ONLINE ASSESSMENT WITH MAPLE T.A.: SHARING AN EXPERIENCE IN ALGEBRA

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Introduction

The aim of this paper is to share some results related to the design and implementation of online assignments with Maple T.A., in the courses of Algebra for engineering students of the University of Sonora. This work is framed in a permanent program of improvement of the services that the Department of Mathematics offers to the different programs in the University and is conceived as an alternative support to the students' homework, to the teacher's work and, particularly, to the evaluation and auto-evaluation processes. The teachers group working in this project had previously analyzed the matter program, teaching activities and materials, use of technology, and was sharing classroom experiences for two years.
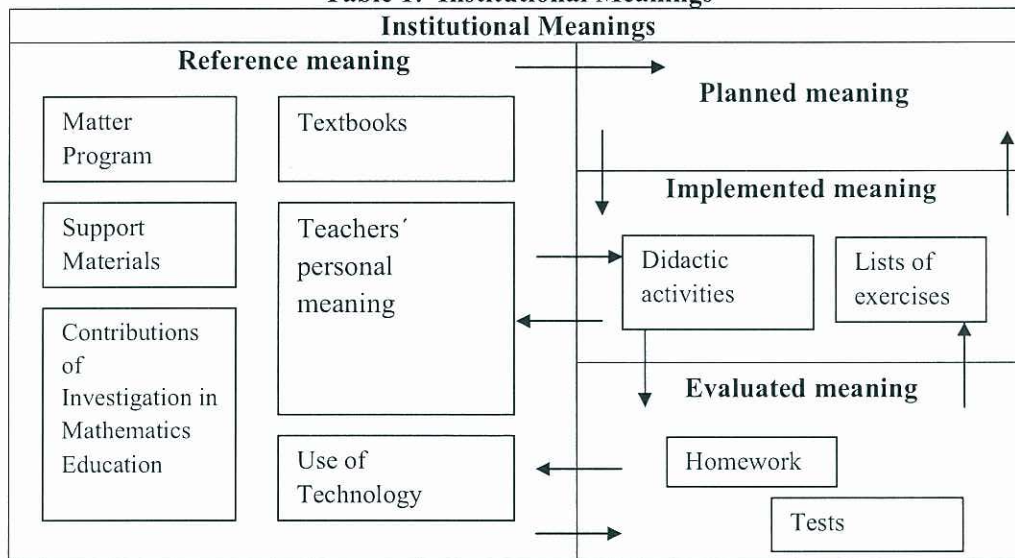
Theoretical Aspects

In this work, it has been considered the use of some theoretical elements from the Ontosemiotic Approach of the Cognition and Mathematical Instruction (OSA), developed by Godino (2003). Between the considered elements, we can mention the personal and institutional objects, the systemic meanings, the basic elements of the meaning, and the relations that are established between them (semiotic functions). In the table 1 there appear the different types of considered institutional meanings, as well as the possible interactions between them. For online assessment, we consider a categories system for classifying the different levels of questions and awaited answers. We use the taxonomy SOLO (*Structure of the Observed Learning Outcome)*, (Collis y Biggs, 1982) interpreting the basic levels of answers, in terms of some elements of the OSA.

This taxonomy includes five basic levels of answer that, in order of increasing complexity, are:

- **Pre-structural:** the students are simply acquiring bits of unconnected information, which have no organization and make no sense.

- **Unistructural:** simple and obvious connections are made, but their significance is not grasped.

- **Multistructural:** a number of connections may be made, but the meta-connections between them are missed, as is their significance for the whole.

- **Relational**: the student is now able to appreciate the significance of the parts in relation to the whole.

- **Extended abstract**: the student is making connections not only within the given subject area, but also beyond it, able to generalize and transfer the principles and ideas underlying the specific instance.

Table 1: Institutional Meanings

Institutional Meanings		
Reference meaning		**Planned meaning**
Matter Program	Textbooks	
		Implemented meaning
Support Materials	Teachers´ personal meaning	Didactic activities Lists of exercises
Contributions of Investigation in Mathematics Education		**Evaluated meaning**
	Use of Technology	Homework
		Tests

Questions Design in Maple T.A.

With base in the presented taxonomy and analyzing problems, lists of exercises and tests proposed by the teachers working in this project, there began the questions design and question banks construction to be implemented with the system Maple T.A. It was proposed to prepare questions with awaited answer corresponding to **Unistructural, Multistructural,** or **Relational** levels.

