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Evaluation of a Programme for Computer-Assisted Learning

Evaluación de un programa de aprendizaje mediante el ordenador

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Abstract

This article lies within the framework of the implementation and use of ICT as a medium of learning in Primary Education. A learning programme was created, implemented and evaluated through using the computer known as IKASYS (derived from the Basque verb «ikasi»-to learn), with the principal aim of assessing its impact on learning by school pupils. In the 2008/09 academic year the IKASYS project was launched in an experimental manner in 19 schools in the Basque Country. In this article, besides explaining its content, the basic tenets and procedures of the IKASYS project as well as the methodology used for its evaluation are described. The system of methodological complementariness, integrating quantitative and qualitative procedures, was opted for. Finally, the results obtained from the project and the general conclusions drawn —overall, positive ones— are outlined.

Keywords: Computer-based learning, evaluation, methodological complementarity, primary education.

Resumen

El presente artículo se inserta dentro del campo de implantación y uso de las TIC como medio de aprendizaje en la Educación Primaria. Se ha creado, implementado y evaluado un programa de aprendizaje mediante el ordenador denominado IKASYS (proviene del término vasco «ikasi»-aprender) con el objetivo principal de comprobar el impacto del mismo en los aprendizajes de los alumnos. Durante el curso 2008/09 se puso en marcha de manera experimental el Proyecto IKASYS en 19 centros escolares del País Vasco. En el presente artículo, además de explicar los contenidos, los fundamentos y procedimientos del Proyecto IKASYS, se detalla la metodología utilizada en su evaluación. En este caso se ha optado por la complementariedad metodológica integrando procedimientos cuantitativos y cualitativos. Por último se señalan los resultados obtenidos, en general positivos, con respecto al Proyecto y las conclusiones generales.

Palabras clave: Aprendizaje basado en el ordenador, evaluación, complementariedad metodológica, educación primaria.

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Introduction

In recent decades there has been a proliferation of research on the incorporation and impact of information and communication technologies (ICT) in teaching-learning processes. However, as Área (2005) points out, these studies have not guaranteed the creation of a theoretical corpus which explains the overall series of phenomena that might make the PC in the school or classroom generate innovation processes and enhance language learning.

> Tenemos mucha información empírica sobre las TIC en las escuelas, pero nos falta construir una teoría sobre este fenómeno particular de la realidad escolar que nos permita comprender qué sucede cuando los ordenadores entran en las escuelas, las causas de la resistencia del profesorado a integrar estas tecnologías en su práctica docente, o cómo implementar exitosamente estrategias de incorporación escolar de las TIC en un determinado contexto nacional o regional (Área, 2005, p. 3).

Unfortunately, one of the common lacunas in these kinds of projects —launched in different educational contexts— has been the fact that they have not been evaluated as they should (Aliaga, Orellana, & Suárez, 2004; Tejedor, 2009).

In this sense, the evaluation carried out by the IKASYS Project throws some light on the processes generated in relation to CALL in language learning.

While, in principle, the tasks undertaken were of a more descriptive character, the desire to know what their impact had been also led to an analysis of whether using PCs increased pupil performance. Subsequently, longitudinal studies were begun and, finally, qualitative methodologies were also incorporated in order to evaluate the use of ICTs in education.

With the aim of systematising the research undertaken, we coincided with Área (2005) in distinguishing four lines of research/evaluation:

A) Descriptive research on quantitative indicators that show the degree of ICT presence in the educational system. Normally this involves government research studies based on the analysis of records or on surveys; statistical data being obtained on the presence of ICT in the schools. Obviously, these studies provide little information about the pedagogical use of ICT and on the impact thereof. Amongst these studies are those of Cattagni and Farris (2001), Euridyce (2001), OCDE (2003) and Twinning (2002).
B) Studies on the impact of PCs on learning by pupils. This type of research is normally of an experimental nature. It is based on certain hypotheses or research questions, there being both a

control group and an experimental one, the variables being measurable, the programme itself (IKASYS in this case) being the independent variable, the impact on the pupils being the dependent variable. In this way, the evaluation of the IKASYS programme that we undertook in part is linked with this type of research work. Nonetheless, in the meta-analysis undertaken and based on the quantity of work carried out, there is not sufficient empirical evidence to indicate possible improvements in pupils' performances when using computers. Research in this ambit is by Blok, Oostdam, Otter and Overmaat (2002), Parr (2000) and Reeves (1998).

