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Mathematical course Design for eLearning environment

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Resumo: A Matemática, embora olhada como o calcanhar de Aquiles de muitos estudantes, tem acompanhado a humanidade desde sempre, adaptando-se à evolução dos tempos, e como tal numa era em que as tecnologias de informação fazem parte do quotidiano das pessoas. Por outro lado, e tendo em conta a necessidade de comodidade dos estudantes, bem como a possibilidade de atingir um maior número de alunos, muitas instituições de ensino começam a adotar o eLearning como uma das possibilidades formativas. Sendo que o eLearning permite ao aluno ter acesso à sua formação em qualquer lugar e em qualquer momento, adaptando-se por isso ao seu ritmo de estudo e tempo disponível para o efeito. Os professores e designers dos cursos de matemática tentam tirar partido desta forma de ensino para que os alunos atinjam os objetivos pretendidos e comecem a encarar a matemática de outra forma.

O envolvimento dos alunos com o curso pode ser uma mais-valia e motivar professores e designers dos cursos de matemática, a criar modelos que envolva os alunos no processo de ensino aprendizagem, e com isso aumentar a satisfação dos alunos perante o curso, bem como a sua maior aquisição de conhecimentos. Para levar a cabo essa tarefa existem algumas metodologias a ter em conta, recomendadas por alguns investigadores.

Palavras-chave: *eLearning, Matemática, Desenho do curso, Presença nas redes sociais, Avaliação.*

Abstract: *Mathematics, although seen as the 'Achilles' heel of many students, has always accompanied humanity, adapting to the evolution of the times, and as such in an era when information technologies are part of people's daily lives. On the other hand, and taking into account the need for convenience of students, as well as the possibility of reaching a larger number of students, many educational institutions are beginning to adopt eLearning as one of the training possibilities. Since eLearning allows students to have access to their training anywhere and at any time, thus adapting to their pace of study and the time available for that purpose. Teachers and designers of mathematics courses try to take advantage of this form of teaching so that students reach their intended goals and start to see mathematics in a different way.*

The involvement of students with the course can be an asset and motivate teachers and designers of mathematics courses, to create models that involve students in the teaching-learning process, and thereby increase student satisfaction with the course, as well as their greatest acquisition of knowledge. To carry out this task, there are some methodologies to be taken into account, recommended by some researchers.

Keywords: *eLearning, Mathematics, Course Design, Social Presence, Assessment.*

I. Introduction

Mathematics must be the science most loved and hated by students and all teachers in this scientific field are faced with phrases such as: "I was never good at math.", "Why do I need math?" and/or "I have no bases.", etc. Also, Aiken (1976), meets the majority of students

when he says that Mathematics as a subject has always remained mysteriously difficult and unpopular for most students. This is despite the fact that no one is in doubt of its importance in almost all careers, especially in the science and technological fields. And it is up to the teachers of the discipline to combat these myths, because the final result is much more pleasant when the teacher leads students to change their opinion. And one of the great difficulties is to overcome the difficulties of some students in order to homogenize the knowledge of all students in the class. With the evolution of time and the use and mastery of information technologies by teachers and students, the doors to teaching through these technologies (eLearning) are opening. This way of teaching/learning can be an ally for teachers and students to better carry out their responsibilities. Although authors like: Smith and Ferguson (2006) refer that qualitative studies indicate that mathematics does not work well in eLearning. The authors used student attrition as a simple measure of student satisfaction and course viability in two studies, one investigating attrition in e-learning and a second comparison study of attrition in face to face courses, to reach that conclusion. The same authors, on the other hand, raised two questions: 1) How does mathematics compare to other disciplines in terms of viability in e-learning? 2) How does mathematics compare to other disciplines in terms of viability in more traditional face to face courses? (Smith and Ferguson, 2006) Bearing in mind these two questions and the characteristics of the Mathematics subject, we can reach opposite conclusions, if the subject's design meets the needs of the students. Before getting into the discipline's design, let's understand what eLearning is.

