

OECD/CERI ICT PROGRAMME

A Case Study of ICT and School Improvement at School '

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1. Overview

School B is a public primary school comprising six grades (A, B, C, D, E, F) and it is situated in a small town of a border island of Greece. It is one of the biggest primary schools in the area since it numbers 185 full time students, 95 boys and 90 girls, split in six grades and 7 classrooms. The school budget sums about 5,5 million drachmas that come from the national budget. The Head teacher and one assistant Head teacher share the school function with 15 teachers both permanent (14) and temporary (1). The academic start school date is scheduled for the 10th of September and teaching school period finishes on the 15th of June. The school weekly days are from Monday to Friday, and the fixed working periods- which last about 50 minutes each- are 30 per week. The students' formal assessment procedure follows the Ministry of Education guideline (National curriculum assessment) which prescribes that the students should be assessed: orally in classroom, written tests, and total material-exams every two or three months in each lesson. There are different types of subject tests that the teachers design on the basis of assigned subject material. The main purpose of assessing students is firstly to perform either in oral or written exams their subject material acquisition in various stages of learning. Secondly, teachers can use formative and summative evaluation of the students performance as feedback in developing tests which will improve their learning in the future.

In this study ICT is mostly perceived as being school - based. We take the stance that schools are live social

organizations and that any use of technological frameworks is shaped by different policies, organisational structures, attitudes of the engaged people as well as the educational system in which the school is set. School B is one of the very few primary schools in Greece that has a five year experience in using ICT for small project work on mathematics introduced in the form of a separate subject integrated within normal curriculum. Since the last year the school participates to an extended project which encourages further ICT integration within schools in Greece. Now computers are not only used for project work but also for geography, history, English and music. In the teaching sessions they are also used internet and CD-Roms while some classes occasionally communicate by e-mail with others during electronic collaborative projects. School community that is involved in the ICT project, reported the aspect of ICT perceived as innovation in itself and the importance of their school as frontrunner. Additionally, all the other members of the community view ICT use of major importance in the modern society and relate it to the students future.

Though one can talk about a sustained innovation the school presents an interesting case since one can follow the evolution of the innovation over the time in relation to the varying factors that affected it i.e. the project participation, the people engaged, the provided support and training, the constraints created by the administrative structure of the greek educational system etc.

2. The past

School B had introduced computers since 1995 in the context of its participation in the project YDEES^[1]. The main objective of the project was to develop exploratory software and to evaluate its implementation to primary school communities aiming to engage students and teachers with open learning approaches. The key person in this procedure was the teacher T1 who initiated the idea of the school participation to the project. The head of one project partner made her the respective proposal and T1 remembers that from the first time was excited with the idea and immediately reported it at the school.

T1: We saw the participation at the project as a chance to have computers in the school. We all accepted the proposal enthusiastically: the mayor, the head teacher ... and decided to send the application form. (Teacher interview, School B)

Teacher 4 who was the Head Teacher that period of time stressed in his interview the fact that all of the early participants shared the generally accepted view about the great importance of the pupils familiarisation with ICT skills in the future. The current Head Teacher of the school was also in the first group of teachers who wanted to participate in the project. As illustrated in his words:

First of all children need to learn about the use of computers. It is a great objective. After the primary school children would be able to continue and be prepared for other more complicated computer applications. (Head Teacher interview)

Head master and the majority of the willing teachers saw the provided opportunity for the school to explore new possibilities in relation to its current status. Their school could be one of the first primary schools in Greece with a computer lab. The initial infrastructure consisted of five personal computers 486 which were placed in a special room on the ground floor.

The use of the ICT in school B was influenced by the collaboration with the university research team according to the project requirements. Under the pedagogical intervention of the research group a new course called

Investigations was developed. The lesson involved the use of a piece of programmable exploratory software^[2] encouraging interdisciplinary project work, students groupwork and investigations cultivating problem solving skills. The organised activities were accommodated to the new computer lab. All students in grades 4th, 5th and 6th had had the opportunity to work in the lab for one hour a week, working on interdisciplinary project work, collaborating and communicating with each other. It is noticeable that this period of time there was not a subject of informatics in the primary national curriculum^[4] and the head master had to overcome bureaucratic issues in order to obtain the respective authorisation by the Ministry of Education.