> …cuando las razones para la implantación se basan en una mejora del rendimiento de los alumnos como consecuencia de la mayor utilización de las TIC en la escuela, los resultados de las investigaciones realizadas han mostrado algunos resultados que, cuando menos, nos previenen contra un optimismo desmedido (Aliaga, Orellana, and Suárez, 2004, p. 444).

C) Studies on opinions and attitudes of external educational players and of teaching staff to using ICT in the classrooms. This type of research is based on questionnaires, interviews and discussion groups. Amongst these studies we can point to Cabero (2000), De Pablos and Colás (1998), NCES (2000), Palomares Casado (2007) and Solomon & Wiederhorn (2000). In the case of the evaluation of IKASYS, it was one of the most relevant aspects.

D) Studies on pedagogical uses and practices with PCs in real contexts. This type of case study research is undertaken at the school or classroom level using a largely qualitative methodology (observations, interviews, analysis of records, group discussions, etc.). The work of Zhao, Pugh, Sheldon, and Byers (2002) can be included within this category. In the case of the IKASYS evaluation, we wished to study our understanding of the application of the project in the classrooms more thoroughly. This is why great importance has been attached to the observation of what happened in the classrooms and to the opinions of those involved in the programme (project organisers, teaching staff, school principals, etc). What was sought was information about the teaching-learning situations arising from the IKASYS programme, seeing in what situations these processes are successful and assessing if these can be transferred to other schools and classrooms and, if so, how.

We agree with Área (2005) when he pointed out that each of these types of study separately pro-

vides certain kinds of information but, at the same time, these are limited by several circumstances. This is why we recommend research that aims to integrate the good points of each of these kinds of study, in order to mitigate these limitations of each one separately.

Consequent to this, for the evaluation of the IKASYS programme we aimed to carry out a quasi-experimental study to compare its efficacy on the performance of pupils, and to examine the opinions about and attitudes to the programme of the teaching staff and family members of participants. Moreover, this information was compiled observing «in situ» the development of the programme in order to have a deeper understanding of its functioning, both in each one of the classrooms as well as in the schools where the programme was applied. In this sense, the work proposed by Correa and de Pablos (2009) was taken into account (the research line that stresses the importance of the presence of the researchers within the context itself where the programme is being implemented).

IKASYS is a system consisting of hardware, software, strategies and curricular content created by the Basque Country Federation of Ikastolas (Basque schools) in 2009 so that pupils could learn using computers. In the 2008/09 academic year the IKASYS project was launched in an experimental manner in 19 schools in the Basque Country. The goal being to apply the project to all the other schools within the Federation, a team of researchers at the University of the Basque Country was commissioned to evaluate its experimental implementation.

The main goal of the project was to provide the pupils with solid tools adapted to their needs, so that they would understand and cope with the situations-problems arising in everyday classroom life, starting with simple situations (specific learning). Through the activities of the IKASYS Project, students do exercises in specific learning that help them acquire various skills defined as specific objectives (Federation of Ikastolas, 2009). Thus, by means of these activities, the goal was to achieve the systematisation of learning in order to develop skills.

The project is based on the underlying hypothesis that each pupil has their own style and rhythm when learning and that one of the main problems in education is getting it right when responding to the needs of each individual student. Also, some school content is interiorised through doing exercises and memorising them and, it is in these ambits where most doubts arise, being the situations where the greatest differences between pupils are observed. To respond in a satisfactory manner to the peculiarities of each pupil, the students have to carry out certain activities or have to undertake memory exercises appropriate to their specificity.

