Artículos

In Higher Mathematics: The analytics of connected learning and MATLAB online

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Educación y sociedad
Universidad de Ciego de Ávila, Cuba
ISSN: 1811-9034
Periodicity: Cuatrimestral
vol. 22, no. 1, 2024
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Received: 12 July 2023
Accepted: 25 August 2023

URL: http://portal.amelica.org/ameli/journal/762/7624845008/

Abstract: This investigation is the foundation of a project related to the teaching of the subject Mathematical Programming. Said work is limited to the investigations carried out in the Digital Education Specialty and based on them it was possible to create structural models as a foundation for the Connected Learning Analytics. Where the basic principles of mathematical programming are outlined through a predictive analysis plan and existing academic doubts between teacher and student are clarified with the use of technology; at the same time projected as solutions. However, this is the beginning of the construction of knowledge for future Engineers. Since, unfortunately, this methodological adaptation is not always assumed by the teachers who take the subjects of Exact Sciences. Reason for this, this time the online update paradigm and one of its key tools have been chosen: MATLAB.

Keywords: education, mathematics, learning, programming.

Resumen: Esta investigación es el fundamento de un proyecto relacionado con la enseñanza de la asignatura Programación Matemática. Dicha labor se ciñe a las investigaciones realizadas en la Especialidad de Educación Digital y en base a ellas fue posible la creación de modelos estructurales como fundamento a la Analítica del Aprendizaje Conectado. Donde los principios básicos de la programación matemática se esbozan mediante un plan de análisis predictivo y las dudas académicas existentes entre maestro y alumno queden esclarecidas con el uso de la tecnología; a la vez proyectadas como soluciones. No obstante, esto es el inicio de la construcción del conocimiento para los futuros Ingenieros. Puesto que, lastimosamente, esta adaptación metodológica no siempre es asumida por el profesorado que lleva las asignaturas de Ciencias Exactas. Motivo de ello, esta vez se ha optado por el paradigma de actualización online y una de sus herramientas clave: MATLAB.

Palabras clave: educación, matemática, aprendizaje, programación.

Introduction

In correspondence with the academic update of the ecuadorian teaching staff, we note that it is something urgent. Furthermore, we know that in a globalized world it is a fundamental criterion and, above all, in

modern times. Although it is true, "...the applications of Information and Communication Technologies make up the student's skills. But it is also indisputable and undeniable that the development of their skills depends to a large extent on the teachers" (Esmaeilimotlagh *et al*., 2019, p.315). Here is the true importance of updating university teaching in teaching-learning framed in the social environment in a developing nation. Therefore, said update is not governed only by an educational change; but rather to the reform of the master class. Referring again to Ecuador, we are looking for, by the way, we need a social exchange that allows us to achieve success in teaching .# Even the governments of the day place emphasis on educational reforms, since only then can substantial improvements in education be achieved. But there is no doubt then, that if the teacher is key to the academic improvement of the student" (Cui, 2020, p.253). Therefore, we must ask ourselves: ¿What is the reason for the low quality of the ecuadorian university environment?

Particularizing, we indicate that all this research is directed clearly to the Santiago of Guayaquil Catholic University and it is here, that the numerical subjects are dictated in the Civil Engineering degree career. Therefore, we put into consideration the ideal way in which to cover the weak areas in computer education and thus enhance the process of teaching computational learning. But having as support an online mathematical portal and maintaining pedagogical relations with the Analytics of Connected Learning. Due to this, according to the Ecuadorian Council for Quality Guarantee of Higher Education, higher education centers must maintain, in a uniform and consistent manner, an ideal education.

So, as the main objective, e-learning is the only way to achieve educational goals. Because only in this way is it possible to provide constructionist social attention to students in the classroom and, above all, in their professional development. Based on this, among other expectations, connected computational learning must be based on student mathematical behavior and, above all, be enhanced by Information and Communication Technologies (ICT).

