An overview of PmatE: developing software for all degrees of teaching

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Abstract

The University of Aveiro, Portugal, has put into practice an unconventional method of teaching first year calculus students of science and engineering. This method, utilizes a special kind of learning objects, the Question Generator Models, consisting of randomly generated true/false tests. The purpose of this experience was to move from a paper-based automated assessment system to immediate and interactive automated assessment computer systems via the internet.

In this paper is given a general overview of a project, essentially in mathematics education, that gives support to the method referred in the previous paragraph. It is based on the internet in order to serve as many and distant users as possible. It will be given a brief description of all the topics, from the technology used, to the concept of questions generator model.

Keywords

Questions generator, true/false tests, software in Mathematics representation, Internet

Introduction

Nowadays teaching is an enormous challenge. Students are surrounded by information but their lack of knowledge and interest is far beyond the desirable. The use of computers still is a reality far away from Portuguese schools; however, it's beginning to change. At the University of Aveiro, a group of lecturers in the early 90's organized a computerized maths contest. It was a success and since then, every year, in May, University of Aveiro gathers a few thousands of students from all levels of scholarity, from primary school to last year secondary students, to participate in these annual contests.

Projecto Matemática Ensino (PmatE) is a project essentially in mathematical education, although in the past two years it has also been developing contents in Physics, Biology and Electronics. It was born in 1989, by a group of lecturers from the Department of Mathematics of the University of Aveiro aiming to have an automated assessment system for the university.

PmatE develops software in mathematics, generating true/false questions that are used either in mathematics contests or in assessment tests (see [2]). The purpose of such a project was to engage students in the learning process turning mathematics into a subject that is worth studying and that can also be amusing. It might be used as an assessment and/or learning process, that's why usually it's said to be learning by assessment (see [1]).

The different assignments are subject to an intensive work of modelling, gathering together teachers from different levels of education and effective members of the Project (see [2]).

Flexibility, modularity and randomness are some of the characteristics of the products developed giving them a renewed interest each time one visits the site (see [2]).

Side by side to this software PmatE has some statistics tools that can give immediate feedback to all users, namely teachers and students that can use them as an auto-evaluation or diagnosis of their knowledge.

In order to visualize dynamical mathematical expressions and graphics in the internet it's used MathML and SVG (see [3]).

This paper gives a general overview of the work carried out by PmatE these last years and a brief description of the basis of its software.

Basic Unit: Questions generator model

Questions Generator Model (QGM) is the fundamental unit in the software PmatE develops, either from the scientific and pedagogical point of view or the technological one.

A QGM is a questions generator, subject to a classification – scientific-pedagogical objectives. Each QGM is associated to a specific objective and to a difficulty level (in a scale from 1- easy to 5- very difficult).

A QGM generates randomly different questions with the same objectives and the same difficulty level. A generated question is a set of four assertions where each assertion can be true or false. Image 1, Image 2 and Image 3 show different questions, each pair generated by the same model.