Taking the aforementioned into account, the current response to this problem is done in a traditional and partial manner. That is to say, the memory exercises are usually carried out without any kind of educational aid, only providing responses by other means to certain content which can be worked on by using various aids or resources, such as the text book (providing the same exercises for all the pupils) and, on occasions, also doing in-depth and revision activities; activity books and or notebooks; photocopies of exercise sheets or dictation exercises prepared by the teaching staff.

All this makes it extremely difficult for the teaching staff to undertake the systematic monitoring of the progress of each pupil in a suitable manner. It was in this context that the IKASYS Project arose, seeking to fill this existing gap and taking these resources to the pupils and the teaching staff in a personalised manner.

This is a system which, through educational activities of a wide-ranging nature, aims to develop the resources that pupils need to acquire basic skills. The IKASYS Project is a system by which each pupil learns with his or her personal computer. It consists of a series of three elements: computer tools (hardware), computer applications (software) and curricular strategies (content). The system has four functions: *to exercise,* a collection of systematic and progressive activities using different content and designed for pupils so that they use various procedures for learning, and providing, amongst other activities, calculation, spelling, problem-solving, algorithms in physics, chemical formulae, and so on); *to memorise,* a series of systematic activities that can help memorise different learning content such as historical data and events, geography-toponymy, literary works and authors, language-lexical content and formulation, etc; *to develop understanding,* a collection of activities of different kinds for developing cognitive and communicative skills on which all the subjects are based; *to work independently and in a personalised manner* (a process designed by the pupil himself or herself, in an independent and individual manner, and on the basis of their abilities, establishing the pupil's level and rhythm of learning and undertaking the corresponding exercises.

There are three basic components of the IKASYS Project. Firstly, there is the *hardware* - the IKASBOOK mobile computer tool, which aims to respond to the needs of the school and is easy and cheap to use. This tool is to be incorporated into the classroom and each student will use their own PC. Then there is the *software* - this takes on board three web applications: one for creating and organising activities; another application is designed to execute these activities in the mobile computer tool; and a third is for the teaching staff to monitor the progress of the work done by each

Laptop

Cupboard

pupil. The third component involves the *curricular content* - a range of activities classified by subject matter and ordered according to level of difficulty. 45,000 exercises for each language in the 6-12 years age range have been prepared. In total, 225,000 exercises divided into five subject areas (Basque, Spanish and English, Mathematics and Environmental Awareness).

The procedure to put the IKASYS tool into practice involved four aspects to be taken into account. Firstly, taking into consideration the aptitudes and abilities of each pupil, an educational contract is drawn up. In this, teacher and student agree on the work programme to be carried out (which and how many exercises, level of difficulty, time dedicated, and so on). Secondly, it is a procedure that *takes plurality on board*, each pupil working on the previously agreed exercises on the basis of their level. Meanwhile, the teacher agrees to supervise this work and provides help when needed. In third place, and related to the above, the project can help in monitoring special needs pupils and also with the various needs of immigrant pupils, i.e. *diversification***.** Finally, evaluation has to be considered, given that, as the exercises are being undertaken, the computer application corrects them; it is instantaneous correction. Once the task is finished, the student, together with the teacher, will make an evaluation of the tasks and of any difficulties arising. Then, on the basis of their evaluation, they will decide between the two of them what measures have to be taken and what work commitments established for continuing and further tasks.

To initiate the project each school in which IKASYS was implemented was equipped with Acer Aspire One laptop computers with Wi-Fi connection and Linux (Ubuntu) operating system, and cupboards located in the classrooms equipped with routers and connections for battery charging.

Method

The evaluation undertaken aimed at achieving two *fundamental objectives*, these being:

— Obtaining empirical evidence on the impact of the programme applied. In concrete, the impact of the programme in the learning of content and skills related to Basque, Spanish, English, Mathematics and Environmental Awareness are evaluated.
— Evaluating the programme itself and its process of application. This objective is aimed at enhancing the programme and its application. The different aspects that can be evaluated are the programme's components (hardware, software and curricular content) and the procedures related to its application.