Development

Establishment of standards for the teaching of higher mathematics

With the didactic approach, we say that the problem is that this task is complicated to put into practice. Since only a tutor is in charge of advising. But the steps to follow must have a wide contingency in the path of learning and the task of the guide or instructor must be the direct projection and consistent with the attitudes towards the student. Obvious, "only then will we be able to assess future mishaps. But also, Connected Learning leads future professionals to search for goals and this brings with it its true importance in Engineering" (Muezzinoglu et al., 2023, p.984). Being teachers in Exact Sciences, more than anything in Mathematics, we must propose a teaching prone to dynamism and achieve novel learning. Therefore, full consideration must be given to the needs of the student body. But unfortunately, in geographical latitudes such as the third world, university centers are not concerned with obtaining an ideal way to maximize student success and, therefore, using Connected Learning should be the first step; but this is not always true.

Worse still, if we consider that said learning "...it gives the opportunity to develop the abstract thought of the student and where to be the builder of a moderate teaching, turns the teacher into a carrier for the achievement of the desired academic objectives# (Bender & Peppler, 2019, p.39). Regarding this, painfully the master classes of the past still have a place and in this retrograde act the institutions of Higher Education in Ecuador must necessarily propose a new horizon. Since the integrity of the system is the only way that gives a truthful vision in the achievement of teaching. Now, having explained the above, we emphasize the concept of Connected Learning. Indicating that,"...in these modern times it is only taken as help and not as a tool. But creativity and research require teachers and students to reach a working consensus. Overhead

all, be receptive to the difficulties that are encountered daily with students who arrive at universities with shortcomings#(Pham & Li, 2023, p.700).

It is here then, where the influence of Information and Communication Technologies predominates in the most pejorative sense. Therefore, "...these students do not contemplate any responsibility and even less, they envision that their learning is connected. But to the contrary, said learning must have enough strength to give a new turn to teaching in Higher Education institutions" (Nissilä, 2022, p.975). Subsequently only in this way can the competences generated in Engineering careers be taken as a reference. Needless to say, but this is the core part to reach integration. Since the traditional way of conducting the class continues to prevail and to achieve a change, every educational institution must be in charge of opening up the new pedagogical paradigms. Even among the variety of goals, there must be recognition of the value that Higher Education has with respect to society. Since it absorbs the skills of the future professional and that is why Connected Learning does not only entail knowledge.

Rather, it brings with it the ideal reason and the way to take advantage of the instructors. However, "...the skills put the entire academic conglomerate in suitable training and in return, the teaching-learning process recognizes the crossroads that are located in working life" (Beneroso & Robinson, 2022, p.44).

But will it be possible?

In response, we note that students today have an obvious methodology for navigating the complex world of networking. Since e-learning, u-learning within, supports online learning and it will surely never decline. But, "...connected learning involves opportunity tracking and therefore this is easily understood as a model for perpetuating the learning curve; at the same time that it is inserted in the experience" (Moore et al., 2022, p. 259). Such that Information and Communication Technologies are the foundation of support in the systemic process of knowledge orientation.

Fundamentals for acquiring quantitative skills

With the pedagogical approach, we can say that Data-Based Education proposes to computerize the information corresponding to the educational field and its agents. This, at the same time, uses resources such as student files, predictive analysis and data processing tools to improve the complex teaching-learning argument. But despite the multiple benefits that this approach proposes, it is important to consider the design of policies that allow implementing and regulating these tools appropriately. About this, Big Data refers to large volumes of data generated by applications, machines and people. In fact, many are the benefits of massive data collection and analysis; especially in the educational field. Based on this, it is proposed that the three uses of Big Data in education. Being: a) Learning, b) Teaching and c) Administration. Specifically, this last point makes it possible to identify strategies for designing improved environments.

That is to say, that the creation of personalized experiences can be facilitated and through the use of virtual platforms, students not only have access to the contents to reinforce knowledge. But they can also do it at their own pace, with the appropriate complexity and with the methods adjusted to their personality. In this, we should not ignore the skills that Information and Communication Technologies provide "... regarding personalized learning and the way in which they are applied as drivers of success. Since in this way we will be able to comply with the Knowledge Society and not to mention, with the innovative methods of learning" (Yang, 2022, p.6).

