# Use of Educational Software in Mathematics Teaching: Case Yucatan, Mexico

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**Abstract**

This paper presents a collection of software projects that have been used as tools in teaching mathematics, and an analysis of their use in the state of Yucatan, Mexico. Today teachers must adapt their strategies to a new way of teaching, for which various programs are being used as complementary tools for teaching_ various subjects and thus improving students' academic performance. Among the subjects chosen to implement new teaching techniques is mathematics, which is considered one of the most challenging subjects for students. The aim is to encourage and facilitate the learning of mathematics.

***Keywords:*** *Learning, Mathematics, Software, Students, Teaching, Tools.*

## 1. Introduction

Currently technology is an indispensable part of people's daily lives and many technological advances are emerging that in some way enhance our quality of life, facilitating tasks that may otherwise prove difficult. Children and adolescents in the more developed regions interact daily with new communication systems (TV, electronic games, etc.), using them naturally and socializing via their codes, cognitive forms and values [1].

In the field of education new technologies are beginning to play a very important role in the teaching-learning process, so teachers need to be innovative in the tools they use when teaching.

Today computers and tablets are widely used in schools and universities in developed countries and are being rapidly introduced in the classrooms of developing countries. Many learning tools for computers or for tablets have been created: from educational games to support software for the teacher [2], however because there are still teachers who do not yet use technology as a method in their daily teaching, new studies have been conducted to show teachers more modern ways of teaching using technology. An example of this is a piece of research presented by [3], in which a two block questionnaire is proposed and its results suggest that computer-assisted teaching does not itself alter the teaching-learning model of teachers but is adapted to the model maintained by professors. However there is some data that indicates significant changes in the opinions of teachers after they have had a limited experience of teaching at a computer laboratory [3].

New technologies have undoubtedly brought huge benefits for teaching, but at the same time, teachers have a greater responsibility because they must be constantly updated to renew teaching methods implemented with their students.

## 2. Educational Software

Educational software is defined as "computer programs created with the purpose of being used as facilitators of the teaching process" and consequently of the learning process, with the key features being ease of use, interactivity and the possibility of customizing the speed of learning [4].

There are other definitions of the term "Educational Software", however, most of these definitions have common aspects that invariably characterize educational software as: "didactic", "with pedagogical intention," "with curriculum support," "with pedagogical material", and as a "teaching tool" [5].

There are a variety of benefits that result from implementing some type of educational software in the classroom. Some of these are presented in Table 1. In this table we can notice that a good educational software and a teacher using it properly for his/her class will bring benefits to student learning.

Today educational Software offers environments where students can interact and acquire knowledge not only of the material with which they are working at that time but also of the computer field.

Table 1. Characteristics of Educational Software

| ***Features*** | ***Description*** |
|---|---|
| Ease of use | Wherever possible self explanatory and with support systems |
| Motivational skills | keep the interest of students |
| Curricular relevance | Related to needs of teachers |
| Versatility | Adaptable to available computer resources |
| Pedagogical approach | Should be current: constructivist or cognitive |
| Student Oriented | with control over content |
| Evaluation | with evaluation and monitoring modules |

## 3. The importance of mathematics and the problem of teaching it

Mathematics is one of the less enjoyable subjects for many learners, because it is often considered one of the most difficult to learn. However mathematics skills are required to a greater or lesser extent in many of the daily tasks we perform, but sometimes we do not realize it. We use mathematics as part of our daily lives through various measures such as age, grade, score on a test, amount of food we have eaten, weight, distance, etc. On the other hand we rely on formulas and use them to solve problems in applied mathematics and its sister sciences physics and chemistry [6].

The UNESCO has stressed the learning of mathematics as one of the key factors for global development and additionally the General Assembly of the International Mathematics Union (IMU) has proclaimed that learning mathematics is one of the great challenges for this century.

The learning of mathematics has always been a specialist area due to the relatively small number of students who like this subject.

In [7] it is stated that the reasons why students fail this subject are primarily due to the student's attitude, and secondly to the attitude taken by teachers when giving a lesson.

Mayta Guedez published in [8] that the problem does not reside in the individual but in the way that mathematics is perceived in the development of the educational act.

Therefore the situation in mathematics education requires a radical change whereby new methods are implemented through which teachers can better capture the attention and interest of students. This way students may acquire knowledge and skills while finding pleasure in the learning process.

Often, mathematics is taught in a similar way to that of 100 years ago: in black and white. The only noticeable change is replacing the use of classic tables of logarithms and trigonometry with pocket calculators, which has undoubtedly been a boon for students [9].