The term eLearning has been used to describe an educational setting in which teaching and learning take place within an Internet-based environment (Berge and Collins, 1995), being able to understand how to eLearning a teaching methodology that uses communication technologies and that allows a student to study anywhere and at any time, being that student is not restricted to a fixed schedule or to a pre-established physical location as for example a classroom.

Connolly and Stansfield (2006) claim that instructional media elements employed within the context of this definition of eLearning could consist of text, video, audio, graphics, animation, or any combination thereof. A central component of most eLearning courses is some form of two-way interaction between learners and their instructor and between the learners themselves. Synchronous communication tools such as real-time chat and asynchronous tools such as email and discussion boards are common.

Also, Connolly and Stansfield (2007) say that e-learning has gone through three distinct generations. The first generation, from 1994 to 1999, was marked by a passive use of the Internet where traditional materials were simply repurposed to an online format. The second generation from 2000 to 2003 was marked by the transition to higher band-widths, rich streaming media, increased resources, and the move to create virtual learning environments that incorporated access to course materials, communications, and student services. The third generation, currently underway, is marked by the incorporation of greater collaboration, socialization, project based learning, and effective practices, through such tools as e-portfolios, wikis, blogs, social bookmarking and networking, and online simulations. Popovici and Mironov (2015) added that the third generation is affected by advances in mobile computing.

Taking into account the technologies used, the contact between teacher and students can be made in a way: Synchronous learning stands for a real-time, instructor-led online learning event, in which all participants are logged on at the same time and communicate directly with each other, and Asynchronous learning describes a learning event in which people cannot communicate without time delay.

As little is known about the effect of e-Learning on students' attitudes towards mathematics and information technologies. Having this understanding, observations and feedbacks from some students, we will focus on a design that can meet the preferences of students and thereby obtain a better use of students.

II. Mathematics Course Design

A course with the specificity of mathematics, which aims to provide students with concepts and techniques that aim to develop the skills of abstraction and logical-deductive reasoning. It must be well organized, and the eLearning format, in higher education, can surpass the discipline's effectiveness in face-to-face format. Liu (2007) confirms this thought, when he affirms that, an effective course design can provide several methods that allow students to model aggregate behaviors and successfully work with learning communities. Also, Goodyear (2015), portrays design as having an indirect effect on student learning activity, working through the specification of worthwhile tasks, the recommendation of appropriate tools, artefacts and other physical resources, and recommendation of divisions of work. Goodyear (2015), also accentuate that In relation to teaching as design, there are three main classes of things which can be designed: (i) good learning tasks, (ii) properly supportive physical and digital environments, and (iii) forms of social organization and divisions of work.

The course designer should start by preparing a teaching-learning model which can anticipate possible difficulties for students, in relation to the course objectives, as well as improve their performance. On the other hand, Berge (1997) writes that the designer must first know what those characteristics of the instructor(s) and learners are and what effect the assumptions about their roles and functions may have on the teaching and learning situation, which itself is in a state of constant change along many different dimensions. We also have to promote exchange between students as students work with other students to learn interpersonal and multicultural cooperation and to practice the roles of leader, collaborator, and follower.

To meet the challenge, designers / teachers need to adapt learning mindsets and goals, to effectively integrate learning communities into the teaching process and to help students improve their knowledge and skills that they will use in their professional careers and future lives, as well as success in the course. When creating collaborative learning communities, instructors must think about more than just technical issues. In order to build a strong and sustainable learning community, we focus on some points, such as: Define objectives, Identify target audience, Prepare teaching resources, Establishing Social Presence, Integrating Communication Technologies, Authentic and Situated Learning and Assessment. If one of the points fails in its implementation we will have to go back to the previous point to remodel it.

Define Objectives

The definition of objectives in the design of a course is the starting point for a good structuring of the course, as well as for the success of the students who attend it, both personally and as an asset for your future. According Liu (2007) clearly identify learning

objectives and expected learning outcomes that match both student and societal needs, and identify community roles and responsibility for students. Liu (2007) goes further and says that, determine and establish the type of learning communities that benefit students, help achieve learning objectives, and encourage sharing and promoting values and norms.

