they could not overcome easily. Furthermore, 47.1 percent of respondents believe that D-learning is enjoyable on a personal level, compared to 33.8 percent who do not. When asked if they wanted D-learning to be partly incorporated into next year's curriculum (25 percent of the curriculum), over 56 percent said yes. Only 23.5 percent categorically opposed this idea, claiming that they would have to go through the same challenges stated in the accessibility rubric above.

It should be highlighted that the psychological impact rubric is the only one that did not achieve high positive returns. The accumulating learning challenges preclude D-learning from being fully enjoyable. The challenges that the students had to deal with may have sabotaged the commonly acknowledged motivation that characterizes ICT use in education [11].

Fig. 4 Psychological impact

Learning Retention

This rubric examines the efficacy and return on investment (ROI) of the D-learning model. Only when students are able to retain knowledge and skills at home that the D-learning experience can be called a success.

Figure 5 illustrates that children may have difficulty exploring new topics for the first time. 18.4 percent believe they are within their grasp, while 48.6 percent believe they are hard to fathom. The surveyed students were only a couple of weeks away from their final exams, and the remaining courses they struggled with only make up a small portion of the overall curriculum. When questioned about the usefulness of the material available on the D-learning platform, 85.3 percent say it is either somewhat or entirely helpful, while just 14.7 percent think it was not. Around 40 percent claimed they were prepared to take a test with no further review in-person classes or make-up sessions, while 38.3 percent said they were not. The remaining 34.6 percent were uncertain. Nonetheless, the great majority (almost 80%) welcomed the idea of make up and reviewing in-person courses before the final exams. A very tiny percentage of 03.7% believe they do not feel like taking them.

Association Rules Applied to D-learning

Following comes the processing of generated data via the Association Rules method to validate the study findings. If we demand a confidence rate of 100% on our rules, we obtain only three rules given in the following table (Table 2):

Where.

(Q1) Is the university's e-learning platform easily accessible?

(Q2) Do you have the necessary materials to access the platforms (phone, tablet, or computer)?

(Q20) Is your D-learning experience enjoyable/pleasant? (see Figs. 1, 2, 3 and 4)

Given the size of our D-learning data set and the number of features, it is impossible to explain the phenomena under study based on only three rules, so we tolerate a doubt rate

of 12%. By doing so, we obtain 14 rules given in the coming table (Table 3) (the rules are given in confidence level):

It is observed that rules 1, 2, and 3 have an impulsive correlation. Rules from 4 to 9 achieved high confidence levels while the lowest value was 0.88. The most frequent conclusion was relative to Q2 in 8 rules followed by Q13 in 4 rules.

Discussion

The early assessment of MIU's D-learning experience, based on Kirkpatrick's impact evaluation, reveals that 14 out of 18 evaluated items produced reassuring results, while four others require further synergic attention from the university and the ministry of higher education. The investigated items may have produced satisfactory results at the level of reaction, but there is still more to be done to improve the students' D-learning experience. Because the students were not eligible for any program that promotes internet and laptop accessibility, such as Injaz, they had to rely on their own financial resources to obtain one. Injaz has supplied public schools with internet connection and multimedia equipment for many years, as well as subsidizing the purchase of computers and internet plans for students and teachers. If this operation had been relaunched during the pandemic, it would have made a huge difference. According to the ministry, the three Moroccan telecom operators have committed to grant free access to platforms developed by schools and universities; nevertheless, video material (uploaded on YouTube) will remain limited [7].

Table 2 Association rules based on 100% confidence level

Number of rule	If (Hypothesis)	Then (Conclusion)	Confidence level %
1	Q1 = 5 AND Q20 = 5	Q2 = 5	100
2	Q3 = 5 AND Q9 = 4	Q2 = 5	100
3	Q4 = 5 AND Q20 = 5	Q2 = 5	100