However,

> "...the data-driven instruction facilitates the study of educational processes by allowing the analysis of learning in the context in which it occurs and even the data collected through this approach, together with the use of analytical techniques. generate inferences regarding contents and their methodologies" (James Bell Associates, 2018, p.29),

Since apart from informing the progress, the strengths, weaknesses and learning styles of the student simplify the understanding of individual differences within the teaching-learning process. Consequently, there are numerous concerns regarding the regulation that can be given to the information coming from the data. Even the information that can be extracted from the data is little and insufficient to identify the teaching-learning problems with the students; worse still, to find solution strategies. In return, data alone has the potential to improve education.

Taken together, this is a simple guess in the use of data that introduces efficiency and objectivity. However, the evaluation processes are strongly influenced by subjectivity and implicitly these become risks by having a large amount of data that absorbs knowledge. Therefore, they can be applied without the approval of the interested parties. Complementing this, we argue that individualized education also has certain disadvantages. This is because students learn what they want and how they want their opportunities are diminished. In addition, that "...Data-Driven Education leans more towards learning strategies; since they are easy to measure statistically. Thus, depriving students of essential experiences to have a good educational development and forcing teachers to teach for the exam and not for life" (Yan, 2024, p.27).

Ubiquitous learning and its formality

Today's society circulates through the universe of virtual connections in developed countries and not to mention those that are developing. Well, here, the New Information and Communication Technologies are already omnipresent. Since tools such as the mobile phone, instant messaging and social networks are always at hand. However, it can be stated that "...they are based on the transition from products to experiences and the connectors of digitization, they allow ubiquity to set aside a space in search of knowledge" (Li & Wang, 2021, p.321). But for its breakdown, in the following paragraphs we can draw conclusions and state that currently the way of working has given a 180 degree turn in Higher Education Sciences.

In addition, the turn of the century, together with the advance of the network, made modern society notice the exchange of information. Multimedia portals, such as YouTube or Vimeo, gave rise to audiovisual content. Such that the written news and paper publications have been in clear decline. Since the time in which we live is at a frenetic pace and the University, as a center of higher education, must quickly become alert. Because the teaching-learning process is clearly framed in the modern, the path for technological updating leads to obstacles and as a possible solution a new model must be generated to work. Likewise, as already indicated, ubiquitous learning occurs at any time and place and we even assert that this already belongs to daily life and the gap between formal and informal teaching is decreasing.

As far as this goes, "...the millennial generation is in charge of self-learning and knowledge is the key factor in today's society; a society that is the result of technological transformations" (Badri, 2021, p.2). However, from experience teaching Higher Engineering, we say that when students have a complicated problem, the first thing they do is look for multimedia material (virtual information that the network offers). In a certain way, said student is already a ubiquitous learner and from here the meaning of virtual community can be obtained.

But what does formal education have to do with this?

In response, under this perception, we can point out that

> ...the education is mobile, ubiquitous and spreads virally giving rise to a digital culture characterized by participation, media convergence and interactivity. But logical reasoning is not considered. Since a problem and solution must carry research framed in the critique of reason (Kukulska-Hulme et al., 2023, p.12).

Unfortunately, it is not fulfilled and we believe that in this way help can be generated for the teaching staff; such that it is expressed as an educational resource. In the case of Ecuadorian higher education centers, they were relegated in the past. Worse, when the development of numerical subjects should be projected based

on the Connected Learning Analytics. So that in this way the fundamentals of mathematical action can be obtained and, as a purpose, provide support to students. More than sure, then, that this can only be done if we proceed towards a consensual understanding with our own learning. However, in computer rooms there must be a Socratic culture; so that the pedagogy follows a parallel methodology.

Notability and types of online portals

The term 'portal' is not that new and is technically known as a 'gate'. This word is used to indicate that 'only' is a website and today it has become essential for navigation. Taro is like that, that this is considered the maximum paradigm of the new millennium and, nevertheless, there are some portals that obtain profits from marketing; others that support education. Therefore, it is necessary to note that some of these are special in the business field (Yelp case), others in the management of educational areas (MindMeister case) and the most experts, in technical areas (MATLAB case). However, the latter"...takes advantage of technology as a diffusion appendix and consequently, contains numerical programming to establish even points in students who are interested in Mathematics" (Kruger *et al*., 2022, p.95). In this sense, the world of education remains absorbed and it is essential to adapt it to the reality of the new century.