In order to achieve these objectives, methodological complementarity has been opted for, enabling taking advantage of the various contributions, both in terms of quantitative and qualitative methodology.

The integration of these quantitative and qualitative methodologies can be carried out using different strategies. Bericat (1998) made an interesting contribution to synthesising, based on his view regarding the integration of methods, the various options for methodology in three basic strategies of integration: *complementation, combination and triangulation*.

In this evaluation, two of these strategies of complementarity have been applied. We can refer to *complementation*, given that different methods have been used in the same situations or schools. Thus, for example, objective tests and closed questionnaires were used and, at the same time, qualitative type strategies were put forward such as interviews, discussion groups and qualitative observation.

Equally we can talk of *triangulation*, in the sense that the use of different methods has enabled a complete vision, on contrasting two different types of information, qualitative and quantitative. This has enabled a more thorough interpretation of the information gathered through the various strategies and tools used.

Design

The evaluation of the impact was done by means of a «quasi-experimental design with non-equivalent control group». The dependent variable is the performance at the 2nd, 4th and 6th years of Primary Education in schools in the Basque Country in each of the five subject areas (Basque, Spanish, English, Mathematics and Environmental Awareness). The quasi-experimental type designs are the ones best suited to the evaluation of programmes in classroom situations. In each centre, at each level and for each subject, two classrooms are selected. The programme is applied

to one of these (the experimental group) while the other group (the control group) continued with the usual programme. On terminating the process to be evaluated, performance data for both groups were gathered and compared in order to analyse the possible impact of the programme on the experimental group. In order to guarantee equality between the experimental and control groups and, as the case may be, know the possible equality or inequality between them, data regarding socioeconomic-cultural aspects, general intelligence and previous performance of the pupils was first gathered. The prior analyses undertaken showed there were no significant differences in the three variables mentioned in any of the three years evaluated (Santiago, Etxeberria, Lukas, & Gobantes, 2009). As regards possible threats from statistical maturation and regression, these are controlled through the control group.

The evaluation of the programme itself and the process of application were basically qualitative, its objective being to understand all the aspects related to the components of the programme with greater precision (hardware, software and curricular content) and the procedures related to its application.

In a complementary manner the opinions of the pupils, their families, the teaching staff and school principals about the programme undertaken at the school were gathered. This we call «case study».

Participants

A number of 19 schools took part in the evaluation of the IKASYS programme. Each school had to have at least two classes from each of the school years studied under the programme (2nd, 4th and 6th of Primary Education). The programme was applied in one of the classrooms —chosen randomly— (the experimental group), the other being the control group. The numbers and distribution of participants can be seen in the following table (Table 1).

Table 1

Participating pupils

	2nd	4th	6th
Control group	405	382	392
Experimental group	410	409	407
Total	815	791	799

Likewise, 2,131 parents responded to the questionnaire and 96 teachers participated in the application and evaluation of IKASYS. School principals from the 19 educational establishments also took part in group discussions.

Data gathering

The strategies used for gathering information were as follows (Santiago et al., 2009):

— *Previous performance of pupils*. This variable was obtained from

the previous year's grades, marks which were adapted to a unified scale.

— *Participant observation in the classrooms*. In this evaluation we deal with participant observation as a synonym of «qualitative and naturalist observation» to mark it off from systematic observation. For registering information field notes were used**.** Through observation, apart from unexpected effects, the aim was to gather information related to the overall functioning of the programme (hardware, software, methodology used), the pupils' and teachers' motivation and the response of the programme to diversity.

— *Discussion groups*. The discussion groups were made up of teaching staffs of the same level. These discussion groups were able to analyse what the tendencies of the implemented programme were, and the opinions about the functioning in the classrooms, of the motivation of the teachers, etc.

— *Semi-structured interviews with school principals, with persons responsible for the programme and with those involved in the design of the programme***.** Through these interviews the aim was to obtain information about the characteristics and problems arising from the implementation of the IKASYS programme, from the perspective of the programmes of management and design teams.

