

GeoGebra and eXe Learning: Applicability in the Teaching of Physics and Mathematics

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Abstract

Today, education in the field of sciences is still characterized by excessive attention to repetitive exercises at the expense of understanding and visualizing the concepts of mathematical and physical phenomena. This article will show the potential of the software GeoGebra to build content and / or activities in Physics and Mathematics usable in isolation or engaged in other activities, such as eXe Learning. For this we constructed two activities: a mathematical content - Application of successive derivatives, and a content of physics - Application of uniform rectilinear motion. These contents were built in eXe Learning, and the graphics was built in GeoGebra and imported into the eXe by Java Applet. The content was done with the exported SCORM to Moodle, it is within this framework that the student will study the movement and display of graphic content.

Keywords: Construction content, GeoGebra, eXe Learning, Activity in Physic, Activity in Mathematic.

1 Introduction

Teachers have encountered growing difficulties of learning that students, in all levels, had presented in Mathematics and Physics. The learning in this areas seems not motivate the students, thus creating more difficulties in this process. The use of traditional methods of learning and the reduced number of inivative technologies are some reasons of this situation.

The scientific knowledge has evolved over the ages and, today, these concepts allow, by exploration of the world around us, day-by-day experience, like moving objects, walking, open windows and drawers.

In problem solving, [1], [2] and [3] shows that the concepts belonging to common sense and that occasionally arise in the process of formal learning of Science, the official concepts overlaps the spontaneous concepts rather than replace them. It is known that mathematics, science abstract and logic, helps in the process of verification of the trials and it can model an experiment, from simple to complex.

However, the teaching of physics and mathematics is still characterized by excessive attention to repetitive exercise. In physics this approach emphasizes the use of mathematical algorithms, rather than understanding of concepts related to physical phenomena involved, while in mathematics it decorates the mechanics of the algorithm, without knowing why to do it.

In its guidelines, the National Curriculum Parameters (PCNs) [4] to seek a new direction for the teaching of physics and mathematics. These suggest that dealing with issues close to the world experienced by students and pursue the development of the citizen to fully able to understand, intervene and participate in the society where he lives. The authors agree with the suggestions of the PCNs, but feel that students should have a basic knowledge and complete all areas in order to improve the performance of their learning.

The use of computers and the Internet in education, coupled with the computational tools (educational software), based on educational paradigms, can contribute to the process of teaching and learning. The use of virtual reality to build simulations and animations, offers vast potential, allowing students to understand the theoretical principles of Natural Sciences.

Specifically for the exact area, there are numerous educational software available for the construction of dynamic content, such examples are the GeoGebra, eXe Learning, Modellus, Geometric Cabri, Maple, etc.. Some of them free, as GeoGebra and eXe Learning, which can be used by teachers to create educational content. They are easy to use tools, without extensive knowledge in programming language.

This article aims to show the potential of eXe Learning to build content and / or activities in Physics and Mathematics usable, isolated or engaged in other activities. The second section will deal with the digital educational content and their specific requirements. The third section will describe about Virtual Environments Authoring (AVAu), with some software used to create educational materials for the teaching of physics and mathematics. In the fourth section will show the creation of a content of physics and mathematics using the eXe Learning, and the graphics built using GeoGebra and imported into eXe through Java applets,

and the final content available on the Moodle platform. The fifth section will focus on the pedagogical work of teachers through the use of digital content. Finally, the sixth section will be carried out other conclusions, showing prospects and difficulties of using GeoGebra and eXe Learning for building material for teaching physics and mathematics.

2 Educational digital and their specific requirements

It is understood as educational content all the information and / or activity necessary for a student reaches a goal previously proposed for learning a concept or skill. Such content can have different forms, such as a learning object (LO), but they are usually digital and are characterized by the reuse in their various contexts, in order to facilitate the acquisition of knowledge.

For a content to be recovered and reused it needs to be properly indexed (completion of metadata) and stored in a repository. These metadata standards include a minimum set of attributes needed to allow these objects to be managed, located and evaluated. According to [7], currently there are several specifications that regulate the development of objects and the main the Instructional Management System (IMS) Learning Design, Object Sharable Content Reference Model (SCORM) and Aviation Industry CBT (Computer-Based Training) Committee (AICC).