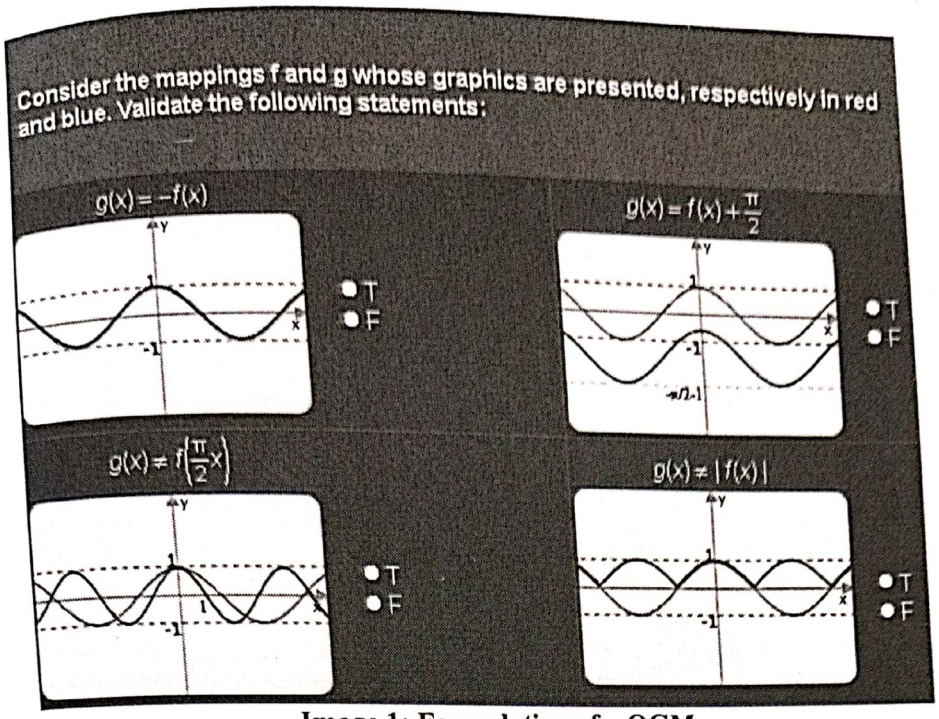

Image 1: Formulation of a QGM

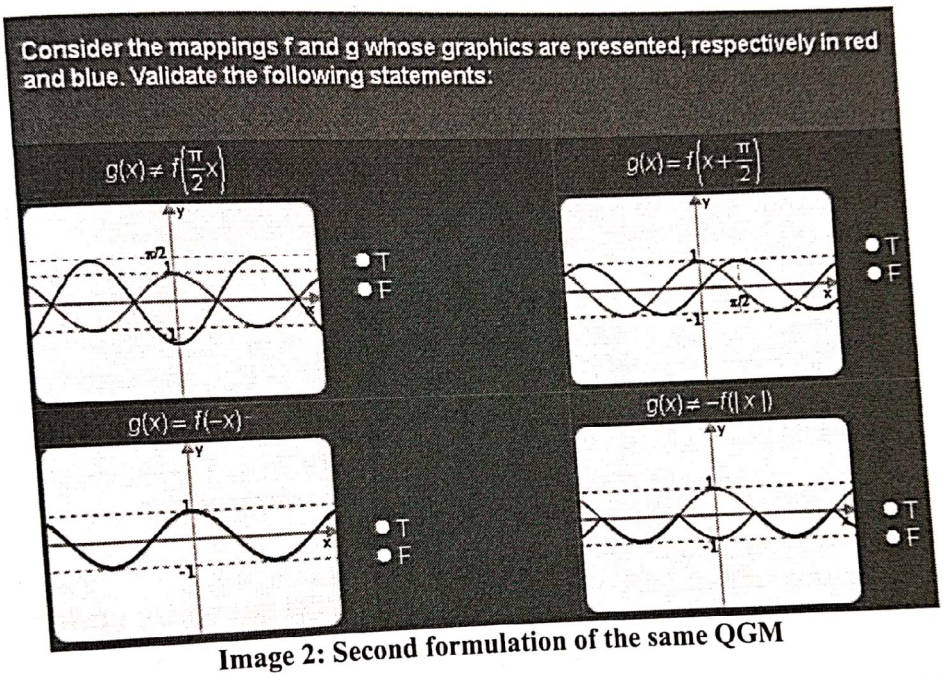

Image 2: Second formulation of the same QGM

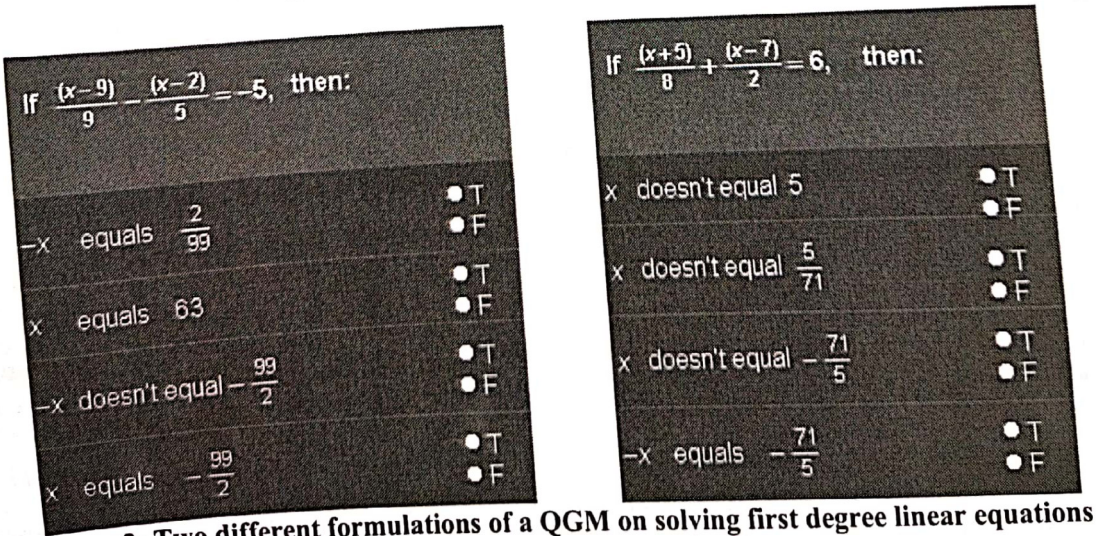

Image 3: Two different formulations of a QGM on solving first degree linear equations

The QGMs are parameterized generators of questions, these parameters being either numerical ones, functions or merely text expressions.