— *Questionnaires for pupils, family members and teaching staff***.** These questionnaires gathered various dimensions together. Concretely, the dimensions of the questionnaire for pupils were those of the motivation to study in the different subjects and their liking thereof. The dimensions of the questionnaire for the families were about the information they received about the programme and their training and skills in technologies. Finally, the questionnaire for the teaching staffs gathered information about aspects such as teaching experience, preparation and training in technologies and their evaluation of the IKASYS programme.

— *Socio-economic and cultural level questionnaires for pupils***.** The questionnaire drawn up by the Institute of Evaluation and Educational Counselling (IDEA) was employed (Marchesi & Martín, 2000).

— *General intelligence test*. The RAVEN test (Raven, Raven, & Court, 1998) was applied.

— *Analysis of documentation* related to the IKASYS programme.

— *Performance tests*. Performance tests were constructed to measure the skills acquired by the pupils in both the control group and the experimental group in the 3 languages in question and in each of the three school years. For the construction of these tests, experts in the subjects being measured were employed and who, based on agreed specifications, constructed the tests. A pilot trial

was undertaken previously. In the following table the coefficients of reliability of the performance tests (Alfa de Cronbach) obtained in each of the tests can be seen:

Table 2

Coefficients of reliability (and number of items) for the performance tests

	Basque	Spanish	English	Mathematics	Environmental Awareness
2nd	.79 (28)	.75 (33)	.84 (43)	.85 (39)	Not applied
4th	.87 (38)	.78 (40)	.85 (42)	.86 (47)	.82 (30)
6th	.84 (44)	.83 (46)	.85 (39)	.87 (54)	.81 (39)

Likewise, in order to verify the validity of the tests, two procedures were followed. On the one hand, the tests were judged by experts in each one of the subjects in question, and who were asked to evaluate the pertinence, relevance and scope of the items included, in order to guarantee the validity of the content. On the other, the criteria validity thereof was judged, correlating the score obtained in the tests with the grades for each one of the curriculum subjects, producing the following values:

Table 3

Criterion validity for the performance tests: correlations and level of significance

		Basque test	English test	Spanish test	Environmental Awareness test	Mathematics test
Basque grades	2nd	.410 .000				
	4th	.534 .000				
	6th	.570 .000				

		Basque test	English test	Spanish test	Environmental Awareness test	Mathematics test
English grades	2nd		.434 .000			
	4th		.618 .000			
	6th		.613 .000			
Spanish grades	2nd			.341 .000		
	4th			.468 .000		
	6th			.553 .000		
Environmental Awareness grades	2nd				Not applied	
	4th				.517 .000	
	6th				.530 .000	
Mathematics Grades	2nd					.297 .000
	4th					.551 .000
	6th					.544 .000

Data analysis

Based on the information gathered, the following statistical analyses were carried out:

— Analysis of the tests used: analysis of reliability and validity of the test and analysis of the items, both of the definitive tests as well as of those applied in the pilot trial. The construction of the tests was undertaken following the classical testing theory.

— Analysis of the data gathered from the tests and questionnaires, basically consisting of the following:

- Descriptive analysis of data: percentages, frequencies, means of centralisation and dispersion.
- Bivariate analysis of the association/relation between vari-

ables: coefficients of correlation and contingency.
- Comparison of averages: T Tests for students.

The analysis of the information gathered through the interviews and group discussions was guided by the following process: a) reduction of the information, b) organisation and presentation of the data and c) analysis and interpretation of results.

As can be seen by the phases presented, what is known as a comprehensive qualitative analysis has been drawn up from the gathered data. To this end a series of categories was selected and identified. This process can be undertaken either deductively or inductively. In the case at hand, we have opted for a mixed procedure. *A priori* a series of categories was put forward based on the bibliographic and documental revision undertaken and on the experience of the evaluators (deductive procedure) so that, subsequently, once all the data had been codified, the categories system was adjusted to adapt realistically to the data collected (inductive procedure).

To carry out the quantitative analyses the SPSS 18 version (SPSS, 2009) was employed and for the qualitative analyses the NVivo 8 (QSR International, 2009) was used.