In order to define the objectives that meet what we want to transmit to the students of the course, we must take the pre-established general prerequisites and objectives in the course program, and write a set of specific objectives, following principles of coherence and scientific rigor, organized so that there is a guiding line of learning. The designer must have the notion that, when defining the objectives, he must establish minimum objectives to be achieved, and allow the teacher to evaluate these during the course, and if it is possible to establish new, more ambitious goals, if the students are prepared for them.

Identify target audience

What kinds of students will we have in the course, where did they come from in terms of schooling, what level of math knowledge do they have? Do the prerequisites and objectives meet the capabilities of most students planned for the course? These types of questions should be asked after writing the objectives. If it fails at some point we will have to go back to the objectives and format them according to the majority of the type of students expected for the course.

On the other hand, information about the type of students expected to attend the course can help the designer and teacher to prepare the course support material. It can be more or less comprehensive, in terms of content, depending on the type of student expected, and may even include subjects that belong to the prerequisites if there is a prediction that there are students with deficiencies in the pre-established prerequisites in the base program of the course.

Prepare teaching resources

For better development of the course support material and better organization of the course, the syllabus should be subdivided by modules representative of the covered topics.

Siemens and Tittenberger (2009) define the steps involved in selecting the type of media to achieve the learning results, in three: 1) Clarify the learning intention. What the student should during the course; 2) Evaluate the media resources - What is possible with the different technologies, available by the institution; 3) Select the media based on availability, cost, time, experience and general considerations. Taking into account these points will be passed to identify materials that can be used to any information technology to student service can support.

The first type of material to be developed should be a manual that covers all the syllabus contents of the course unit, dividing these into chapters (modules), taking into account the necessary scientific rigor, as well as written in a language accessible to the target audience. It should contain plenty of examples and at the end of each chapter it should contain a set of exercises representative of the contents of the chapter, and ordered according to the order whose theme appears in the chapter. In these sheets, the first exercises of each theme must be of the same type as the examples and then follow a level of increasing demand.

For each module, a worksheet should be created with a set of exercises that are in accordance with the general and specific objectives of the course in relation to the programmatic however present in the module. The resolution of all exercises present in the form must be made available to students later, it must contain an explanation of the steps taken in language perceived by the students.

The next type of material should be the creation of representative videos for each module. Each video must contain a theme or sub-theme of the module, its time must not exceed 6 minutes and must contain examples that exemplify the content in question. The creator of the video must take into account that he must put the essentials and be as objective as possible, he must also speak slowly and the contents be presented clearly as he narrates.

No less important is the search for reliable links made available by other authors, where the programmatic contents of the module are treated, such as: Open educational resources (OER) and YouTube videos. OER's are content that is made available for free and in which your content can be considered reliable, as it is made available by educational institutions and teachers with credibility. Bell (2020) defines OER´S as educational materials and resources, freely available, accessible to the general public, which means that they are openly available for anyone to use. The authors who create these resources are licensing the content, according to some licenses, so that it is publicly accessible and can be reused, improved, recombined and redistributed, by third parties for educational applications. As for the YouTube videos, the teacher himself, before placing the link, should have the opportunity to view it, and if it is scientifically correct and has some use for the course, he should keep the access address in order to make it available to students later. As an observation, the teacher must confirm the existence of the aforementioned links a few days before making them available to students, given that the content available online undergoes some mutations over time.

All of these contents should not be made available to students as mandatory consultation sources, but optional consultation.

Establishing Social Presence

The presence on social networks is paramount nowadays, to allow visibility of the teacher and the discipline to students. The longer the teacher connected to social networks, the more confidence he/she transmits to the student, given that the student sees it online, taking into account that it is available in case of doubts. According to Liu (2007), the establishment of a social context will help to eliminate isolation and strengthen relationships in the learning communities. The feeling of isolation is one of the main barriers for online students.

Crosslin et al. (2018) consider that although there are different ways to use social presence in an online course, they generally fall into two different categories: 1) Official communication: Useful information and other course communications are posted on various social media for increase your visibility with the universe of students and/or to encourage interaction with these communications. 2) Social interaction: students form groups on social networks to ask questions, get help from other students, and possibly form future network connections. They are less formal and easier to connect to than the official course forums.

