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The computer helps in the acquisition of educational knowledge. An experience with Spanish's students

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Summary

Traditionally, people have tried to compare the effectiveness of traditional teaching with Computer Aided Learning (CAL), however, it is very difficult to work out which of them is best. In our research we want to show that the use of the computers in learning processes can represent an important element in improving them.

The results obtained show that many of the contents worked on with the help of the new technologies are better assimilated by the students as they get better results than using a traditional method. However, we should highlight that although we use the new technologies, the figure of the teacher will always be necessary and that in the design of computer applications the interaction of the technician with an expert in educational methods is very important.

Keywords

Learning, Computer, Teacher, Education, CAL

Introduction

The problem with introducing computers into schools is not simply an economic one, or a case of providing schools with enough machines. The greatest problem refers to the use and instructive value of the programmes; therefore, it is necessary to create new programmes with a good quality and that are suitable both for the school curriculum as well as the characteristics of the children, as the educator will not have enough time and knowledge to be able to create these educational materials.

With the reduction in the price of hardware, in education the spread of computers cannot be stopped and in this terrain their use can be quite worthwhile. It seems that one trend in schools will be to introduce more technology and put the emphasis on technological development: machines will be more

powerful, faster, with greater resolution and graphic abilities, with all kinds of peripherals that help data input and output: printers, digital boards, tactile screens, devices that reproduce voices or recognise orders, peripherals that interact with the environment, interactive videodisks, communications, etc. This will mean that the programmes can be more powerful and provided with means that will facilitate greater interaction with students favouring learning (Tesouro and Puiggalí, 2004a).

In this sense, some useful concepts have appeared, such as:

- **Distance learning:** Physical separation between the student and the teacher at certain moments of the learning process. To do this, you need one or more means of communication that enable interaction between them both. From this perspective, we could highlight the influence of Multimedia in education. With this kind of education, large groups of disperse public are reached, with different time and personal conditions who do not have the chance to access face-to-face learning.

- **Open learning:** Open Learning refers to a type of training that allows the student total autonomy in his or her learning-teaching processes. This kind of education achieves the recognition of the individual characteristics of each student, but requires that the knowledge is created in a media that the student him or herself can handle.

- **Wireless mobile devices in the learning area**. Many researchers see the potential of these devices in learning thanks to their portability, low cost, etc. (Roschelle, 2003).

- **Virtual knowledge communities.** The statement "virtual learning communities" tries to cover a wide field of offers and communicative phenomena derived from experiences in learning settings that have New Information technologies as a support. They have been defined as a set of social relations, united by a common interest or shared circumstances that take place in cyberspace and that enable the exchange of knowledge between students.

Socio-cultural theories have been imported from the fields of cognition to suggest that this and learning occur both at a group and community level as well as at an individual level (Stahl, 2005).

These communities appeared in the academic area, in social activities and between people who wanted to share interests, beliefs and values with other people. However, they have currently spread to all the institutional areas of society, which include the area of education.

According to Gómez and Gewerc (2004) virtual learning communities mean a field of offers and communicative phenomenon derived from experiences in settings that have communication and information technologies as a support.

It should be pointed out that flexible teaching models are required, that are able to renew and transmit this knowledge and these techniques, as well as offering a response to the increase in the educational demand (Zapata and García Martínez, 1999).

Related work

Some experts, such as Professor Seymour Papert of the Media Laboratory of Massachusetts Institute of Technology (MIT) in the United States, comment that today's School is showing a certain conservativeness in maintaining intact its teaching methodologies, neglecting the new demands of the ICTs, or simply adapting them to it from a traditionalist approach. In this way, he considers that, on the whole, the world of education understands the role of these technologies incorrectly (Aznar, 2005). Due to this, in the United States, in recent years, the suitability of the education system has been questioned, reaching the conclusion that steps should be taken to improve it. Therefore, various plans of action have been set up to promote a greater use of computers in elementary and secondary schools.

Along these lines, most researchers and professionals in the field of educational informatics are convinced that the information technologies have the potential not only to improve the efficiently of our current teaching methods, but also, and perhaps to a greater degree, to face the basic changes in methods that could have significant implications on future generations (Fernández Prieto, 2005). Thus, Oliver (1999) proposes improving learning through the introduction of the technology in the most effective way possible within the learning area.