Fig. 5 Retention

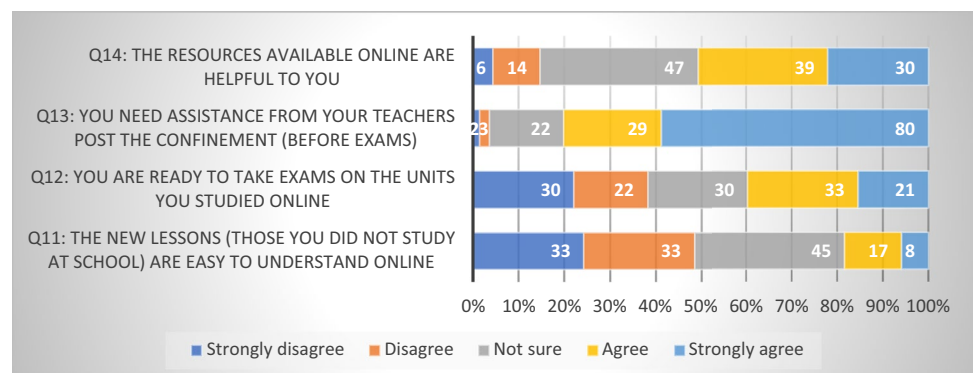


Table 3 Association rules up to 12% doubt rate

Rule number	IF (Hypothesis)	THEN(Conclusion)	Confidence level
1	Q1 = 5 AND Q20 = 5	Q2 = 5	1
2	Q3 = 5 AND Q9 = 4	Q2 = 5	1
3	Q4 = 5 AND Q20 = 5	Q2 = 5	1
4	Q1 = 5 AND Q7 = 5 AND Q13 = 5	Q2 = 5	0.95
5	Q8 = 1 AND Q18 = 5	Q13 = 5	0.94
6	Q2 = 5 AND Q4 = 3 16	Q3 = 5	0.94
7	Q1 = 5 AND Q3 = 5 AND Q13 = 5	Q2 = 5	0.94
8	Q1 = 5 AND Q14 = 4	Q2 = 5	0.93
9	Q3 = 5 AND Q8 = 1 AND Q13 = 5	Q7 = 5	0.93
10	Q10 = 1 AND Q18 = 5	Q13 = 5	0.89
11	Q1 = 5 Q7 = 5	Q2 = 5	0.88
12	Q3 = 5 Q4 = 5	Q2 = 5	0.88
13	Q2 = 5 Q3 = 5 Q10 = 1	Q13 = 5	0.88
14	Q3 = 5 Q7 = 5 Q10 = 1	Q13 = 5	0.88

The analysis of association rules has revealed that items Q2 (possession of apparatus) and Q13 (assistance from professors post the lockdown) are the most recurrent ones that interrelate with most of the other items. The finding comes in harmony with those attained through the preliminary Kirkpatrick evaluation, which reinforces the call for establishing the adequate environment and requirements for any D-learning program before it is officially launched.

Following are interpretations of the rules whose confidence levels (CL) range between 88 and 100%

1	If Q1 = 5 AND Q20 = 5	Then Q2 = 5	CL 100%
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- 1) Is the university's e-learning platform easily accessible?
- 20) Is your D-learning experience enjoyable/pleasant?
- 2) Do you have the necessary materials to access the platforms (phone, tablet, or computer)?

Having easy access to the university's platform and developing a *positive attitude* toward the e-learning experience is conditioned by ownership of decent-quality material. Students who share devices (laptop, desktop...) with other family members may not enjoy higher levels of satisfaction with the D-learning model. Direct interviews with a sample population revealed that the students who oppose the idea of incorporating D-learning as a permanent syllabus constituent (because of the challenges they came across) changed their minds once they were proposed subsidization to own new ICT gadgets and internet connection.

2	If Q3 = 5 AND Q9 = 4	Then Q2 = 5	CL 100%
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- 3) Is internet connection always available at home?
- 9) Do you ask your peers for assistance at this time?
- 2) Do you have the necessary material to access the platforms (phone,

tablet, or computer)?

We assume that possession of hardware automatically widens the margins of *networking* and collaboration between learners. An investment by the ministry of education in the form of subsidization may serve in rendering the auto-learning process more autonomous and encouraging.

3	If Q4 = 5 AND Q20 = 5	Then Q2 = 5	CL 100%
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- 4) Is the platform easy to navigate?
- 20) Is your D-learning experience enjoyable/pleasant?
- 2) Do you have the necessary materials to access the platforms (phone, tablet, or computer)?

Ownership of material grants the learners sufficient time to *understand* and digest the material available at the university's portal. Students who share laptops or mobile gadgets ... may come across challenges that have nothing to do with D-learning (storage of data, software updates, etc.); they rather need a material they are familiar and comfortable working with for as much time as they have to.