Therefore, both the presence of the well-structured course unit on the distance learning portal of the educational institution and the presence on the social networks most used by students can be a solution and an additional motivation for students to increase their curiosity about the course content, as well as obtain better results from students in the course. Course materials can also be posted on social networks, for example videos can be posted on YouTube, so students can post their questions on their forum and in real time are visible to the entire community enrolled in the group, and with that help other students.

Finally, Crosslin et al. (2018), recommend that the person in charge of the course create a short name to represent the name of the course, and with this create a Twitter account, that account will become a hashtag, which can be used by teachers and students. The

creation of a Facebook page for information, as well as the creation of a group. Google Hangouts and YouTube Live, if the teacher or students want to have a live session with one or more people of the course, Google Hangouts or YouTube Live are good options.

Integrating Communication Technologies

According to Connolly and Stansfield (2006) the elements of instructional media used in the context of the definition of eLearning can consist of: text, video, audio, graphics, animation or any combination of them. A central component of most eLearning courses is the form of bidirectional interaction between students and the teacher and even among the students themselves. It can be classified as synchronous communication: chat in real time, and asynchronous tools, such as e-mail and discussion forums.

According to Sweat-Guy (2007), a community can be built with Asynchronous and Synchronous Communication, in which with asynchronous communication, students and instructors are able to interact with each other and with each other at different times and from different physical locations. Asynchronous forms of communication include e-mail, guest books, mailing lists, discussion forums and newsgroups. In asynchronous communication, students can work at their convenience when or where they want and are able to control their pace of instruction. On the other hand, Sweat-Guy (2007) states that synchronous communication occurs at the same time between teacher and students. For synchronous interaction to occur, all participants, including instructors and students, must be present online at the same time, but do not need to be in the same physical location. Forms of synchronous communication include chat, instant messaging and whiteboard. Although he does not quote, videoconferencing today is undoubtedly the most used.

The most commonly used technologies in most courses are synchronous tools, such as: live classrooms, chat rooms, whiteboards, weblogging and video conferencing, or asynchronous tools, such as discussion forums, e-mail and podcasts. Asynchronous tools are more flexible than synchronous tools for eLearning communities that involve students with geographic and / or intercultural differences (Liu, 2007). Asynchronous communication, by observation, is preferred by students who like to work at their own pace, as this has no time or place, while synchronous communication is preferred by more participatory students, although it can be used to take doubts, perform exercises, give examples and/or even reinforce some content, in many cases it is used to expose the contents. These communication techniques, as well as the time made available to them by the teacher, must be considered throughout the course. According to Inglis (2007) the use of interactive videoconferencing, allows students the opportunity to interact with the teacher, which allows them to ask questions in real time, obtain feedback and see the reactions of the instructor and learners.

In order to improve the course, Liu (2007) says that communication technology can also be used to extend the learning community and create situated learning interactions with experts in the field. They can participate in the discussion forum or chat with students as invited speakers to provide valuable information and contributions to students' learning.

Authentic and Situated Learning

While traditional teaching, teaching is centered on the teacher, in eLearning learning is centered on the student himself. By centering teaching on students, they will be more involved and assume the learning model for themselves, which will facilitate the learning processes. Hence the need to find teaching and learning models and techniques so that it can improve students' ability to learn, bringing them more motivation and, with that, better results.

According to Berge (2002) there are three learning environments: active, interactive and reflective, so that in an eLearning environment you can take full advantage of the learning environments, the learning environment must be designed so that the learning is situated within

the context, be focused on learning and pre-learning activities planned.

The active learning learning environment focuses on students and they participate in their learning, researching, discussing with partners and teacher and creating. According to Berge (2002) Active learning involves putting students in situations that compel them to read, speak, listen, think deeply, and to write. The responsibility of organizing what is to be learned is put into the hands of the learners themselves, rather than resting in the hands of the instructor. With this type of methodology, it is expected to involve students more in the course, more feedback from them to the instructor, less interactivity between them and the teacher, resorting only in case. On the other hand, students with more difficulties may tend to become discouraged and abandon the course.