In addition, different studies show the appearance of attitudes that are more positive towards computers after using them because confidence and the ability to understand among students who have used computers increases. The attitude towards schoolwork also improves by getting better results (Tesouro, 1995) and, therefore, there is greater motivation to work with this resource that helps improve learning. If we consider the positive aspects that the use of the computer has on learning, on cognition, attitudes and social effects, as well as other positive characteristics such as interactivity, personalisation, ease of use, means for researching in the classroom, motivating means, individual learning, etc. they show that the computer should be used more to improve various aspects of learning (Tesouro and Puiggalí, 2004b).

In some work it has been seen that students do not feel so threatened before the judgement of a machine that has limited knowledge, and they docilely accept the repetition of mistakes without

showing so many signs of fatigue; therefore, through the computer, as there is greater motivation, better school performance can easily be achieved. With this, students learn through "trial and error" as the interaction there is between the student and the computer offers fast feedback which enables them to get to know their mistakes as they occur, so they can be corrected immediately (Medina, 2004).

It has also been seen in studies such as the one carried out by Sung-Bin Chang et al. (2002) and Chi-Wei Huang et al. (2001) that in the same way that all human activities are directed by events, learning can also be achieved in the process of preparing an event. In the case of the use of a computer programme, the fact that there are different levels depending on the knowledge shown can help to achieve knowledge as it creates competence in the student.

The current trend, with the generalised use of the computer, the introduction of microcomputers in classrooms and homes, has also had important educational consequences. The computer has become an efficient learning tool. In addition, the creation of new educational programmes, the use of certain computer programmes to help schoolchildren with special needs learn, etc. have opened new possibilities in the pedagogic use of these means (Álvaro, 2005). This means envisaging a considerable increase in this kind of software. Therefore, teachers will need to learn to discriminate between different programmes according to specific teaching needs to improve the teaching/learning process. This has created the need to have elements that enable us to evaluate the information and the information technologies that are used in learning and an example of this can be found in Scanlon (2000).

Traditionally, people have tried to compare the effectiveness of traditional teaching with Computer Aided Learning (CAL), however, it is very difficult to work out which of them is best. One of the reasons mentioned by Brahler and Johnson (2000) is that a lot of the material for CAL is designed by computer technicians who are not experts in educational matters. Studies carried out into this subject, such as that of Nielsen (2002) come to the conclusion that the application of cognitive and behavioural theory to learning applied to the design of programmes aimed at teaching improves their performance.

Therefore, it would be important for the teacher to have good application programmes related to the subject he or she teaches. However, in the current state of development of educational software, many of the programmes or packets of programmes available are usually dissociated from the overall reference framework of the subject (courses, textbooks, etc.) so there is still a lot to be done.

Thus, we find that many different points of view have been raised in the creation of learning platforms. Taking as an example the case of Technology-Based Learner Interface for School in the review carried out by Recesso (2001) into the points of view of the various experts, it can be seen that most of the discussions are focused on the economic side and on the learning strategies they should represent,

although it can also be seen that there is no agreement on the planning of the development of the tool.

In recent years, the software industry has based a great deal of its efforts on different stages of education. For younger children, they use the "learn through playing" formula, and make the very most of the multimedia qualities of current computer equipment, as well as offering attractive programmes that are impeccably made (Urbina, 2000). In different studies, we can observe that this trend is being followed in most countries. Therefore, we find a study carried out in the United States that shows that 67% of the software published there is aimed at young children (Haugland, 1998).

For older children, the software has to take into account that learning settings are comprehensive, they are integrated systems that promote adjustment through activities focused on the student, including guided presentations, handling and exploring between interrelated learning matters (Hannafin and Gall, 1990).

Currently, with the advent of the information highways, with Internet as the historic event of the 20th century, changes that were previously unimaginable are taking place in society (Cardona, 2002) and they also affect the production of educational software as well as education methods, even allowing elements of help in education for diversity to be introduced, as shown in the study carried out by Bishop (2003). Consequently, what we should do is prepare teachers to make the most of the educational potential of the new technologies, because if schools do not explore the possibilities of the computer as an educational instrument, it seems less likely that the child will do so on his or her own.

Studies have been carried out on the opinion that people have of the use of ICTs in schools, such as that of Sime and Priestley (2005) in which it was observed that in the responses that were given, the changes in the nature of classroom relationships were shown and it was highlighted that it was an element that modernised teaching, although they also detected a variety of factors that made the process more clumsy. We can also find studies such as that of Mioduser et al. (2000) in which they use the computer in the development of skills in the reading area in children with reading difficulties, the results of which clearly showed that the technological intervention noticeably improved their reading ability.