To [8], the digital educational content has the following characteristics: (a) Interoperability: content from multiple vendors can be easily disseminated among consumers and a multitude of systems. (b) Reusability: the content and codes can be packed and unpacked quickly and easily. (c) Manageability: The system can track the appropriate information about the student and content. (d) Accessibility: You can access the right content at the right time and at right way. The content repositories are developed and made available to the student based on common standards. (e) Durability: the content is produced once and inserted several times on different platforms and systems with a minimum of effort. (f) Scalability: learning technologies may have expanded its functionality to meet the different public and educational purposes. In addition to these features, a digital educational content should be freely and openly[9]. The content can be produced and subsequently transported to the virtual learning environment which will be used, with minimized efforts for adaptation and configuration of activities[10].

The authors believe that the digital educational content for Mathematics and Physics must have some specific requirements such as:

2.1 Strong content: full content, which corroborates student learning. Presented in a sequence from simple to more complex [11].

2.2 Illustrated Content: Content is not limited to text, but is illustrated with figures (tables or graphs), videos or other tool that shows the student what is written in the text, facilitating learning.

2.3 Treatment and Conversion of equations: Equations are open sentences expressed by an equality involving mathematical expressions, which are used to solve problems. An equation consists of unknowns and coefficients, which are mathematical entities known. To apply this method of solving problem situations you must follow these steps: remove important data to solve the problem, identifying what is the unknown, or what the problem wants to find out, identifying the mathematical operations involved; mount equation, solve the equation found, obtaining the value of the unknown; verify the equation if the value found is correct and show the significance of this result.

According to [12] should pay attention to two types of transformations that are totally different, and that is fundamental to the process of teaching and learning of equations: the treatments and conversions. When a student is solving an equation and he writes equivalent equations to find the value of the unknown, he is performing a treatment. When a student becomes a problem situation, given in natural language to algebraic language, he is performing a conversion. For mathematical conversions are only important when choosing the best record, in which the treatments are made more efficient. As for the teaching and learning is much more important to consider the conversion of the treatments, because this is when the student needs to mobilize the necessary mechanisms for understanding the mathematical object in question.

2.4 Dynamic Simulations: are used to simulate and illustrate a theme. Simulations can give life to abstractions of the sciences. They can be a learning object built as applets, as in this article. Applets are interactive programs written in Java and can run on any browser or another Java application. They are able to simulate real life experiences, allowing the change of parameters and comparison and verification of results [13 and 14]. The use of applets provides a better representation for the explanation of a concept, when compared to static pictures or a textual description [15].

2.5 Studying varied to problem solving: A mathematical problem is any situation that requires a mathematical way of thinking of the individual and mathematical knowledge to solve it. There are software programs that solve specific problems such as geometry, CABRI, MAPLE, Mathematica, Cinderella, Curve Expert, Dr GEO; Euklid; Descriptive Geometry: Geoplan; ruler and compass; functions: GraphEquation; GraphMatica; MathGV; Modellus; RATS; VRUM-VRUM; Winplot; algebra: WinMate. Some systems, such as WebQuest, eXe Learning, NAVI, are used as authoring tool for creating any type of content.

3 Virtual Environments Authoring

The expansion of the use of Virtual Environments Author (AVAut) provided more interaction and facilities for the teacher to create content and / or view applications made in proprietary or free. The Free Software Foundation defines free software when it can

be executed, copied, distributed, studied, or even modified and improved by the User. Already proprietary software is software that can not be redistributed or modified without permission from the company or person who did. Some of the best known proprietary software are Microsoft Windows, RealPlayer, Adobe Photoshop, Mac OS, WinZip, some versions of UNIX, and others.

The AVAut allow the inclusion of animations, simulations, images, formulas, among others, which helps in the process of teaching to facilitate learning. In a survey of teachers of Mathematics and Physics, and each teacher can work with more than one software, [16] claim that 71% use the software Cabri and Excel, 43% GraphMatica, 29% Tangram and Winplot, 14% Maple and Poly, and only 7% GeoGebra, WinMate and Shapari. The authors noted that the software Slogo and Tess, although available in schools, were not used by teachers who participated in the survey.