Results

IKASYS and performance

The following tables present the arithmetical averages and the typical deviations obtained with pupils from the *2nd, 4th and 6th years of the Primary schools* who took part in the IKASYS Programme, together with those pupils who made up the control group. The last column indicates the value of the statistical significance after comparing the scoring from both groups.

Table 4

Group statistics: 2nd Primary school year

	GROUP	N	Mean	Typical deviation	T-test significance
BASQUE	Experimental	392	24.81	5.549	
	Control	390	23.49	5.327	.001
SPANISH	Experimental	64	24.55	3.862	
	Control	66	22.06	5.059	.002
ENGLISH	Experimental	395	37.70	6.277	
	Control	394	35.68	6.669	.000
MATHEMATICS	Experimental	391	28.18	6.296	
	Control	394	27.25	5.893	.033

Table 5

Group statistics: 4th Primary school year

	GROUP	N	Mean	Typical deviation	T-test significance
BASQUE	Experimental	395	42.95	7.879	
	Control	369	40.31	8.704	.000
SPANISH	Experimental	395	27.05	6.002	
	Control	373	26.36	5.357	.091
ENGLISH	Experimental	393	36.01	7.299	
	Control	372	35.00	7.005	.052
ENVIRONMENTAL AWARENESS	Experimental	396	30.14	6.884	
	Control	371	29.57	6.714	.246
MATHEMATICS	Experimental	396	42.30	8.468	
	Control	369	41.07	7.907	.038

Table 6

Group statistics: 6th Primary school year

	GROUP	N	Mean	Typical deviation	T-test significance
BASQUE	Experimental	394	40.72	7.414	.011
	Control	381	39.38	7.151	
SPANISH	Experimental	397	30.98	6.540	.566
	Control	381	30.70	6.780	
ENGLISH	Experimental	397	39.66	8.184	.071
	Control	382	38.59	8.426	
ENVIRONMENTAL AWARENESS	Experimental	395	39.05	6.747	.074
	Control	383	38.18	6.851	
MATHEMATICS	Experimental	385	46.65	9.733	.001
	Control	376	44.35	9.236	

As can be seen from the table above, in the 2nd Primary school year, for all of the subjects evaluated, the scores obtained with pupils from the experimental group are superior to those of the control group by a percentage that oscillates between 3% and 11%. Moreover, in

all cases these differences turned out to be statistically significant.

In the 4th Primary school year the situation is similar. In all of the subjects evaluated, the scores obtained with pupils from the experimental group are superior to those of the control group by a percentage that oscillates between 2% and 6%. Nevertheless, solely in Basque and Mathematics were significantly different results obtained.

The same occurred in the 6th Primary school year as in the 4th. Although scoring for pupils from the experimental group are greater than those of the control group by a percentage that oscillates between 0.9 and 5.2%. Only in Basque and Mathematics were significantly different results obtained.

IKASYS and motivation

In general, the pupils at all the participating schools worked with IKASYS in a highly motivated manner. This motivation, verified in all the school years studied, contributed to the pupils expressing a greater liking for the subject. In this sense, when asked if they preferred working on the subjects using IKASYS or the traditional system, the large majority of pupils opted for IKASYS. It has to be pointed out that this motivation was observed with all types of pupil, i.e. both with top achievers and with those pupils with difficulties and/or who are less hard-working. This contributed to the fact that, in the IKASYS sessions, the concentration of the pupils on the work they had to do was considerable. This was verified both during the observations made in the classrooms as well as in the discussion groups undertaken with the teachers.

This motivation was greater at the beginning of the course, falling off somewhat in later school years and as the school year progressed.

Moreover, the perception the pupils have as regards the advantage gained by using IKASYS has been positive. In all schools years and in all subjects, more than 50% of pupils considered that, through the IKASYS Programme, they learned more than with the traditional method.

IKASYS and diversity

It has been shown that the IKASYS Programme takes into account the pace of work of each pupil. Given that it enables adapting the exercises to each, it thereby enables responding to diversity in an appropriate manner. It also encourages the pupil to work independently.