One of our reasons for carrying out this piece of research was due to realising that despite the fact that there are currently numerous programmes available concerning educational material, there are some shortcomings and therefore, we need to have computerised programmes that cover these shortcomings and are aimed at improving school learning. These programmes must be suitable for the level of the children that use them as it was seen that the greater the "differentiated educational action" the greater the increases in development of the abilities occurred and it should be taken into

account that if we optimise the performance of our students, they will also improve in other areas of learning.

On the other hand, the conviction that we had that the use of new technologies could provide greater help in optimising learning than the simple help of the teacher led us to present this piece of research to check whether this hypothesis was correct, as in a previous study (Tesouro and Puiggalí, 2004a) a piece of research was carried out in which it was seen that by means of the new technologies learning improved, but it did not take into account that this learning could be improved with the help of the teachers without the use of computers. Therefore, below we present the piece of work which improves on the previous one by creating a new experimental group that worked on the same contents as the computer programme with the help of the teacher, but without the use of New Technologies.

Objective and hypothesis

The main objective in our work is to compare the effectiveness of traditional teaching with Computer Aided Learning (CAL) in the school.

The hypothesis are:

- The children who do the WinDat programme will improve more than the children in the control group who attend normal classes, both in the test on which this programme is based: DAT-AR, as in the Raven General Test.

- The children who work on the same contents as the WinDat with the help of the teacher will improve more than the children in the control group who only attend normal classes.

- The children who do the WinDat programme will improve more in the test on which this programme is based: DAT-AR and in the Raven General Test than the children who work on the same content with the help of the teacher as they will have received immediate feedback.

- The control group, that only attended normal classes, will not improve as they would not have worked on the processes involved in the different tests.

Instruments

The instruments that we used in the work are:

- DAT-AR test.
- RAVEN GENERAL test.
- WINDAT

DAT-AR test:

The Differential Aptitude Test (DAT) is an integrated battery of eight aptitude tests that provide assistance in educational and vocational guidance. The major areas being measured by the DAT are often closely allied with vocational career areas:

1. Verbal Ability
2. Numerical Ability
3. Abstract Reasoning
4. Clerical
5. Mechanical Reasoning
6. Space Relations
7. Spelling
8. Grammar

We used the subtest AR (abstract ratiocination). This subtest has 50 items.

RAVEN GENERAL test:

Raven General are widely used non-verbal intelligence tests. In each test item, one is asked to find the missing part required to complete a pattern. Each set of items gets progressively harder, requiring greater cognitive capacity to encode and analyze.

The Raven General measure the two main components of general intelligence: the ability to think clearly and make sense of complexity, which is known as educative ability and the ability to store and reproduce information.

WINDAT (A program that improves learning):

To carry out this piece of research we created the programme WinDat, taking into account that in various works it has been seen that students do not feel so threatened before the judgement of a machine - which has limited knowledge - as they do before the judgement of the teacher and they docilely accept the repetition of mistakes without showing so many signs of fatigue.

The computer programme called WinDat is based on the subtest AR (Abstract Reasoning) of the DAT test (Differential Aptitude Test) and it is an adaptation to Windows of the INFODAT programme that was created by the same authors (Tesouro, 1995). Both programmes consist of 50 items (the same as DAT-AR) and thanks to a previous study carried out they were ordered according to difficulty. In each

of the items there is a series of 4 elements in which the subject must complete the fifth, choosing a drawing from five offered. The great difference there is between working on the content of the DAT-AR with the WinDat programme or with the teacher is that the programme immediately informs the students about whether the answer he or she has given is correct or not. Therefore, if it is incorrect, at that precise moment it gives a full explanation with the correct answer and says why it is the correct answer, as it tries to improve performance and the learning of the students, while the teacher cannot resolve all the students' doubts at the same time.

It should be pointed out that the DAT-AR is applied from 14 years of age and involves the processes of analysis and logical abilities, functions that are associated with "general intelligence" and the ability to reason with non-verbal forms, but in this piece of research it was applied to students aged 11-12 because it was considered positive to offer a certain level of difficulty to achieve a greater improvement as if the exercises of the programme had been too simple and had had too easy an answer for the students, the improvement of the students would not have been so considerable.

Figure 1. WINDAT Programme

Methodology

Sample:

The participants were 276 students from schools in the province of Barcelona, Spain aged between 11 and 12.

The children selected were divided into three balanced groups (two experimental groups and a control group). It should be mentioned that they were not children with high marks in the pre-test because, as we pointed out, the DAT-AR is applied to 14-year-olds and we applied it to 11-12-year-olds. We made this choice because if we had chosen older children, we would have had much higher marks in the pre-test, in other words, they would have been much closer to the optimum level and therefore the difference between the pre-test and the post-test would be much smaller than we obtained in this experience.