But in Ecuador the teaching update is very poor. Since chalk and blackboard continue to rule the classroom universe and teachers do not project new methodological knowledge at all.

So, it is useful to ask ourselves:

- This adaptation. How expensive is it?
- Are educational centers ready for such a transformation?
- Among teachers, will there be motivation to update?
- The students, what role do they play in this change?

Yes, clarify that a web portal is dedicated to facilitate the transmission of material to the reader and that its various topics are directly related to knowledge. Thus, we can find an infinite number of them, but at the beginning we must note their differences. Indicating that a "...portal denotes a degree of completeness and a website is a simple page that contains information in hypertext and multimedia" (Palau-Sampio & Sánchez-García, 2020, p.11). So, when offering public information to society, they can be classified by their complexity of manipulation into:

- Horizontal. In virtual communities and e-mail; https://us.yahoo.com/
- Verticals. For information from advertisers; https://www.amazon.com
- Corporate. Business information to employees; https://www.redhat.com/en
- Mobile. Connection from the Internet to a phone; https://play.google.com/store/games?hl=en
- Specialized. For specific topics in education and scientific research; https://www.mathworks.com/products/matlab-online.html

Based on these literals we will focus clearly on the last point. Therefore, speaking of mathematical portals, we indicate that "...in today's world, students have all kinds of tools at hand for their academic work and educational institutions endorse their use; since they support learning and relieve the teacher" (Musna *et al*., 2021, p.6). What's more, the best has been hosted on the web for a long time; MATLAB online.

MATLAB online: Numerical and programmable portal

Mathworks project and is applied in all areas of mathematical research. In addition, its interface is easily adapted to the novice user and among its advantages is the programming in source code: therefore, it is accepted worldwide. This largely accompanies scientific research in various technological areas; case of the National Aeronautics and Space Administration (NASA) and the Massachusetts Institute of Technology (MIT). But also, these portals contemplate points for and against. Of the first, we have usability in the engineering sciences with the exchange in collaborative tasks, the operation and the numerical analysis. Apart from this it consists of the data flow, the common user design and the stability in the cloud build. In return, referring to the second point, emphasize the high cost of the license, knowledge of structured programming and simulation techniques, including the M language and its poor performance in 3D modeling. However, in the environment of the MATLAB online portal, because it is a high-level tool, program development requires less effort than conventional programming languages; Visual Basic type. Consequently, MATLAB-type portals become computer tools to support mathematical calculations and even give the possibility of performing advanced graphics. In addition to this, its environment is aimed at a common user. So much so, as indicated in Figure 1, the student is not complicated by absorbing their manipulation; since its work environment is simple.

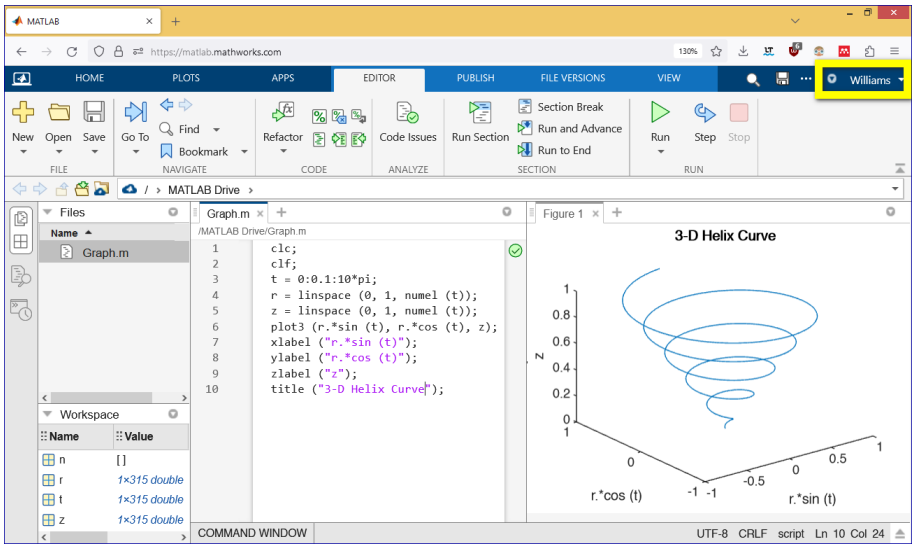

FIGURE 1

Figure 1

MATLAB online portal interface.