Likewise it was proved to be a positive application for pupils with special needs, turning out to be enriching for those with most needs and require attending support classes. It was shown that these students worked constantly and diligently in front of the screen.

It should be taken into account that the programme enables

the teaching staff to previously programme the exercises that each pupil has to do, thus being able to adapt to each concrete learning situation.

IKASYS and methodology

Another aspect that was of interest to evaluate related to the methodology used to undertake the project and the changes this might mean for traditional methodology.

In general, the observations made both in the group discussions and in the interviews carried out were able to show that the methodology proposed was efficient. A number of changes took place as a result of the IKASYS sessions. To start with, the teacher went from being the sole classroom reference to being a helper and adviser in the learning process.

On confronting each pupil with the programme in an individual manner, the independent work of each one was boosted, with a high concentration on the work —unusual in other kinds of situations— was observed. In this sense the satisfaction of the teaching staff was unanimous - they pointed to the fact that the climate of work in the classroom could not be bettered.

Nevertheless, an aspect that was not very well assimilated by teachers participating in the project was the integration of the Programme into the curriculum. As was previously mentioned, the IKASYS Programme does not aim to be a substitute for the traditional curriculum but to be complementary to it, with specific weekly sessions. Obviously, we considered it essential for the teaching staff to know what the pedagogical basis of the programme was and the way in which it should be integrated into the curriculum.

IKASYS Software and Hardware

The use of Software turned out to be very easy for all the pupils of the three school years participating. The different kinds of exercises put forward turned out to be, in general, appropriate. On responding to an exercise, the programme tells the user if it is correct or not. If the response is wrong, and before going on to the next question, the system obliges the pupil to see what the correct answer is. This aspect was evaluated highly positively by the pupils, given that it contributes to improve learning.

As regards the Hardware involved in the programme, a number of devices should be differentiated. The micro-computer used by each pupil turned out to be suitable, as did the mobile cupboard for charging the micro-computers and the router. Nevertheless, technical problems were observed in some schools, above all at the beginning of the school year. These problems arose for three different reasons: the deficient infrastructure of the school itself, the Wi-Fi system, and the lack of knowledge about the use

of the programme, the computer, the router, etc.

In some cases these problems were serious, even to the point of jeopardising the viability of the programme itself.

Discussion

Pupils who participated in the IKASYS Project obtained better results. In the 14 tests applied in the 2nd, 4th and 6th years of Primary school it was shown that pupils who participated in the project obtained better performances. Nevertheless, on analysing effect size, we can say that the improvement is moderate.

Where there is no doubt whatsoever is the motivation that the programme has generated amongst pupils. This datum has been corroborated from various perspectives and it was confirmed that working with these technologies is much more motivating for pupils than using traditional materials.

The IKASYS Programme has been shown to be a versatile tool enabling the adaptation of the exercises to each individual pupil and to each concrete learning situation. It proves to be a valid instrument for responding to diversity amongst pupils.

The methodology used to carry out the IKASYS Programme proved to be appropriate. It was shown that pupils work highly independent of each other and with great concentration. The teaching staff went from being the only classroom reference and guide to being a helper in the learning process. However, it was not clear to the teaching staff as to how to incorporate the IKASYS Programme into the regular curriculum.

The Software used in the IKASYS Programme proved to be appropriate, both with what is referred to as the simplicity of use of the programme for the pupils as well as with the different types of exercises proposed. As regards the Hardware required to undertake the programme, it was shown that technical problems can make the appropriate operation of the programme difficult. This is why it is advisable that, before beginning IKASYS sessions, the school infrastructure is adequately guaranteed, the Wifi system functions suitably and the teaching staff involved in the Programme has the necessary training to resolve any problems that might arise.

In short, this research has enabled us to conclude that the most relevant factors contributing to the success of educational programmes like IKASYS are:

— Access of pupils to technology
— Technological training of teaching staff
— Child education training of teaching staff
— Motivation of teaching staff
— Setting up a technical support team
— Integration of technology into the classroom.

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