In the case of interactive teaching, this teaching environment is more geared to the use of information technology, much focused on social networks and institutional platforms. Psotka (2012) defines interactive learning environment (ILE) as a system embedded in software and sometimes with specialized hardware designed to support the teaching - learning system in education. The interaction in the system can be between the student and the system, the teacher and the system, or between teachers and students using the system, or even between students. The environment can be more situational and passive, as in a micro world or virtual world, or Socratic and tutorial as in an intelligent tutoring system. An ILE will normally work on the Internet, as well as on mobile devices.

Taking into account the definition is to denote a great involvement of the student in their learning, they become more active, present and the interaction between the stakeholders is greater, which may favor the students in the acquisition of skills for solving problems/exercises, it also helps students to socialize by providing greater interaction between students and between students and teachers. This technique can fail in more reserved students and with difficulties to express their doubts.

Regarding reflective learning Ramsey (2006) defines this as a deliberate process of entrepreneurship, which is called research cycles. According to her, the term 'cycle' is used to capture the way a reflective student moves between action and reflection. That is, reflection must lead to action and vice versa, and so it oscillates between action and reflection.

Taking into account the definition and application of reflective learning, Colomer et al. (2013) writes that these conditions have led some researchers to reflect on the initial and continuing training of professionals, in relation to some areas of education. From this rethink, reflective skills can now be considered as an essential tool for professionals and, therefore, ways to teach and learn them should be studied. It is not just a matter of acquiring certain skills, but also of reformulating the relationship between knowledge, practice and human experience.

On the other hand, Bubnys (2014) states that reflective learning opens possibilities for the student to act independently analyzing his experience and his learning ability, relating theoretical knowledge to practical ones. Reflecting on experience allows a better understanding of a learning approach and, from there, develop metacognitive skills. Reflection promotes deeper learning, involving conscious thinking and analysis of the present or past, thus developing professionals as lifelong learners. Such apprentices will be committed to activating prior knowledge, and to building, deconstructing and rebuilding their knowledge, seeking continuous improvement.

This type of teaching-learning methodology was meant to bring some responsibility to the student, since he becomes responsible for his learning, which implies his personal growth. The student also ends up consciously verifying the evolution of his knowledge acquired over time and what he is profiting from.

Assessment

Assessment can be defined as a regulatory act, and in a teaching-learning

environment, we can assess the student and the course. The student's evaluation will reflect the student's evolution and the acquired skills. At the course level, assessment serves as a means of regulating its functioning, that is, it serves to regulate the learning process throughout the course period and serves to gauge the teaching methodologies used, materials made available, time spent on the subjects, and much more. On the other hand, students 'evolution should be related to the course evaluation if we observe a positive relationship is a good sign and there we should look for points where new improvements can be made so that the students' results are better, if the relationship is negative you have to analyze the whole process to see where the teaching-learning process fails and to impose improvements on it. According to Yushau, (2006) who states that since attitude is a determining factor in people's behavior, it is critical in education. It is common practice that, if a new program is introduced, part of the assessment is to determine people's attitude towards the program. In most cases, positive attitudes are interpreted as an indicator that the program can be successful. Otherwise, there is a tendency for failure and therefore the attitude needs to be modified or possibly changed.

Crosslin et al. (2018), identifies some types of assessment that can be used in an eLearning course, such as: 1) Informal Survey (used to assess understanding of recent topics or interest in future topics); 2) Standardized test (use of problems such as multiple choice, true/false, correspondence and other forms of standardized question formats); 3) Written answers (can take many forms, from open questions in standardized tests to comprehensive exams and course completion works); 4) Oral presentation (students need to answer a series of questions correctly); 5) Skills Test / Demonstration (practical demonstration of acquired skills); 6) Activities (work / task produced by the students); 7) Group projects (activities / projects that involve several students); 8) Portfolios / Cumulative projects / Capstone (collection of various tasks gathered throughout the course).