One of the central reasons for the low level of mathematical learning and the rejection of this area of study by students, is due to the way that mathematics has been taught at school, that is, by the type of relationship established between children and the math activities in their learning process.

The strategies of "traditional" teaching in mathematics have shown it as an object of rigid knowledge that does not accept questioning, analysis, testing or management alternatives. With this approach, the only thing it can be done is to follow step by step the guidelines given by the teacher to achieve at least a “passing” grade [10].

No doubt, many authors agree that the traditional teaching of mathematics must be replaced by new methods in which teachers include new techniques that are much more attractive for students. Among these techniques, educational software is a useful tool.

## 4. Educational software in teaching mathematics

Students of the XXI century not only need the basic principles of arithmetic, algebra and geometry, but they should handle algorithms, forms, functions, data, attributes and actions as well as many other skills which use computers as support tools [11].

In [12], several examples of educational software are mentioned which are currently used in this area. Among them we have the following:

*Graphmatica*. This is an interactive graphic program of mathematical equations. It lets users compare

simultaneously several graphs, calculate the area under a curve, trace the tangent to a point, resolve inequalities and determine families of curves. It contains an equation processor and a complete library of math functions (see Figure 1).

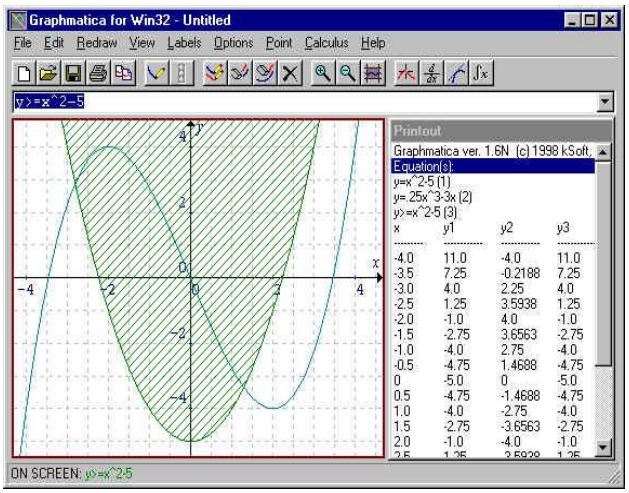


Figure 1. Graphmatica GUI

*Winplot*. This is free piece of software. It is a 2-dimensional (X, Y) and 3-dimensional (X, Y, Z) graphic program. It draws curves and surfaces which can be displayed in a variety of formats. It consists of menus or windows, which can be handled without difficulty. Each menu has detailed information on the functions performed (see Figure 2).

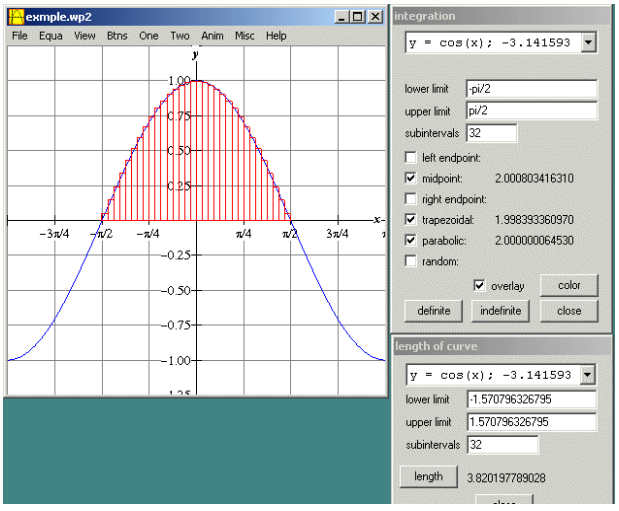


Figure 2. Winplot GUI.

*Scratch*. It is a programming environment developed by a group of researchers from MIT (Massachusetts Institute of Technology), one of the most important universities of the world, under the direction of Dr. Mitchel Resnick. Scratch makes programming more enjoyable for anyone who is faced for the first time with the challenge of learning programming. According to its creators, it was designed as a means of expression to help children and young people express their ideas creatively while developing logical thinking and learning skills [13].

## 5. Implementation at different educational levels

Various types of educational software have been developed which contain specific characteristics according to the area for which they were created and depending on the educational level at which they will be implemented: preschool, elementary, high school or higher education.