Example of **Unistructural** *level question:*

In this question, the student is asked to calculate the product of two given complex numbers. The advantage of using Maple T.A. is that this question is designed of algorithmic form, so that the product of the numbers is programmed $(a+bi)(c+di)$, where the variables a, b, c and d take values in a stated range. This way, with only one question in Maple T.A. there are many versions of the same exercise (See **Fig. 1**).

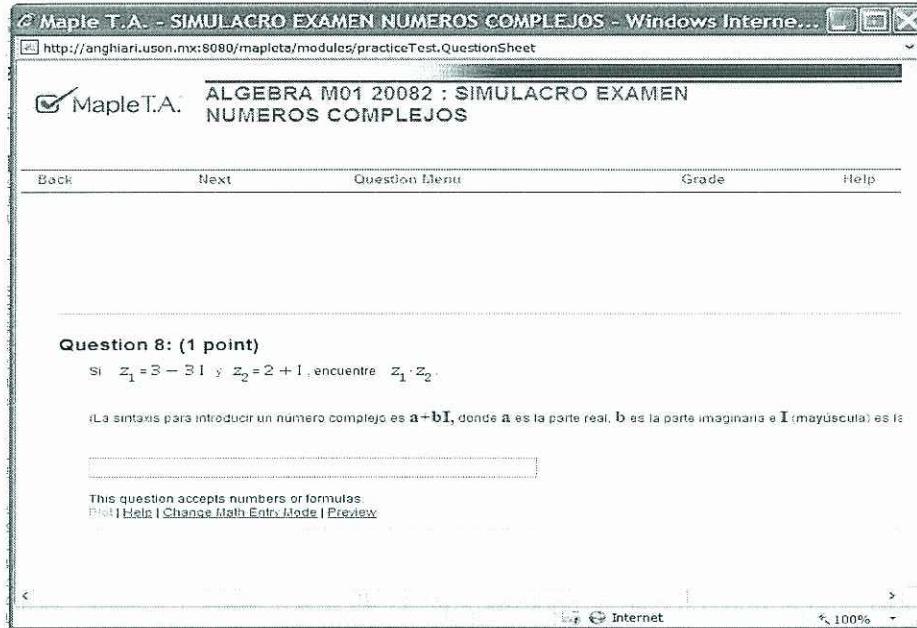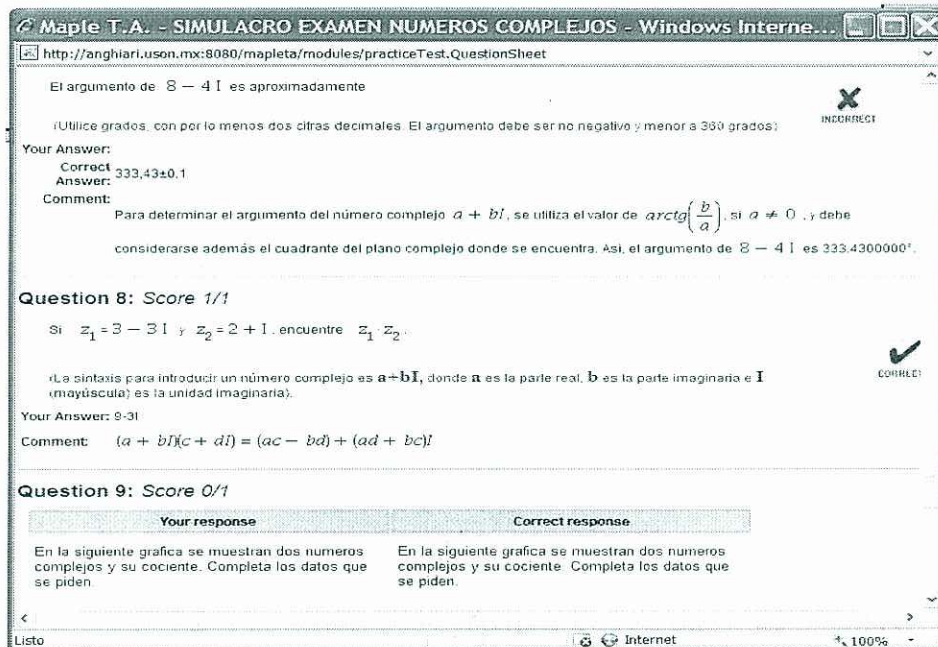**Figure 1a:** *Example* of **Unistructural** *level* question

Figure 1b: *Answer for* **Unistructural** *level* question

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*Example of **Relational** level question:*

In this question, a square (or cubic, fourth, fifth or sixth) root of an unknown complex number is presented graphically. The student is asked to find another one of such roots, to represent it in polar and Cartesian form, and to find the complex number of which it is a root (See **Fig. 2**).

