An experimental study on the use of computers in schools

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Abstract: - One of the current topics of debate about the future of mathematics education is the use of the modern technology, with particular attention given to the use of computers in the teaching, learning and in searching information. New ways of presenting material should carefully be examined since the students must firs get familiar with the software tools. The content of this paper is based on a teaching experiment using software in the subjects of Calculus, namely functions and derivatives.

Key-Words: - Learning styles; Computer assisted learning; Exploratory Data Analysis

1 Introduction

The main objectives are the description of two software tools on concepts and skill acquisition in calculus, and to show the opinions of the students that participated in the experience on aspects that have influence in the elaboration of the software tools. The results are based on an experience carried out with students of ages between 13 and 15 years old.

The computer packages that were chosen for the experiences are two Windows compatible applications, developed in Visual Basic with academic objectives*: Study of Functions* (Estudio de Funciones), developed by Villalba, [9]; and *The derivative: Concept and Applications* (La derivada: Concepto y Aplicaciones), by Aguirrebeña, [1]. The designers of the software provided technical assistance and provided modifications to adapt them to the educational levels involved.

For the realization of the experience we selected four courses. A course of 4th degree in Obligatory Secondary Education (4th O.S.E.), with youngsters between 13 and 14 years old and three courses of 1st degree of High school, one of Social Sciences (1st B) and two of Nature and Health Sciences (1st C and 1st D), aged 14 to 15 years old. Each course was broken down into two groups: a control group, with 20 students per course receiving a traditional instruction; and an experimental group, with 10 students per course that was instructed, exclusively, through the software tools described. The students of the experimental groups of 4th O.S.E. and 1st B worked with the software on Functions and those of the other two courses with the software on Derivatives.

Students that participated in the experience belonged to a public school that had laboratories with 10 computers each, this being the reason for the experimental groups to have 10 students. If two students were to work together at a computer, then at the end of the experience some student could have learned of his co-worker and not of the software tool.

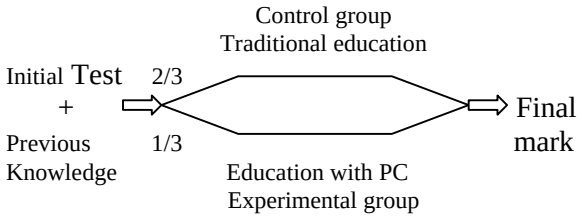

Fig. 1: Diagram of the experiment

2 Description of the software tools

The two software applications dwell on the concrete area of the mathematics that was to be experienced. This was an advantage for the students taking part in the experience, since no time had to be spent on localization instructions nor looking for the particular content.

The general objectives of the computer package are:

a) To teach the concepts and their applications by means of screens of friendly with contents readily understood.

b) To provide communication mechanisms between the user and the system for an easy access to any part of the application and for selecting subjects or concepts.

c) To provide the students with an introduction to the use of new technologies.

The contents of both software tools are grouped in a number of independent subjects. Each subject contains graphic that allows the student to extend the explanations and to color the screens. These

elements are important for the process of learning of the different concepts and their applications, and make the use of the computer package more interesting to the student. Exercises (with solutions) are also included so that the student assimilates the concepts. The Figures 2 and 3 show screens of each of the software applications.