It follows the application of types, some of these types of assessment that can be undertaken in a type mathematics course in an eLearning environment, in order to take full advantage of students' learning.

As the course was divided into modules, intermediate course evaluations should be carried out at the end of each module to assess the learning during that module. This type of intermediate evaluation serves for the teacher to have feedback on the students' learning and, on the other hand, the students will have an extra motivation because they have the notion that their knowledge is being counted in addition to that the contents are more present in the when the module ends than at the end of the course. The ideal for this evaluation is to perform a short task, which may be the resolution of some exercises on the subject of the module. In this type of mid-term evaluation, one should choose a type and approach in the correction/evaluation, and give students another responsibility, that of evaluating their peers. Peer review is the assessment of student work done by other students at the same level. Students reflect on their own efforts, expand and enrich this reflection by exchanging feedback on their work and that of their colleagues (Student Peer Assessment, 2019). The peer review, assigns the responsibility to the student to correct the task of a colleague, and in the end the teacher will be assigned a rating for the task and the correction, in many cases each student having to correct three tasks of colleagues, can bring more advantages because it thus consolidates your learning better, given that although you have made mistakes in carrying out your task when checking with other resolutions you will identify the most correct one. On the other hand, peer review is a powerful metacognitive tool. It involves students in the learning process and develops their ability to reflect and critically evaluate their own learning, as well as the development of skills. It also supports the development of critical thinking and interpersonal skills, as well as increasing your knowledge of the discipline (Student Peer Assessment, 2019).

Bearing in mind the principles of eLearning, and the form of interaction between students, group work comes to help in socializing among students, given this principle, assessment by group work is an asset, because in addition to the socialization of students reinforces the homogenization of content within the group. This assessment can also be used to show a connection between mathematics and the real world, so one should always ask for a job in which the student has to do a research to find the presence of a mathematical theory, studied during the course, in explaining a real-world phenomenon. Group work is an important factor for students' success in university courses. This is especially true for first-year students; group work provides a structure in which they can socialize and thus reduce their sense of isolation (Assessing by Group Work, 2018). Many teachers think that the evaluation by group work is not representative of the knowledge of the elements of the group, but although this can happen the teachers must think that some students have a greater capacity to acquire knowledge through their peers than from the teacher, hence the work group work is important in the consolidation of knowledge by some of the elements of the group. The presentation of these works can be done through the creation of a Wiki, encompassing all the works, in which each group will be responsible for its chapter, a blog, a video presentation, or even an oral presentation and consequent preparation of a written report.

Finally, there is the final assessment that will be carried out individually and will be representative of all the syllabus of the course. Here the student will be evaluated by his global knowledge acquired during the period in which he had contact with the course, answering a limited number of written questions. This is undoubtedly the most used, and unique, in traditional education and it limits the student to the passive position of assistant. This is undoubtedly the most used, and unique, in traditional education and it limits the student to the passive position of assistant.

III. Conclusion

Starting from the purpose that students can change the way they face mathematics, with the transition from traditional teaching to eLearning, taking advantage of the characteristics of this teaching environment for the involvement of students in the teaching-learning process. In order to obtain results of this involvement in what concerns a better use on the part of the student and with that the growth of the student's self-confidence in relation to the syllabus, reflecting this in his overall satisfaction with the course.

The organization of the course taking into account that the student is the center of the teaching-learning process, leads the designer and the teacher to try to anticipate, during the course preparation, the students' difficulties, so that when they are in contact with the course the respective difficulties are overcome.

Taking advantage of information technologies and presence on social networks for the teaching-learning process, allows greater interaction between the teacher and students, associating them to the propagation / acquisition of theoretical and practical knowledge involved in the programmatic content of the course, in such a way that the information is available for the student to consult anywhere and anytime. If an assessment is added to the learning environment that meets the needs of the students, it will further improve their performance. As there is usually a relationship between the students' performance and the final classification, if it exceeds their expectations, their way of looking at the discipline will change, and the sentence: “Mathematics is difficult!”, Will be replaced by the sentence: "After all, math is easier than I thought."

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