4	If Q1 = 5 AND Q7 = 5 AND Q13 = 5	Then Q2 = 5	CL 95%
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- 1) Is the university's D-learning platform easily accessible?
- 7) Do you need to look up similar data (e.g. videos) on the internet to better comprehend the lessons?
- 13) Would you need help from your professors before exams?
- 2) Do you have the necessary materials to access the platforms (phone, tablet, or computer)?

The results prove that ownership of the material does not alleviate the need for support from peers and professors. The students who own their proper material do not see technology as a substitute for human interaction at

school. Our hypothesis is that students refuse to permanently cope with the new remote learning imposed by COVID restrictions as a reliable alternative. It is, however, noted that the two surveyed groups (business and computer science departments) reported different degrees of reluctance vis-à-vis the “hypothetical” idea to go 100% online for another academic year in favor of the computer science students who showed more openness (see Table 4).

5	If Q8=1 AND Q18=5	Then Q13=5	CL 94%
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8) Do you communicate with your teachers to request more information about the material?

18) Would you like to have D-learning as a part of your curriculum in the future?

13) Would you need help from your professors before exams?

Despite the versatility of ICT devices, only the human factor can internalize undisputed amounts of confidence and self-efficacy. Thus, any potential D-learning programs in the future are, preferably, to be initiated and concluded by start-up and post-training face-to-face encounters between professors and students. Ignoring the procedure, otherwise, may result in a tottering pace of study.

6	If Q2=5 AND Q4=3 16	Then Q3=5	CL %94
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2) Do you have the necessary materials to access the platforms (phone, tablet, or computer)?

4) Is the platform easy to navigate?

3) Is the internet connection always available at home?

Issues relative to internet connectivity have been the biggest obstacle for students who were engaged in the D-learning scenario, particularly during the pandemic [12]. Most students who developed a negative attitude towards D-learning were impacted by the poor internet service. It is thus important to help the students to have affordable access

to the internet if the ministry of higher education is willing to adopt the model as a constant constituent of syllabi.

9	If Q3=5 AND Q8=1 AND Q13=5	Then Q7=5	CL 93%
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3) Is internet connection always available at home?

8) Do you communicate with your teachers to request more information about the material?

13) Would you need help from your professors before exams?

7) Do you need to look up similar data (e.g. videos) on the internet to better comprehend the lessons?

Autolearning skills are systematically boosted through the abundance of material (hardware, software and internet connection) and ongoing networking with teachers. Thus, professors need to maximize the student's exposure to online material to keep their interest and motivation high. The D-learning model is new for many professors and most of the students, so when challenges surface, the blame is often put on the entire process which is, then, seen not effective. Exploiting every communication medium, by both parties, helps to draw a much clearer idea about the ends that should be met. The challenges that go mishandled will eventually lead to losing confidence in the utility of D-learning and even in the students' self-efficacy.

10	If Q10=1 AND Q18=5	Then Q13=5	CL 89%
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10) Do you think you could complete a whole academic year entirely online?

18) Would you like to have D-learning as a part of your curriculum in the future?

13) Would you need help from your professors before exams?

The students are not confident that D-learning is a reliable substitute for the classes they are familiar with and are not ready to trade off human interaction for technology in education. Realizing a shift toward a 100% D-learning model requires higher amounts of *engagement*

Table 4 Correlations

		Department of affiliation	Going 100% online next year	Easy access to the platform
Department of Affiliation	Pearson correlation	1	0.194*	0.431**
	Sig. (bilateral)		0.023	0.000
	N	136	136	136
Going 100% online next year	Pearson correlation	0.194*	1	0.256**
	Sig. (bilateral)	0.023		0.003
	N	136	136	136
Easy access to the platform	Pearson correlation	0.431**	0.256**	1
	Sig. (bilateral)	0.000	0.003	
	N	136	136	136

*The correlation is significant at the 0.05 level (bilateral)

**The correlation is significant at the 0.01 level (bilateral)

from faculty members (by deploying more time, techniques, and synergy), yet it should be important to maintain in-person encounters with students.

Rules 7, 8, 11, 12, 13 and 14 confirm what previous rules have concluded.

It is noted that Computer Science students, who are better equipped with technological devices, enjoy a higher degree of comfort to use the university's D-learning platform (Table 4). In contrast to their counterparts in the Business department, they have exhibited a more favorable attitude towards D-learning as an instructional method. Such comfort may also probably explain their seeming willingness and self-efficacy to engage in online learning for more prolonged time.