Basic education (preschool and elementary education) is a training stage for children in which thinking skills and core competencies are developed to promote systematic and continuous learning, and dispositions and attitudes that will regulate their life [14].

### 5.1. Preschool Education

Preschool education plays a role of primary importance in the learning and development of all children. This level of education plays a democratizing function as an educational space in which all children, regardless of their origin and social and cultural conditions have learning opportunities that enable them to develop their potential and improve their capacities [14].

It is a suitable stage at which to instill in 3-6 years children the taste for technology, which will be an essential part of their training.


Figure 3. Clic 3.0 GUI

An example of an educational project created for preschool education is conducted in [15] which describes an experience with teachers and students of the first stage of basic education, through the use of software such as "MSPaint", "Clic 3.0" (see Figure 3) and "Poly 1.6" (see Figure 4). Teachers created simple multimedia materials using Clic 3.0 supported by the other two programs mentioned to address elementary notions of geometry in the laboratory. This improved the learning progress in the classroom, as well as the collaborative work between teachers in the classroom and teachers in the laboratory for the development and application of produced materials [15].

Implementing Educational Software at preschool age helps children to develop new skills at an early age, so that during their development they may more easily adapt to the environment in which they are growing up, one where technology and information are paramount.

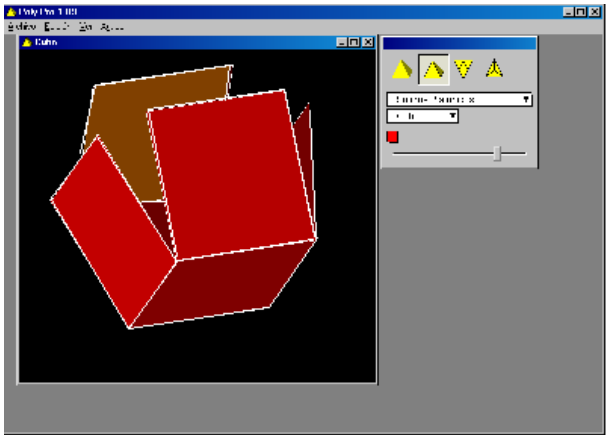

Figure 4. Poly 1.6 GUI

## 5.2. Elementary Education

Elementary education is an essential part in the child's education, because in this stage, he/she is acquiring the taste or distaste for the materials that are taken into classes, this is the time in which the teacher must introduce the child to a new approach for teaching-learning, because at this stage it is the ideal phase to instill an interest in learning.

Software is constantly being created to implement strategies at elementary level as a method to instill interest in the child. An example of this is a project called "Mathematics for All", aimed at improving the competitiveness of young people. The development of a website to complement textbooks was considered essential because at present it is necessary to know how to use the Internet as a basic input for competitiveness. For this purpose 20enmate.com (see Figure 5) was created, which is an interactive and direct access website focused on making mathematics learning fun. The author says that the program is predicted to be a success because students who have interacted with it achieve progress in their knowledge of mathematics [16].

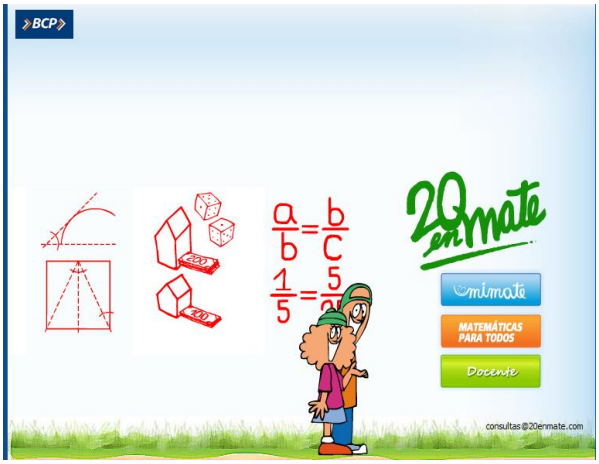


Figure 5. 20enmate GUI

Another example of educational software at a elementary level is a software collection named "Multisaber" which consists of thirty types of educational software for this level [17]. The "Multisaber" collection has a curricular approach, covering the contents of the basic curriculum (from 1st to 6th grade). This methodological concept has been called a ‘learning hyperenvironment’ and it is usually made up of 6 areas such as subjects or classes, exercises, library, games, teacher, and registry. With specific regard to the mathematics area it contains a child-aimed section called classes which discusses the significance of the four arithmetic operations, the part-whole relationship, and gives support to graphics and illustrations for working with problems in the field of natural numbers [18].