As in section four will be shown two activities using the software eXe Learning and GeoGebra, then they will be respected and shown the main tools used in this article.

3.1 The eXe Learning

The eXe (eLearning XHTML editor) is an authoring program, where teachers can develop and publish learning materials without the need for expertise in programming language [6]. This tool allows you to publish online content on several platforms, for example, in Moodle. The portability of this tool to the extreme of not requiring the installation of software, since it can take a portable version of eXe software on a USB (or other removable storage medium).

With eXe teacher can develop content or projects, in a structure of nodes. At the main node can be connected to several other nodes in the form of section and sub-section. Each part of a project may correspond to a iDevice, which must first be saved as a file .elp (elearning package). After finishing the project, the resources created using eXe can be exported in formats of IMS Content Package, IMS Common Cartridge format, single page web sites, web self-contained, SCORM 1.2, text file or group of notes to iPod. The IMS and SCORM formats can be inserted in virtual learning environments like Moodle, and need not be unpacked. The export of content in HTML format, requires that the resulting compressed file is decompressed after exportation that is on a server.

In software, the mathematical equations are written following some LaTeX commands, which is a set of macros for the word processor (PHP), widely used for the production of texts in mathematics and science because of its high quality printing.

3.2 The free software GeoGebra

GeoGebra is a free software that brings mathematics geometry, algebra and calculus, and the equations and coordinates can be introduced directly into the keyboard [5]. He works with variables linked to numbers, vectors

and points to calculate derivatives and integrals of functions and provides a set of commands specific analysis of mathematics, to identify single points of a function, such as roots and ends. It was built in Java and its applets are available on the Internet and can run on Windows, Linux and Macintosh.

It offers three different perspectives of each mathematical object: graphical window, algebraic window and a window of the Spreadsheet. So you can see the mathematical object in three different representations: graphically (as in the case of points, graphs of functions), algebra (such as point coordinates, equations), and cells in a spreadsheet. Each representation of the object to bind the other in a dynamically adaptive to each other and, absorbing the changes produced in any one of them.

4 Activities of Physics and Mathematics using GeoGebra and eXe Learning

The authors chose to create learning objects (LO) using open source software in order to show the potential of eXe Learning combined with GeoGebra for building educational content and match it up with practically no cost, making it easier for both the teacher and for the institution. It created an LO using eXe Learning importing the graphics by Java applets, which was built using the GeoGebra, showing that content in Moodle is imported it to the SCORM standard.

4.1 Applications of successive derivatives

The successive derivatives are great tools for calculating points of maximum, minimum and inflection, especially in very complex equations, which makes the viewing geometry. They are also used to analyze the growth and concavity of a polynomial function.

4.1.1 Objectives: (1) Study the criteria under maximum, minimum and inflection of a polynomial function. (2) Review the criteria of growth and concavity of a polynomial function. (3) Show the graph of the polynomial and the derivatives of first and second order. (4) Show the graph points maximum, minimum and inflection.

4.1.2 Prerequisite: (a) basic mathematics. (b) Calculation: limits and derivatives.

4.1.3 Criteria points of maximum, minimum and inflection: In mathematics, the criteria for the points of maximum and minimum growth of a polynomial function are given a function $f(x)$ and a point b such that

(a) if $f'(x) > 0$ for all x belongs $]a, b[$,
 (b) $f'(x) < 0$ for all x belongs $]b, c[$ and
 (c) $f(x)$ is continuous in b , then b is maximum point.

(a) If $f'(x) < 0$ for all x belongs to $]a, b[$,
 (b) $f'(x) > 0$ for all x belongs to $]b, c[$,
 (c) $f(x)$ is continuous at b , then b is the minimum point.

If $f'(x) > 0$ for all x belongs to $]a, b[$, then f is strictly increasing in $]a, b[$.

If $f'(x) < 0$ for all x belongs $]b, c[$, then f is strictly decreasing in $]b, c[$.

The criteria for the point of inflection and concavity of a polynomial function are given a function $f(x)$ and a point b such that

(a) if $f''(x) > 0$ for all x belongs to $]a, b[$, then f is concave upward in that interval.