The technology

All the QGMs are in databases, and whenever a QGM is formulated it passes through an interpreter and afterwards it is visualized. Basically the diagram is as follows:

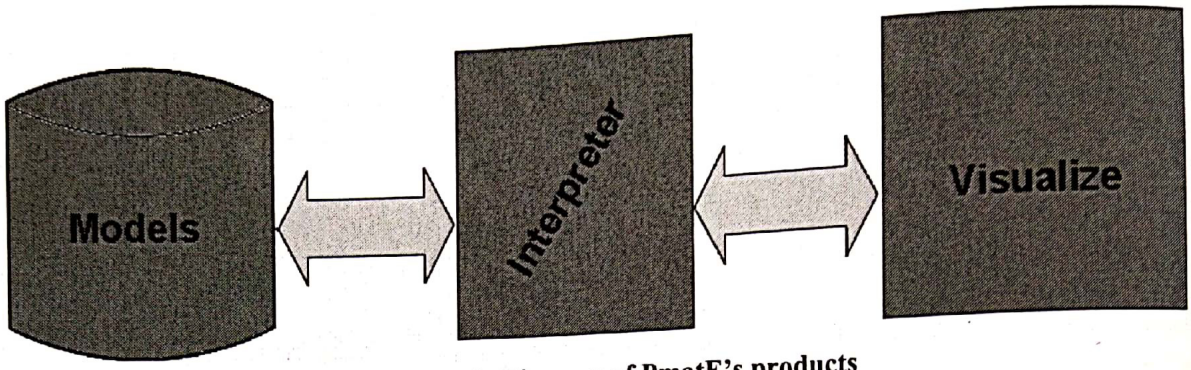

Image 4: Basic Diagram of PmatE's products

PmatE has developed a special kind of programming language, LRM (models language representation) to simplify, evaluate and validate the data before sending the information to the interpreter.

After this process the model is converted into MathML and graphics are drawn using the representation of mathematical functions SVG (Scalable Vector Graphics) which is a language for describing two-dimensional graphics in XML, allowing three types of graphic objects: vector graphic shapes, images and text.

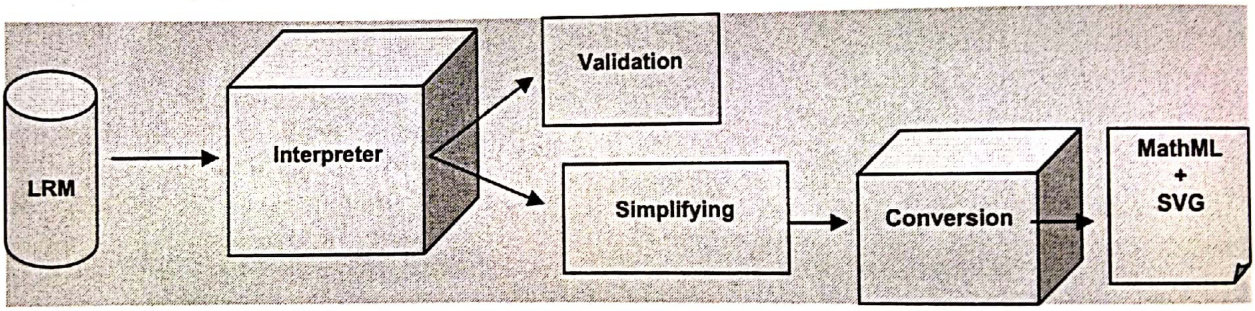

Image 5: The structure of a QGM's representation

The access to the contents PmatE develops is done using a platform, named PEA (teaching assisted platform), where the user registers and navigates within all the materials available, depending on its profile. Teachers can elaborate tests for their own students and can access all the results of his class. Students may access to the tests or to the trainings of the competitions and may also see their results, namely what was wrong in their answers.

The data of all the different products: competitions, classes and tests is analysed and used in PmatE.

The research topics of PmatE are

- Computer-assisted learning
- Mathematical representation on the web
- Dynamic data representation
- Information systems theory

More detailed information on the technology can be found in [3].

Projects currently underway and under Development

Several projects are currently under development in PmatE. Each project unifies the previously described technology together with QGMs to achieve specific goals; the most important one is to engage students in Mathematics.

TDmat

Since 2002, Project TDmat consists of an online diagnosis test to detect and evaluate mathematical competences of certain groups of students pertinent to evaluation. This computer aided test is automatically corrected and the analysis of results is promptly available to students and educators. TDmat is the subject of [3].

Next image presents a general overview of TDmat's results in 2004/05.