## 5.3. Secondary Education

Secondary schools have computer rooms that mostly remain closed or are used only in the hours of a computing subject. It is observed that many teachers do not use the computer room for lack of security resources as well as a lack of support from specialized personnel on the subject [19].

The use of computers and the development of educational software in the teaching of mathematics in secondary level can be an innovative tool for teaching support in the classroom.

An example of the use of educational software to secondary level is the project described in [20] which aims to analyze the use of educational software from a constructionist perspective in the teaching of mathematics, specifically in the teaching of equations and algebraic functions. The central activity of the project is the management of educational software, through which movement is given to mathematical content on the screen of the computer. The movements made are related to changes of algebraic symbolization, parameter changes, sign changes, and changes of linear, quadratic and independent variables [20].

Another example of educational software at a secondary level is "PoliEstudio 1.0", which is a freeware computational tool designed to work with polynomials in a variable. This is a validated educational program, which gives a partial response to the problems afflicting the mathematical training of secondary students, in particular, on issues concerning polynomials in a variable (see figure 6).

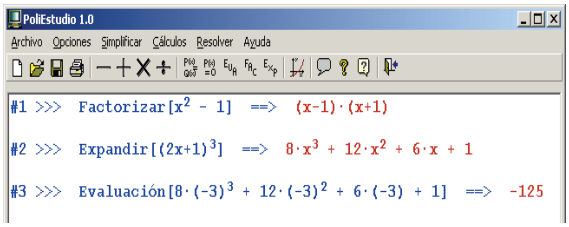


Figure 6. Options of "PoliEstudio 1.0"

Additionally, PoliEstudio 1.0 provides a graph plotter of polynomial functions that can represent one or more polynomials on a Cartesian coordinate system, this application is called "PoliGraficador" (see Figure 7).

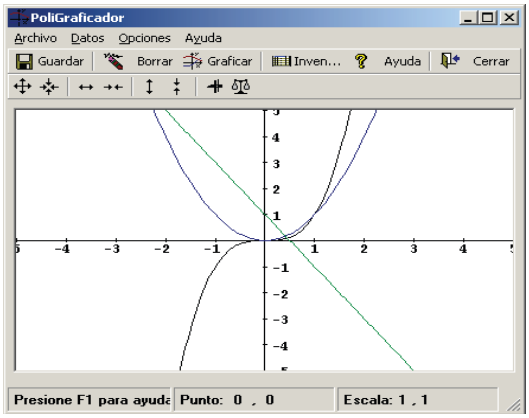


Figure 7. PoliGraficador.

Teachers and students can use PoliEstudio 1.0 without restriction in the classroom, computer lab or, if necessary, in their homes as it is a freeware program [21].

## 5.4. High School Education

A poor High School Education, can become an obstacle that limits the proper training of students and limits potential development towards higher education. It is necessary at this level to implement technological resources in the classroom to motivate student learning, inasmuch as students' learning should be largely linked with technology.

In the area of mathematics it is essential to employ more dynamic techniques to capture the interest and enthusiasm for the subject by students, otherwise interest will be lost and rejection will follow.

One example of this is illustrated in an article from the newspaper "La Jornada" [22], mentioning that recently, national indicators showed that 40 percent of students in sixth semester of high school in the state of Baja California (the total number was 18, 878 students) taking the National Assessment of Academic Achievement (a test called ENLACE) had an insufficient level of proficiency in mathematics. With the certainty that gaming is a common hobby that can be exploited as a vehicle to raise interest in mathematics, since 2000, researchers of CICESE (Center for Scientific Research and Higher Education of Ensenada) have been developing computer programs that can be implemented in the curricula of high school to facilitate learning and teaching of mathematics, as well as motivating students and arousing their curiosity about the subject [22].


Figure 8. Issues of Eureka

Within this new context and as part of a future collection aimed at high schools, a project called Eureka has arisen (Figure 8) which is designed to support the teaching of

mathematics at this level. Eureka is composed of seven modules to support the various stages of the educational process [17].

Another example is a software called FunReal 6.0 software [23], which was designed and developed with a constructivist approach in the tutorial mode. It allows the use of multiple media (sound, text, images, animations) transforming any activity to an attractive task that arouses interest and motivates. Its main benefit is in helping students develop a sense of autonomy in the acquisition of knowledge, making them more active, creative and participatory

## 6. Teaching of mathematics in High School Education in the state of Yucatan

The teaching of mathematics in the state of Yucatan requires special attention because the state is among the seven states with the lowest levels of educational achievement and thus greatest obstacles to generating high-level specialists to assist in the development of society and of a more competitive economy in the XXI century.