(b) If $f''(x) < 0$ for all x belongs $]b, c[$, then f is concave side down in that range.

(c) If $f''(x)$ has different signs in the intervals $]a, b[$ and $]b, c[$, then b is a point of inflection (changes concavity).

4.1.4 Example: Check the growth of the function $y = x^3 - 3x^2 + 4$, showing the point of maximum or minimum. Analyze the concavity and the inflection point. No software GeoGebra, the following steps: the algebraic window, enter the function $y = x^3 - 3x^2 + 4$ and press Enter, which will free the object.

To calculate and show the derivatives: insert in the algebra window commands: Derivative [f] and Derivative [f,2], after press Enter. The derivatives depend on the function and therefore are dependent objects in GeoGebra, being represented by the graph of quadratic function (first derivative) and linear function (derived from second order).

GeoGebra to investigate roots, local extrema and inflection points of polynomial functions. For this to occur, insert in input field the following commands and press Enter after each command: E=Extreme [f], I=PontoDeInflexão [f], R=Root [f] .

These commands calculate the extreme points, that is, maximum, minimum, inflection point and the roots. Automatically appears in the window geometric points on the figures of the polynomial and its derivatives. All this activity for the application of successive derivatives described here was created in eXe Learning, and the graphics have been imported from GeoGebra, using Java applets, as appears of Figure 1.

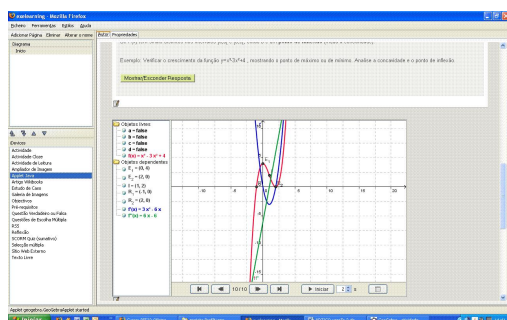


Figure 1 - The figure shows the same activity imported by eXe Learning, the use of Java applets.

4.1.5-Analysis of results: The graph polynomial $f(x)$ has the extreme points $E_1(0,4)$, the peak and $E_2(2,0)$, which is the minimum point. The function $f(x)$ is increasing when $x < 0$ or $x > 2$ and decreasing when $0 < x < 2$. You can do this study through the derivative of first order (quadratic function), where $f'(x) > 0$ in the

intervals $x < 0$ or $x > 2$ and $f'(x) < 0$ in the range $0 < x < 2$. The point where the function change of concavity, the inflection point is given by the point $I(1,2)$. This condition can be seen the derivative of second order (linear function), which is positive in the range $x > 1$ and is negative at $x < 1$, and the concave up when $x > 1$ and down, when $x < 1$. The figure below also shows the points where the function $f(x)$ cuts the x -axis, which are the roots of this function, in this case $R1(-1,0)$ and $R2(2,0)$, respectively.

This activity in eXe Learning was exported with the SCORM to Moodle, for it is there that the student will see this content. The student sees the activity as shown in Figure 2.

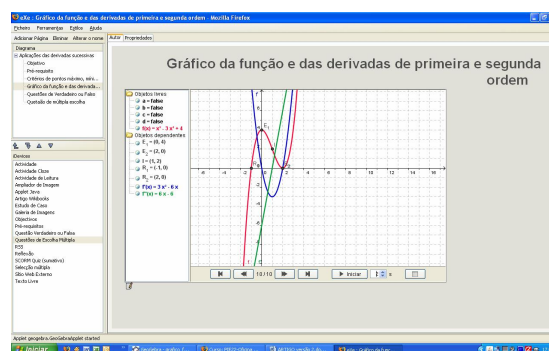


Figure 2 - Presentation of mathematical activity in Moodle.

4.2 Physical Activity - Implementation of uniform rectilinear motion (URM)

The uniform rectilinear motion (URM) is a movement whose speed is constant and whose graph is a straight line.

4.2.1 Objectives: (1)Identify the types of motion (progressive and retrograde). (2)Check graphically the types of movement. (3)Examine graphically the point and moment of encounter of two mobile.