Design of the experience:

We carried out a pre-test using the odd numbered items of the Raven General Test to make three balanced groups, in other words, with almost identical average marks. The assigning of the condition of the control group, experimental group 1 and experimental group 2 was random, with the three following:

- The control group attend normal classes
- Experimental group 1 follows the WinDat programme.
- Experimental group 2 does exercises from the WinDat with the help of their regular teacher, both orally and with the use of paper.

PRE-TEST		ATTEND NORMAL CLASSES	WORK CONTENTS OF THE DAT-AR WITH THE WINDAT PROGRAMME	WORK CONTENTS OF THE DAT-AR WITH THE HELP OF THE TEACHER	POST-TEST
	CONTROL GROUP	Yes	No	No	
	EXPERIMENTAL GROUP -1	Yes	Yes	No	
	EXPERIMENTAL GROUP-2	Yes	No	Yes	

Table 1. Design of the experience: Distribution of the 3 groups (a control group and two experimental groups) depending on the work on the contents of the DAT-AR

Once the pre-test measures had been applied, they worked on the contents of the DAT-AR (experimental group 1 with the WinDat programme and experimental group 2 with the help of the teacher). The work of the two experimental groups was parallel to attending class, while the control group only did normal classes without specifically working on the contents of the DAT-AR.

Then, we applied the post-test measures that consisted of the application of the DAT-AR and of the even numbered items of the Raven General Test (and not of the odd numbered items that had been used in the pre-test to prevent the retest effect).

The DAT-AR enabled direct evaluation of the improvements during the experimental period in the two experimental groups, while the Raven General Test provided indications about the transfer of the acquired processes.

The period between the application of the pre-test and the post-test was approximately four months.

Results

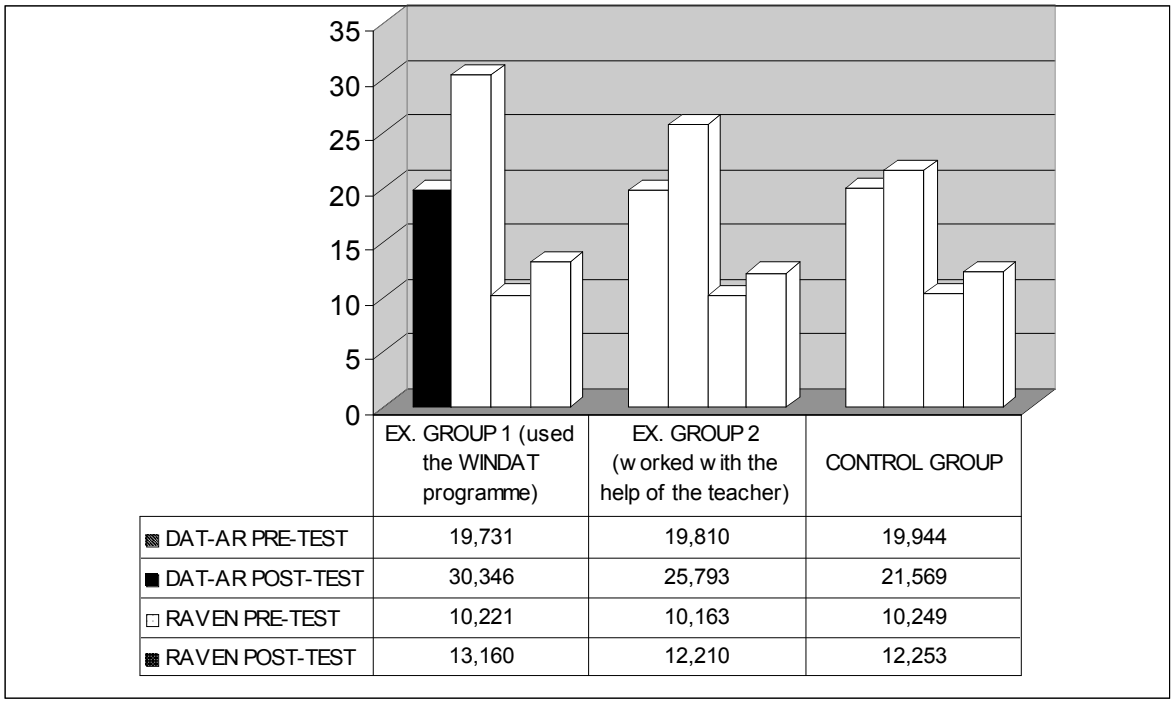
The following table number 2 is presented, that shows the results obtained, in which we have applied the student t-test for related samples, and the level of statistical significance can be seen in each of the three groups and the percentage of improvement of the second application of each test with regard to the first.