Online assignments design

In the Maple T.A. system it is possible to design different types of assignments. The questions can be selected randomly, of one or several groups of them, from the questions banks. This way, from the same test design, it is possible to generate an important number of versions of the same one.

In this project three different types of assignments were used:

- Anonymous practices: These assignments are not registered in the system and the students can complete them freely, without limit time, the number of times they wish. The students access this type of assignment from any computer with Internet at any place.

- Homework/quizzes: These assignments, in contrast to the previous ones, remain registered in the system, both the work of the student and the grades. The students access this type of assignment from any computer with Internet at any place. They can complete each one of this type of assignments up to three times, taking into consideration the highest grade. Before trying to complete one of these assignments, the student has the opportunity to make a similar one as an anonymous practice.

- Proctored exams: This type of assignments needs the authorization of the teacher. The students access this type of assignment in a computer laboratory in the presence of the teacher.

Results

Online assignments have been carried out during the last two years. At the beginning, there were six teachers working on the project. During the second year, all the Algebra course teachers were invited to participate, so the online assignments were realized in a more systematical way. A training workshop was offered to the teachers for the handling of the system and a parent class was created, with question banks and assignments to be inherited by the child classes of all the other teachers.

Figure 2a: *Example* of **Relational** *level question*

Figure 2b: *Answer* of **Relational** *level question*

Six question banks were prepared: one of them for diagnosis test design about arithmetic and algebraic basic skills, and five question banks related to the contents of the algebra

course: complex numbers, polynomials, second and third grade equations, linear equations systems and matrix algebra (See **Fig. 3**).

Figure 3: Questions Banks in Maple T.A.
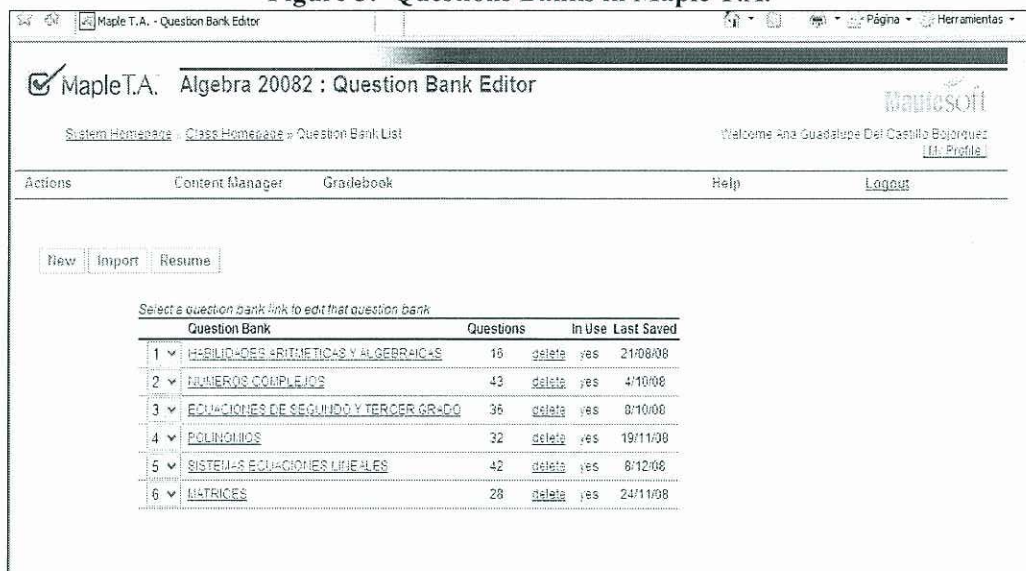
From the questions banks, there were designed 15 anonymous practices, 13 homework/quizzes and four proctored departmental exams.

During semester 2008-2, thirty one groups of Algebra were formed in Sciences and Engineering Area in the University of Sonora, with fifteen teachers working on them. Thirteen teachers got involved in the project, but only nine implemented the online assignments in a systematical way, to a whole of seventeen groups.