This is a truly alarming situation, because mathematics is essential to our daily lives. It is necessary to implement new methods to achieve an improvement in performance and skills of students in High School Education, since this will depend on how they will continue with their education.

In [23] the situation of the High School math curriculum is analyzed with special consideration for two different subsystems: General high schools (e.g The School of Bachelors of the State of Yucatan, COBAY) and high schools belonging to the Autonomous University of Yucatan as well as Technical High Schools (e.g The College of Science and Technology Studies of the State of Yucatan, CECYTEY). This study mentions that in recent years high school institutions have implemented curricular reforms to achieve, among other goals: a flexible curriculum, promoting integral education of individuals and encouraging their growth through cultural environments. However, there are inconsistencies between the ends and the means to achieve them; for example in the current reform there is a need to relate the teaching of mathematics with technology so that students understand and reason to a greater extent, nevertheless, the course programs use the technology only as a resource to break with the traditional teacher instruction and not as a means to develop mathematical thinking of students [25].

Also in [26] a comparative examination between two high schools is conducted which discovered serious deficiencies in math and verbal reasoning skills. In high schools belonging to the Autonomous University of Yucatan (Preparatoria #1 y Preparatoria #2), there has been poor academic performance in the subject of mathematics (taking as an indicator the percentage of disapproval of the subject). In Preparatory #1 over half of the students (53.26%), fail mathematics at least once during their academic career at this level. Students of Preparatoria #2 show a smaller but still significant (33.6%) rate of disapproval of the subject of Mathematics [26]. The main difficulty when attempting to propose solutions to these problems and so raise the academic performance of students, is that there is such a large number of factors that can influence it.

## 7. Presence of educational software in high school and higher education in the state of Yucatan

Recently in the state of Yucatan several projects aimed at improving high school and higher education in the area of mathematics have been developed, in which a wide range of educational software has been used. Next, some examples of these are presented.

An example of how robotics in education brings major benefits to students is shown in [27]. In this project a comparison between two forms of education was made: one using LEGO NXT Robots and other with animation software using Scratch, both in order to determine which tool provides better results in teaching a particular subject of mathematics. The obtained results indicate that the use of robots is very attractive for high school students, but with animation software better results were obtained.

[28] describes the teaching experience of a group of professors at the Autonomous University of Yucatan, Tizimín Multidisciplinary Unit using technological tools to teach a course of differential calculus to undergraduates by implementing a new teaching strategy. The benefits and advantages were reflected in both teachers and students of the degree.

Another example shown by this group was a 2D automatic landing simulator using calculus, physics and scratch [29], which allows students to visualize complicated issues by a simulator.

Notably, at the Latin American Joint Conference on Technology and Learning CcITA (2012 and 2013 editions), students of the University of Yucatán published several projects that can be implemented by the teacher in the

classroom of High School Education in order to encourage better student training.

## 8. Conclusions

In the field of education, information technology is being applied in various areas and adapted to all levels, so teachers should change traditional teaching methods with new techniques that encourage better learning in the classroom in order to develop skills and knowledge improving the student performance.

Currently no education level should be left out of the technology, inasmuch as we are at a stage where it is indispensable to our daily life, and we should consider that the new generations need to grow along with technology.

Implementing technology in the classroom through educational software as a teaching method is increasingly common in the world. Everyday more benefits are found and its use is expanding because it is becoming an excellent tool in teaching different subjects.

There is a high rate of failing students in the area of mathematics, this is something that should concern us, because mathematics is a fundamental part of our daily lives. The fact that most students do not give the necessary importance to mathematics, depends on the way in which the teacher gives the lesson. Teachers are required to implement new techniques in which students interact in a dynamic way to arouse interest in this area.

The way the teacher gives the lesson can promotes the enjoyment or indeed give rise to displeasure in learning this subject as currently happens in many students. For this reason it is important that teachers supplement and/or replace traditional strategies with new methods offered by technology.

We must work hard in the classrooms of Yucatan state to use educational software in the teaching of mathematics at all educational levels. We have emphasized its use for high school and higher education but would be most beneficial to implement it at all levels. It is true that the first steps towards bringing technology into the classroom and facilitating the learning of mathematics have been made, but we are still far from making these technologies everyday tools in the teaching-learning process for the benefit of young people.

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