In the graph you can easily see five sections: 1) File browser, 2) Workspace, 3) Programming area, 4) Printing results and 5) Command line; the 2 most important are 3 and 4. However, in literal 3, after user registration and in the main window of MATLAB online we find the space for writing the source code; with numbered lines and syntax highlighting.

Demonstrative practical class and sketch for classroom research

Exemplifying with the students, the Santiago of Guayaquil Catholic University projected, from 2013 to the present, the teaching of the subject called 'Applied Computer Science'. The MATLAB portal was chosen and as the primary prototype the academic period was divided into 2 stages: The first was devoted to Data Flow Diagramming (DFD) and the second to mathematical programming. For the first period, governed

by the syllabus, there were 7 class weeks in the computer lab; 1 for research work. This schedule, based on resolution, could be applied and fulfilled. Together, in the proposed agenda, the structured programming was considered in the sections: Introduction, IF conditional statement, FOR automatic counter, WHILE manual counter, Methods, Procedures, Functions and Investigative Work (Task directed for the end of the semester). However, for the second period, in the last literal and as a practical assumption, collaborative work parameters were applied in the open modality with distance activities; like this exercise.

S = \frac{\sqrt{1 - \frac{n^{3} + 1}{1 + \frac{1}{1 - \frac{2^{n - 1}}{1 + \frac{1}{\left\lbrack \sum_{k = 3}^{n}{k!} \right\rbrack^{4}}}}}}}{n^{n}} + 1

Cooperation, as indicated in Figure 2, was established as an instrument to opt for teleworking.

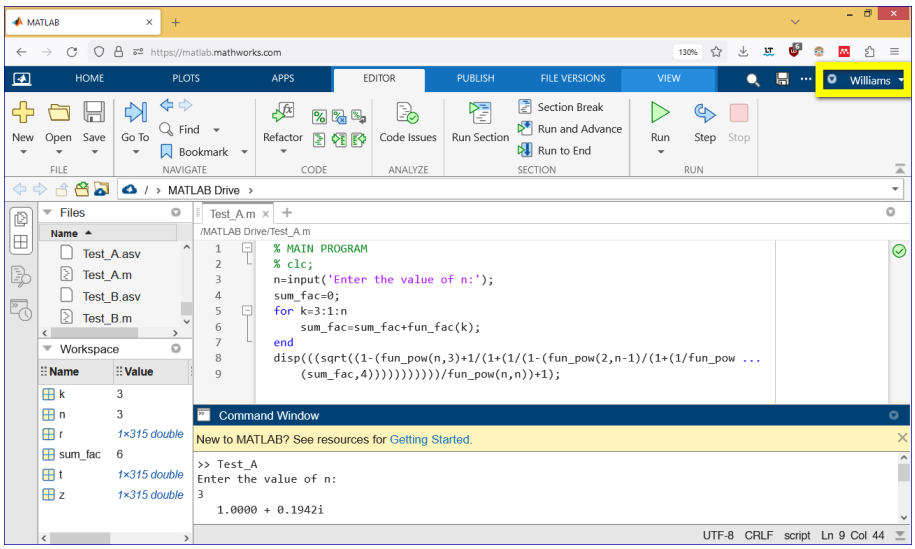

FIGURE 2

Figure 2

Structured Programming in the MATLAB online portal.

However, taking advantage of the benefits offered by the portal, it was possible to achieve the commitments of reciprocity and the union between peers with the response; locating the sections of the modality in collaborative teleworking and mathematical programming. Without forgetting the guidelines of the applications for research work. At which time, the MATLAB online platform had as pedagogical support the social network Twitter in microblogging and Google in the blog.

Apart from that, the scheme and the modular content were schematized based on the contact data obtained from multimedia portals (Dailymotion and Twitch) in supporting visual learning. To then have newsletters as support in distribution lists, vector illustrations as self-promotion and banners as marketing processes; adding the norms to be developed in the course of the investigation.