Although the assignments were the same (except for algorithmically generated variables) for all of the groups, the results varied significantly from one group to another, apparently depending on the engineering program the students were registered in. We show the grades obtained by three groups in the complex number test in one of the forms provided by the Maple T.A. system (See **Fig. 4**).

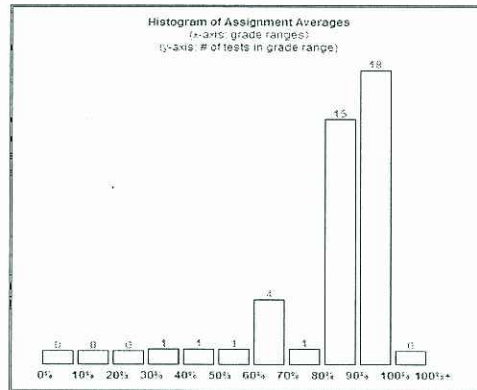**Figure 4a: Mechanical and Electronics Engineering group results.**

Histogram of Assignment Averages
(x-axis: grade ranges)
(y-axis: # of tests in grade range)

Figure 4b: Geology group results.

Histogram of Assignment Averages
(x-axis: grade ranges)
(y-axis: # of tests in grade range)
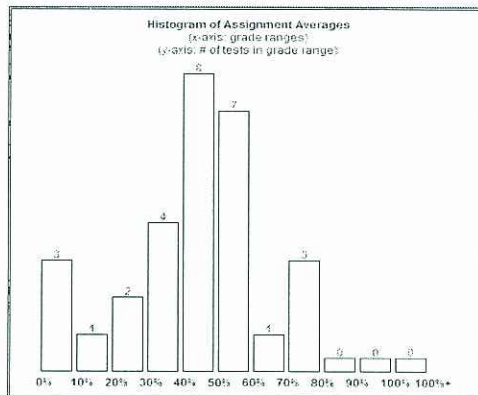
Figure 4a: Industrial Engineering group results.

Histogram of Assignment Averages
(x-axis: grade ranges)
(y-axis: # of tests in grade range)
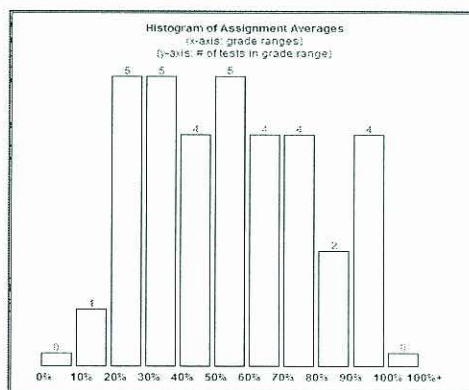
Final Considerations

During the experience of applying online examinations, it is possible to emphasize that:

- We conceive the system Maple T.A. as a great support to the students' activity out of the classroom, with the advantage of offering immediate feedback to the actions they carried out for the solution of the problems and exercises that are presented to them.

- Whenever a student selects an assignment, the system presents to him a different version, with questions selected randomly, and these, in turn, are algorithmic, that is to say, they include parameters that change whenever they appear in a task. This way, we can say that the assignments are individualized. This reduced enormously the possibility of cheating and promoted, on the other hand, the exchange of strategies and methods of solution.

- The use of anonymous practices promoted team work. The students were working together in the same assignment since this one was not recorded for anybody. Also, it gave them the opportunity to solve several versions of the same task before realizing the one that would remain recorded in the system.

- Some students, after completing several times the "same task" and receiving immediate feedback from the system, identifying his wise moves and errors, concentrated on his shortcomings and they were capable of raising more specific questions during the class.

- Also there were students who expressed his dissatisfaction for this type of examinations on line, they did not complete the homework assignments, and they only presented themselves to the proctored tests. They were blaming the use of the system for his low yield. Depending on group characteristics, it is considered useful to take students to a computer lab, so they could familiarize themselves with the general environment of Maple T.A.

- Actions are being taken in order to attend some of the adverse comments of the students, among them we can mention:

    o The navigation menus in the system are presented in English and they were feeling it as a disadvantage.
    o They had problems with the syntax used in the open questions.
    o The system not always qualified equivalent answers correctly.
    o The assignments were interrupted by problems of Internet connectivity.
    o The server presented saturation provoking access problems.

- The students who completed the anonymous practices and homework/quizzes obtained better results in the proctored exams. At a group level, we consider the role of the teacher to be very important to promote, in a systematical way, the achievement of these homework assignments.

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