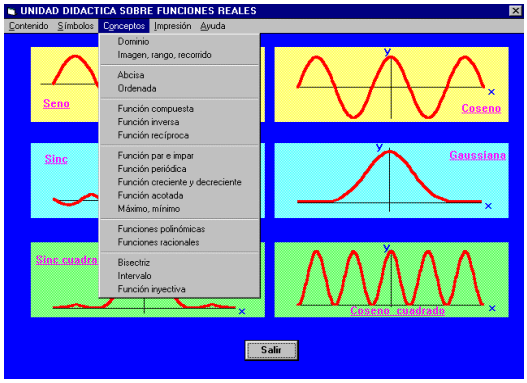

Fig. 2: Study of Functions

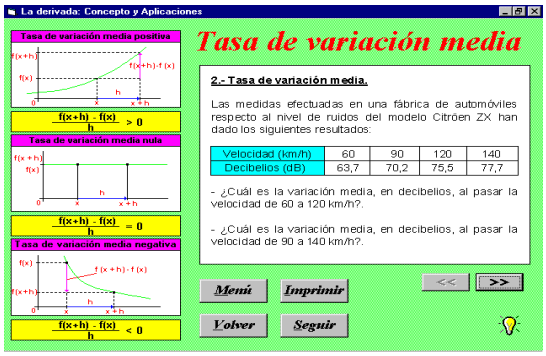

Fig. 3: The derivative: Concept and Applications

The menu structure in *Study of Functions* follows the Windows standard layout; that is, a Menu bar, across the top of the application window, contains the titles of commands on pull-down menus of varying levels. The application contains a set of questions, with a theory and a practice part that allow the student to verify the level of knowledge acquired.

The Derivative: Concept and Applications is structured in chapters which are accessed from the main menu shown in the first screen. All the screens have buttons that allow the user to navigate the application. The program also includes annexes with collections of theoretical and practical exercises.

3 The students of the experimental group and the computing resources

Computers are transforming the world in which today's students will live. To know the involvement and the opinion of the students of the experimental group on the use of the computers, a test of 66 questions was presented to them. It had four possible answers for each question: “In disagreement”, “Little agreement”, “Rather agreement” and “Complete agreement”. The answers were grouped in six categories:

A) The student has used software applications (26 questions).
B) The student considers that the software tools ease learning (8 questions).
C) The student considers that the use of computers is interesting and entertaining (13 questions).
D) The student has interest in aspects related with computers (12 questions).
E) The student has curiosity for the software applications (30 questions).
F) The student disagrees with the didactic use of the computer (14 questions).

The categories considered above are not independent because some questions belong to more than a category. We recode the answers to the numeric values 1, 2, 3 and 4, respectively, to treat them numerically.

Table 1 contains statistical information on the categories, where the first columns describe the number of values in the variable, and the following provide statistical information about the center and spread of the data.

Category	N	Means	Median	Range	Std. deviation
A	40	2.16	2.36	2.00	0.58
B	40	2.22	2.27	2.13	0.61
C	40	1.88	1.69	2.50	0.70
D	40	1.89	1.75	2.25	0.56
E	40	2.21	2.24	1.92	0.51
F	40	1.82	1.79	1.64	0.34

Table 1: Summary statistics of Categories

Figure 4 shows a box and whisker plot for each variable that is a useful tool in the initial examination of data.

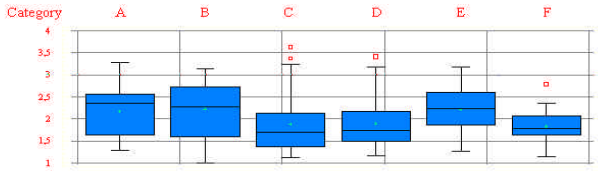

Fig. 4: Box plots of Categories

It is worth underlining that:

a) The six categories considered show no similarity, since the summary statistics and the box and whisker plot are different.

b) A bipolarity exists in relation to the use of software applications, 40% of the students had hardly used the software applications, and 53% of them used them regular.
c) The opinions on whether or not the software applications facilitate the learning are concentrated around the two central values, 37% for ``Little agreement'' and 33% for ``Enough agreement'', the difference with the above category being that the data are distributed symmetrically.
d) For 70% of the students the use of the computer is not interesting. However, some students gave very extreme answers, considering the use of a computer as very entertaining.
e) The data on category D are similar to those of the preceding category —70% of the students had very little interest for aspects related with the computers. The students that considered the use of the computer as interesting also had a large interest for these subjects.
f) Curiosity for the software applications was the variable with the highest number of questions in the survey and the data seem to be distributed according to a Normal.
g) With the last characteristic (the student disagrees with the didactic use of the computer) we wanted to know her o his opinion on this topic and also to test for random answers. We confirm that the students that felt curiosity for software applications agreed on the restrictive use with didactic ends of software tools, while the students with no curiosity were in disagreement with the didactic ends of the specialized software.