However, in search of the objectives and projections, 3 phases were projected. Being these: 1) Knowledge of expectations, 2) Evolution of content and 3) Quantification of skills. In other words, meeting development demands, the degree of aptitude and increased participation were considered guidelines in the reduction of dropout: which projected the prototype of the tasks in the intelligent classroom. But counting on the data analysis and the qualification of the course in the intelligent classroom within the subject of 'Mathematical Programming'. However, the plugins were vital in collaborative work with electronic devices and smart tutoring. Above all, counting on the initial parameters in the quantification of the intelligent classroom.

Conclusions

The evolution of MATLAB online, despite the license cost, has become a great support for the teaching of Higher Mathematics in Engineering sciences. Therefore, the success of their work in a country that is still in the process of technological development is not surprising. If we break down important points, it is false not to consider that this platform should not be a stationary environment, that the rejection comes from the little interest shown in collaborative work and that the student's critical spirit should be a communication tool between peers.

All of which envisions that the abandonment of individual work must contemplate the achievement of complementary reasoning skills and obtain camaraderie as an emotional generator. should provide lines of thought to facilitate teaching work. Such that in this way, pleasant emotional environments are developed in the generation of a common interest and that the classroom climate can also become more bearable; more than anything in the challenge of technological change.

Of these points, we owe it to the fact that the use of this instrument served as an academic link and in the conception of the agenda, being collaborative, the classroom knew how to enlarge before the demands made. Even the atmosphere became formal and above all in the management of the class theme. In addition, mathematical programming was part of the university competencies and the digital aspect was amalgamated with the treatment of information. But it turned out to be paradoxical that among the different uses of the portal was the little collaborative dissemination; being that this should help in its acceptance. But rather it was extremely small and there are very few people who gave value. In addition, if we analyze the progress of Information and Communication Technologies from the beginning of the millennium, we realize that they already have extreme importance.

Therefore, the benefits offered by virtual technology must be absorbed; including mathematical portals. At the same time, become aware of the help it provides. But unfortunately, one of the reasons detected for which the students do not work in the portal and at the same time is objected to, is that the majority of the students have a mobile phone for distraction. However, based on informal interviews, it is indicated that this portal is already referenced by the members of the teaching community. But almost none of the teachers use it as a support for the good of their classes. Therefore, of the universe of 73, the 82% of them are still engaged in the GeoGebra portal (the only one they know). In addition, there is no agreed method to motivate the student. Noting yes, that the use of this MATLAB tool should become a precursor resource for your learning and the very fact that it is a support for Exact Sciences, should be the beginning. So that only in this way, the student is able to complete the proposed activities and the faculty can be at the forefront of modern technology. However, there are teachers who state that there is no way to involve the student body and that the only advantage of promoting their knowledge is empiricism.

There are even teachers who don't even know about the existence of this mathematical instrument (they don't manipulate it, they don't work on it or they don't investigate it); thus, giving rise to the reasons for denial. Therefore, with important guidelines, the reasons for the rejection could be noted. Being these: a) Boredom and b) The reluctance to learn. But contradictorily, almost no one was averse to Information and Communication Technologies; but yes, to the update. In other words, topics such as mathematical programming and virtual classes are taboo.

Which, in Ecuador are still unknown and worse when the activities carried out in the network were weighed. At that time, it is when there was annoyance and disagreement due to the ignorance of certain topics and, therefore, in a general way there was rejection. However, future actions to be carried out with MATLAB online must be positive. Since these would give an added value to the transmission of knowledge and only in this way, the teacher can take a leading role by becoming a specialized guide; so that the student body preserves its professionalism. Above all, that it is framed in magisterial content knowing that it revolves around the study of Connected Learning Analytics and with this platform, together, they are tools to support

the teaching of programming mathematics in Engineering. For this reason, "...having carried out the analysis of the information, it can be concluded that the teacher's non-updating is the primary cause for rejection, that due to ignorance teachers do not use or will use this tool and that few teachers endorse it" (Isrokatun *et al*., 2021, p.2).

Finally, this research revealed that teachers do not have technological skills. But yes, it is longed that at some point they can implement academic training according to the environment and in this way, they can be part of a social structure for the sake of a pedagogical model according to modernity. Since only in this way, ecuadorian education will become a fundamental pillar in social progress.

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