The children aged 11-12 who did the WinDat programme improved significantly ($p<0.01$) both in the DAT-AR Test (53.8% improvement), the test on which the programme is based, as the Raven General Test (28.75% improvement). However, we could see that the children who worked the contents of the DAT-AR with the help of the teacher also improved significantly ($p<0.01$) in the two tests although the percentage of the improvement was lower than in the group that used the WinDat programme (30.2% in the DAT-AR and 20.14% in the Raven General Test).

In addition, we applied the student t-test to groups independently (experimental group 1 that did the WinDat and experimental group 2 that worked on the DAT-AR contents with the help of the teacher) and it was seen that experimental group 1 improved significantly with regard to experimental group 2 ($p<0.05$) in the DAT-AR test while the improvement in the Raven General Test was not statistically significant. We should also point out that experimental group 2, which worked on the DAT-AR contents with the help of the teacher, also improved significantly with regard to the control group.

		WORK ON THE CONTENTS OF THE DAT-AR		
		WITH THE WINDAT PROGRAMME	WITH THE HELP OF THE TEACHER	CONTROL GROUP
TESTS	DAT-AR	0.008 53.8%	0.003 30.2%	0.091 8.15%
	RAVEN GENERAL TEST (even numbered items)	0.003 28.75%	0.009 20.14%	0.215 4.13%

Table 2. Improvement in the second application of each test with regard to the first application: level of statistical significance and % of improvement



	EX. GROUP 1 (used the WINDAT programme)	EX. GROUP 2 (worked with the help of the teacher)	CONTROL GROUP
DAT-AR PRE-TEST	19,731	19,810	19,944
DAT-AR POST-TEST	30,346	25,793	21,569
RAVEN PRE-TEST	10,221	10,163	10,249
RAVEN POST-TEST	13,160	12,210	12,253

Figure 2. Comparison of results by groups

We finally observed that the control group, which only had normal classes, did not improve significantly either in the DAT-AR or in the Raven General Test ($p>0.05$) although in both tests there was an improvement (8.15% in the DAT-AR and 4.13% in the Raven General Test) due to the retest effect.

Conclusions or discussion

We can see that the first hypothesis that says that the children who use the WinDat programme will improve more than the children in the control group who attend normal classes, not only in the test on which the programme is based: DAT-AR, but also in the Raven General Test was fully met, as well as the second hypothesis that says that the children who work on the same contents of the WinDat with the help of the teacher will improve more than the children in the control group who attend normal classes.

However, the third hypothesis that says that the children who do the WinDat programme will improve more in the test on which the programme is based: DAT-AR, and on the Raven General Test than the children who worked on the same contents with the help of the teacher were partially met, in other words, in the case of the DAT-AR, the children who did the WinDat improved significantly with regard to those who worked on the contents with the help of the teacher, while in the Raven General Test, on

applying the student t-test for independent samples the improvement is not statistically significant. This is due to the fact that although the new technologies help a great deal in the field of teaching, if you have a good teacher, the students also optimise their learning suitably.

Finally the fourth hypothesis which says that the control group, that only attended normal classes, would not improve as it had not worked on the processes involved in the various tests could be said to have been met although the control group showed some gain which was due to the repetition of the measure that we used for the pre-test and post-test (indicative of the retest effect).

This work shows that school performance and learning can be improved using new technologies due to the fact that computer programmes have special characteristics, in other words, they offer a guarantee that we have a homogeneous medium for optimising learning as computers always work in the same mode, which a teacher does not always do and, in addition, the computer allows individualised use because the programmes are used independently for each student and the children can take the time they need to look at the explanations given by the programmes, while a teacher's explanation is given in a limited time and he or she cannot solve the doubts of the different students at the same time. This assumption will be met as long as we have well-designed applications that are adapted to teaching.

In later research it will be interesting to use as pre-test and post-test measures, in addition to the tests that were used, contents from the course the children are studying, because in the results of the research we could see that intelligence tests are particularly sensitive to training and one of the things that increases the marks of the post-test is the affinity with the test, although we were able to observe that feedback, both from the programme and from the teacher, is very important.

As a final conclusion, we could say that many of the contents worked on with the help of the new technologies are better assimilated by the students as they get better results than using a traditional method. However, we should highlight that although we use the new technologies, the figure of the teacher will always be necessary and that in the design of computer applications the interaction of the technician with an expert in educational methods is very important.

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