4 Evaluation of the used software

For the evaluation of the software a test of 26 questions related with different aspects that should have a software application with educational purposes was done. The first 25 questions had five options, and the last question was of open type.

The students of the experimental group were concerned about the possibility of not passing academic course due to the experience, although they were reassured that was not to be the case. This circumstance was communicated to the teachers of each of the courses that participated in the experience, and it stimulated the students of the experimental group in increasing the time dedicated to the study of the subjects treated. To avoid the influence of the software evaluation on the students' grades the questionnaires were answered after knowing the grades obtained in the course.

The application *Study of Functions* was valued better than *The derivative: Concept and Applications*. Possible explanations are that the preparation needed to approach the concepts of functions is lower than that required for the Derivative, and that the contents of *The derivative: Concept and Applications* had a slightly higher level that requested in high school.

4.1 Study of Functions

The aspects pointed out as positive were:

1. No specific knowledge is needed to handle the application.
2. The use of the program does not distract from the learning of the contents.
3. The user gets easily accustomed to the way in which the concepts are presented in the screens, each screen having few words.
4. The application has a good help menu about the program and the mathematical contents.
5. The user chooses the rate of learning, the application gives enough time to think and, mainly, it provokes questions in the user.
6. The application shows explanatory examples of the concepts presented and develops most of the intermediate steps in the operations.

The negative aspects pointed out have been:

1. The student has to carry out a higher effort to acquire the same knowledge.
2. The user spends more time than in the current education, since many of the doubts that arise are not solved by the program.
3. The communication between user and application needs to be enhanced and, also, the program should be less static.
4. The application provides little encouragement and hardly ever rewards the answers offered.
5. The acquired level of knowledge is not sufficiently shown to the student.
6. The students wanted software applications of didactic use to have more multimedia effects, sounds and images, making them more amusing.

4.2 The derivative: Concept and Applications

The aspects pointed out as positive were:

1. No specific knowledge is needed to handle the application.
2. The use of the program does not distract from the learning of the contents.
3. The user gets easily accustomed to the way in which the concepts are presented in the screens, each screen having few concepts.
4. The help menu of the program is easily found.

5. The user chooses the rate of learning, the application gives enough time to think and, mainly, it provokes questions in the user.
6. Previous knowledge is taken into account, showing explanatory examples of the concepts explained.

The negative aspects pointed out have been:

1. The student has to carry out a bigger effort to acquire the same knowledge.
2. The software needs a help-menu on previous subjects and also should develop the intermediate steps more thoroughly.
3. The communication between user and application needs to be enhanced.
4. The application provides little encouragement and hardly ever rewards the answers offered.
5. The acquired level of knowledge is not sufficiently shown to the student.
6. The students wanted software applications of didactic use to have more multimedia effects, sounds and images, making them more amusing.

5 Conclusions

When software applications of didactic use are designed, several aspects should borne in mind, such as the educational levels where they will be used, the hardware available, as well as the educational goals of the students that will use them. The point of view that should be given to a subject directed to the students of sciences changes when the students are of humanistic, for example. Other problems that arise are the space for laboratories, number, access and localization of the equipment; personnel for installation, maintenance and reference consult; and the work-load of the professors in the development of the course and in the instruction of the laboratory.

The biggest problem that caused the experience was the insecurity of the students in not having the explanations of the subject, and in the relation to previous knowledge they receive from the teacher.

The computer tools used need no training for their use, include explanatory examples, have a help menu and allow the user to study in agreement with her or his necessities, although they need of more personal effort to obtain the same goals that with current methods. The students demanded better communication between the user and the programs, more multimedia effects and a full-fledged help menu.

Therefore, the educational computer applications should be of wide scope, interactive, adaptable, allowing the user to guide the study and to know the acquired knowledge. So, it is very difficult to substitute the teacher's figure completely.

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