4.2.2 Prerequisite: (a)Cartesian coordinates. (b)Straight ascending and descending.

4.2.3 Problematising the URM: Constantly students have difficulties in solving problems that are of more than one speed, that is, appears more than one object to be analyzed. Given this, we elaborated a problem that involves two objects and uses the GeoGebra to its resolution.

4.2.4 Example: Two cars travel in the same path and the distances are measured from a common origin. One of the cars start the position 3m with progressive movement whose speed is 2m/s, while the other start of the 6m position and its motion is retrograde speed 1m/s. Question is: what is the time of the meeting of the cars and their position?

4.2.5 Answer: In the input algebraic software GeoGebra is part of the equations of motion of slot cars. Initially GeoGebra presented as Cartesian coordinates x and y , need to be renamed to set, according to the nomenclature used in physics.

The scheduling functions used in this example were: S1: $y = 2x + 3$ and S2: $y = -x + 6$, as depicted in Figure 3.

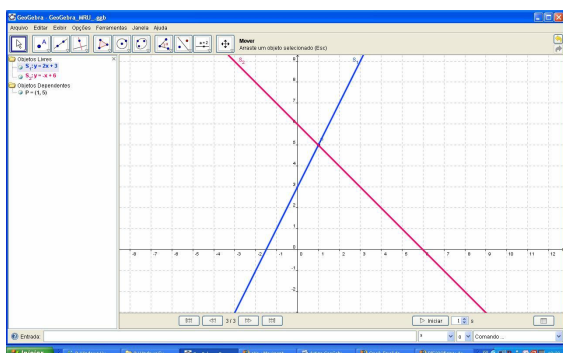


Figure 3-Presentation of the activity of Physics in software GeoGebra.

4.2.6 Analysis of results: Through the chart, one can see that the line that describes the trajectory of the progressive movement (S 1) is increasing and the line that describes the trajectory of the retrograde motion (S 2) is decreasing. Given this, they will intersect at the point $x=1$ (second) and $y=5$ (meters). This shows that the moment of meeting the cars are in the same position, regardless of how much each one passed. Therefore, the time of the meeting is the 1st and the second position of the meeting is 5 meters.

5 Teachers and digital content for Physics and Mathematics

The search for motivators that help arouse greater interest and understanding in their disciplines has led teachers to insert the digital content in their teaching.

The digital educational content (EDC) includes all the information necessary for achieving an objective previously proposed to learn a concept or skill. But the EDC does not guarantee the contextualization of the content and nor student learning. It takes planning and study of the object. Therefore, we suggest that teachers explore the materials in advance, consider whether they are compatible with the computer room of the school that serves, finally, plan their lessons, their educational strategy and the feedback activity and that it will ask the students.

When creating and / or reusing the content, the teacher can make use of free distribution of software and easy to use, as GeoGebra and eXe Learning. Thus, the technology can be used as an aid to enrich the lessons innovating didactic and pedagogical activities. According to [17], in the context of the area of logical reasoning and abstract, learning environments created by computer applications can streamline the curricula and enhancing the teaching and learning focused on "trial", with the possibility of the emergence of new concepts and new mathematical and physical theories in order to make it an important allied in the construction of knowledge.

One of the EDC used by teachers are the learning objects (LO). These are digital educational content involving collaborative activities and constructed in

accordance with a need, following an object-oriented methodology to facilitate reuse [10]. For them to be reused some authors [10] and [18], suggest the adoption of a standard Sharable Content Object Reference Model (SCORM) making these educational materials available. Its use implies issues such as portability, use and reuse of these materials in different contexts, in person or remotely, and virtual environments.

6 Closing remarks

Today is no longer accepted that a student studies the laws and formulas decoupled from reality, but it should look updated content in context with their day to day. This article showed that the teacher can create educational content using the tools and GeoGebra eXe, which can simulate real phenomena, improving student learning.

It is obviously to replace the problem-solving using mathematical formulas, but also added a new technology that facilitates the learning process, which contributes to a better understanding of the concepts studied in physics and mathematics, making these subjects less exclusive and boring.

Using these tools, even simple for the Common User requires of teachers a minimum knowledge of programming language, allowing it to leverage its use and adapt the content for the student.

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