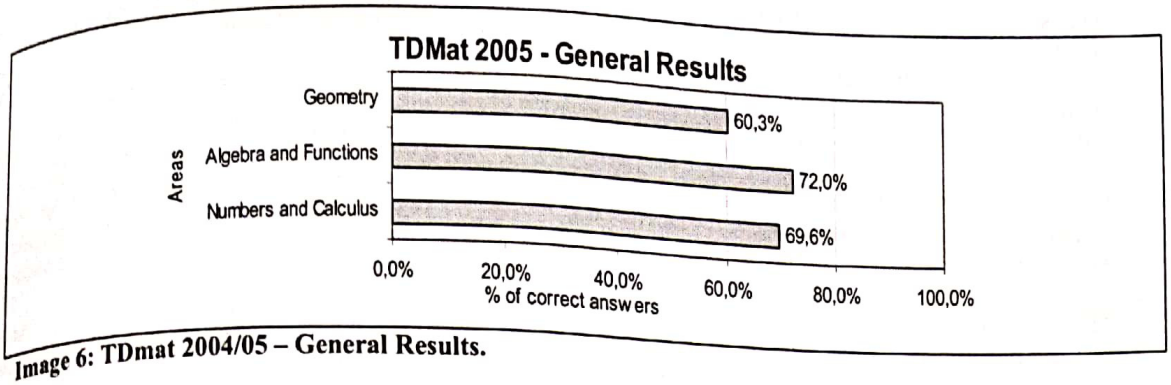

Image 6: TDmat 2004/05 – General Results.

PmatE at the University

Project "Ensino Superior" (University) takes these concepts to a university level where students use these tools in classes to diagnose and evaluate their performance in subjects such as Calculus, Numerical Methods and Digital Systems. The results are of great value both to students and lecturers since they reveal decisive information about what subjects are being correctly apprehended by students.

The great advantage of the use of these computer tests is that it makes possible to assess one thousand students in an easy and non-laborious way, assuring that all students have different tests although having exactly the same purposes and the same difficulty level.

However it's just a component of the assessment in these courses. Beyond the computer tests, for instance in Calculus first year courses, the students are also subject to a final written exam and four small tests during the semester.

Schools Network

"Rede de Escolas" is a project aiming to explore the potential of these tools at elementary school levels for computerized assessment of learning, teaching and evaluation. There are six schools using the PmatE's assisted learning platform, and the results reveal that students are enthusiastic about the use of computers in maths classes, and one of the advantages is that students and teachers approach each other in order to overpass the difficulties felt when accessing the computer tests. A great number of students work with these contents even at home, and sometimes they send feedback directly to PmatE's members.

International

Project "International PmatE" is an international project that expands our intentions to other areas of intervention, mainly other Portuguese speaking countries that may benefit from our software. Currently under way in Mozambique is sub-project pensas@moz, whose main purpose is to educate students and instruct teachers. As the far distances in Mozambique may be covered by satellite networks, it makes possible to deliver contents such as texts or exams very fast and everywhere. There will be a group of schools, spread all over Mozambique that shall be responsible for the delivery of all the products and also will help to form and support teachers in their intervention area.

School Manuals

Viver@matematica (living mathematics) is one of the most recent projects of PmatE. It consists of a school manual incorporated together with an information system. This information system allows teachers, students and educators to experience functionalities that can transform studying into a very pleasant daily experience.

Mathematics contests

This is perhaps the most known project PmatE develops. Nowadays there are contests for all levels of education, since primary school to university level.

Every year the number of students participating in these events grows. It's party day; thousands of students from schools all over the country join together and spend the day around Mathematics.

Advantages / Disadvantages

The previously described technology associated to QGMs, constitute a new online automated assessment system that can be put to great use in different situations. The high performance, random characteristics, modularity and flexibility of QGMs guarantee that students can use the system to evaluate their knowledge on certain subjects or develop competences while engaging in different exercises. The results of their performance outline potential difficulties in certain areas while propelling them to overcome problems.

This system is also used to evaluate students that in spite of being seated next to each other in an exam can gain no benefit from trying to overlook their colleagues' answers, because although being submitted to the same type of exercise, the questions are randomly generated and thus different. This system also calculates results automatically by percentage and/or competences acquired.

However on itself it can't be a reliable way to assess students as they have to fulfil a series of competences, as writing capacities that should be evaluated differently. Also the way they communicate and express their reasoning is rather important.

Conclusion

Working within several levels of education, involving teachers, students, persons with different professional profiles is a rich experience for everyone, allowing crossing the bridges built between the various teaching cycles.

The simplicity of use of the software developed by PmatE and the amount of subjects that are nowadays available makes it easy to use in classes and also wherever there's an internet access point.

The reader is invited to visit the website [11] and register as user.

One of the main goals of PmatE is to develop a computer assisted learning and assessment system[1] that is giving its first steps with a work that will be presented in this same conference.

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