The observed reluctance to embrace D-learning noted at the business department students could be alleviated once they are trained on how to use the platform and once they are able to own the necessary apparatus to network with their peers and professors [12].

The findings above should help understand the lacunas of D-learning reported by university professors in related studies [3] [13] during the pandemic that may have been based on qualitative or quasi-quantitative research. From a purely mathematical and AI perspective, the abundance of certain requirements will lead to "hypothetically inevitable" results on at least three occasions that read as follows: making a required condition available implies having two direct effects, or putting two requirements together should lead to a single direct effect ($a + b = c$ or $c = a + b$).

1. Ownership of hardware material and the internet will certainly and empirically make accessibility to the University's platform easier and will make D-learning a reliable and enjoyable learning method.
2. Ownership of hardware material and the internet will certainly and empirically enhance communication with peers and teachers. One cannot expect optimal networking among peers and professors when the basic requirements are missing.
3. Ownership of hardware material and the internet will certainly and empirically improve the students' interactivity with the platform and enjoyment of its content.

Study Limitations

Given the enormity of generated data, the authors opted for focusing on the students' perspectives alone and are dedicating a separate paper that is being worked on to the instructors' perspective. This should enable the teachers to understand the students' needs first and to propose, subsequently, more efficient scenarios to deal with the challenges.

This study will also be followed by a post-COVID investigation for a comparison of the results. It is also important to acknowledge that the lockdown atmosphere may have affected our students' answers. This environment probably contributed to establishing an affective filter that does not favor the permanent adoption of remote classes. It is thus important to work on a future comparative study that incorporates data during and post the lockdown.

Conclusion

This research aims to look at the effectiveness of the D-learning scenario suggested under the extreme COVID-19 lockdown constraints. It is a real-time assessment of a learning method that has long been thought of as supplemental and substitutional for students whose professional or personal circumstances prevent them from attending in-person courses. Many education departments and institutes throughout the world are now required to assess their ICT resources, and the D-learning model is undoubtedly being reconsidered as a primary plan component. Although Kirkpatrick [14] claims that the four levels of assessment (reaction, learning, behavior, and results) do not have to be undertaken in that sequence, doing so is essential for gaining a deeper understanding of the program's efficacy. The amount of money invested in the apparatus and learning environment determines whether the project succeeds or fails. At the level of reaction and learning, this study looked at linked and interdependent aspects of the D-learning experience at MIU and concluded the following:

- It is of great benefit for the Humanities and Social Sciences (HSS) to open up to fields of artificial intelligence. We can make better-informed decisions and recommend more efficient solutions thanks to technology.
- The Association Rules method used in this study can provide creative solutions beyond what is conventional for HSS scholars.
- The reaction of MIU students to the D-learning experience is affected by their accessibility to decent-quality devices and the internet. If underprivileged students are not assisted in this regard, they will fall behind their classmates. When technology is accessible, it aids in maximizing one's auto-learning abilities [27].
- The psychological impact rubric is the least satisfying of the four. Concerns and apprehensions were expressed about a lack of D-learning materials, poor internet connectivity, and poor interaction with faculty.

- It has been observed that when the resources uploaded to the university platform are simply grasped, such as through virtual chatrooms, the students' enthusiasm to engage further in the D-learning experience increases.
- The student's satisfaction with the D-learning courses is largely dependent on their sense of autonomy and capability to solve issues independently.
- The students can regain their confidence in D-learning as a permanent educational constituent only if they have a firm grasp of the curriculum and are constantly mentored. Stronger and more direct interaction with teachers can aid in the process once again.
- The better communication with instructors is, which according to the findings is unsatisfactory, the lower levels of stress and tension the students may suffer. Once the issue is redressed, communication will serve as a scholarly catalyst and a learning psychostimulant.
- Finally, the survey revealed that some students' household atmosphere during the lockdown may have negatively affected their attitude vis-a-vis D-learning. The study, thus, recommends a validation re-examination of the D-learning acceptability where social distancing is forcible no more.

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Data availability Access to the data (surveys) is subject to approval as they include personal information of participants. Please contact the authors.

Declarations

Conflict of interest Disclosure of potential conflicts of interest. The authors have no conflict of interest to declare.

Informed consent No personal data was retrieved from the surveyed participants and informed consent was obtained from all individual participants included in the study.

Research involving human and animal participants Research involving human participants and/or animals. The was no research on human participants and/or animals in the study.

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