According to the project planning teacher training was appointed to three research teams from the Athens university with one taking the main role in this process. The training scheme included two or three visits of trainers every school year. The seminars that took place in the computer lab involved training on educational issues of the ICT integration in the classroom (groupwork issues, open approaches to learning activities, problem solving skills, communication among pupils and teachers) as well as technical issues including

presentation and installation of new versions of educational software. However, technical problems in the lab are reported to set one of the reasons that drove some of the teachers from the first ICT team to interrupt their engagement with computer activities.

Though there was no resistant in the participation at the project not all teachers were involved. T1 was the key person employed to organise and implement the new discipline. Every year there was a core team of teachers T1 and three or four experienced teachers with some of the new teachers^[5]. In the end of the first year the headmaster and three teachers left the team making points about technical problems in the lab or family matters. The next year (1996-97) the current headmaster took his position to school and the project continued with him, T1, T5 and some of the new teachers. Two very active participants - T2 and T3 came to work in the school in 1997. The next two years (1997-99) there was the same team: T1, T2, T3 and T5 and some (2-3) of the young teachers were involved in some computer based activities. As far as further project experience after the duration of the YDEES school kept an impressive record of fruitful relations with the academic team in two EEC projects that created new opportunities for internet communication among classrooms (IMEL^[6]) and innovative teaching approaches in mathematics (ITFR^[7]).

3. The present

3.1 Infrastructure and Support

The school in order to accommodate ICT use developed the following technical infrastructure: a) One PC and a printer in the administration office since 1999 used for the internal paperwork. There are no secretaries in the school and all administrative tasks are in the responsibility of the Headmaster and Sub-headmaster and b) One computer lab locally networked with one server, ten work stations Pentium II 64 Ram and one printer. It seems that at this point infrastructure is adequate for the school needs. As for the technical support there is an in-school computer lab technician as a result of the school's participation to Odysseas project. However, all interviewees argued there were no problems related to technical issues since the desktops were newly established. —owever, the technical specialist is mainly responsible for software and network issues. Hardware problems are solved under the supervision and guidance of the central technical support team of the project. Data reveals that teachers involved to the previous educational projects received training on educational and technical issues by the university research team twice a year. Moreover, the internet use - initiated at 1998 - enriched this communication giving to both sides the opportunity to exchange ideas and discuss topics related to the design and the implementation of educational activities. School's participation to Odysseas brought a change to the training pattern that was followed until then. Training seminars now are not provided only by one partner and the balance between technical and educational issues appears to be differentiated since the team of the trainers is not always homogeneous. However, data showed that in the past technical difficulties evoked teachers to spend more time on the computers which strengthen their willing to continue effectively the computer-based activities in the classroom.

3.2 Computer use and activities

Up to now school B has a five year experience in using ICT for small project work focusing on mathematics and has been using internet and communication technology the least two years. ICT use was introduced in the form of a separate subject integrated within normal curriculum. The subject was labelled Investigations implying that the focus is on what is being taught rather than on the tool used. Specifically, the aim of the university team was to infuse the use of computers for co-operative small group project work, investigation, creative and critical thinking on topics taught traditionally within the system with particular emphasis on mathematics. All pupils from year 9 to 12 are involved for two hours a week. Each class is taught by its normal teacher and there are four teachers who teach this subject. According to the grade pupils interact with appropriate Logo applications followed by write and paint, which are also used as tools for creative educational projects activities. Students of the 5th and the 6th grade, gradually begin to apply some formal commands, approaching the logo's syntax and semantics. They get aquatinted with building, editing, saving, using variables

and recursion. The special characteristics of the Investigations are: a) all pupils work in groups of two or three, b) teacher selects a theme taken from maths or another subject (history, geography, environment etc.), c) pupils design a drawing with Logo relevant to the selected topic (e.g. a castle, a map, an animation etc.), d) then they paint on the design and e) finally they write a composition describing the phases of their work from the beginning to completion with emphasis on the encountered difficulties and how they overcome as well as the way they cooperated. Children should have opportunities both to create their own design from imagination, and to respond to challenges set by the teacher. The whole procedure lasts nearly three months. As one teacher described it:

Investigation doesn't finish at the end of the teaching session. We start with a topic and then we discuss it with pupils and decide with them. The topics follow their interests. This class has chosen the topic Olympic Games. This is the general topic. We discussed the general topic with pupils and we decide to divide it to subtopics. (Teacher 2 interview)

The introduction of the internet use in the classroom also enriched the investigation lesson with focused navigation for information related to the emergent subtopics. Unlike current views of internet use in the classroom that give emphasis on the provided access to quantities of information this way site navigation is perceived as a way to enrich a general educational procedure in which students have an active role by creating their own body of work. As it was mentioned earlier the participation of the school to Odysseas project encouraged further ICT integration within the site. Now computers are not only used for the Investigations but also for geography, history, english, music. In the teaching sessions they are also used internet and CD-Roms while some classes occasionally communicate by e-mail with others during electronic collaborative projects.

3.3 School community's perceptions on the use of ICT

Teachers

As far as the teachers are concerned the way they perceive the ICT use depends mostly on the way they are (or were) engaged in computer integration within the site and their respective role accordingly. The administrator was a member of the key personnel involved in the ICT implementation in 1995. His view of ICT focuses on the importance of ICT skills nowadays as well as on the fact that working with computer supports student's understanding of mathematical concepts and cultivates pupil's cooperative skills.

First of all, children acquire knowledge on computer technology from the childhood. This is a great target. We intent to prepare our students to continue after the primary education and not to be surprised if they have to learn different information programs in the secondary school. Secondly, it [e.g. computer] helps students to achieve better understanding of some mathematical concepts through the Investigation projects. (Headmaster interview)

Teacher 1 is the key person in the process of ICT integration. She is the first one who accepted the proposal for the school participation in YDEES project which led to computer introduction in the site. Her opinion on ICT use focuses on the pupil's benefits by the groupwork in the computer lab:

Firstly I will stress the cooperation. Secondly I will distinct the right to make a choice. In the way we teach pupils feel that they have the right to choose and take decisions as well as express their opinions even if they are not good students. This is impressive. (Teacher 1 interview)

A great part of the initial educational training in the project YDEES had to do with the investigation projects and the exploratory nature of the suggested software. In T1's we distinguish that in her words computer use is seen in close relation to the piece of software used within Investigations.

Turtleworlds is a very important piece of software. From the beginning I trusted it. Children can use computers - sometimes without realising that they use a tool - they have the chance to complete the tasks and at the same time they learn mathematics, discover geometrical figures and their properties, write text in the Word, chose information related to their topic and negotiate which would be included in the final version of their work. (Teacher 1 interview)

Teacher 2 participates at the computer activities in the school during the last three years. The motivation for her engagement in the ICT activities was a trainer's words at a training seminar who urged the participants not to find themselves behind the new technological challenges that future generations including their students- would follow. She uses ICT within the Investigation subject and views computer as a medium that encourages new

ways of learning but its more effective educational use is a matter of study. She points out the chance to experiment in computer-based activities and suggests more freedom to teachers in order to form their own teaching agenda with fewer limitations of the national curriculum.

Computer is a new representational medium but a lot has to be done for its more effective use in the classroom. It is a tool that impress children but as teachers we have to leave behind the first impressions ... The Turtleworlds allow children to experiment so as to reach the knowledge, by trying continually, doing experiments and draw conclusions without our intervention. They have the chance to experiment ... I need more freedom... more flexibility to plan things I would do with my students in the lab. This is a problem. The organization and the structure of the school program is strict. The national curriculum in the last few years has been much more pressuring on the teacher and sets limitations on what to do. (Teacher 2 interview)

Teacher 3 is also one of the more experienced teachers in computer-based activities. His permanent professional position is in another school but he teaches once a week in one class of the school B in which had been working for the previous three years (1996-99). As far as his motivation to be involved with computer use in school T3 focuses on the improvement of his work. As the teacher said:

I wanted to find something new to teach, to help myself in teaching. That was my aim. I went to see what was that thing [e.g. computer] and because I liked it I decided to continue. (Teacher 3 interview)

Focusing on his educational aims through computer use he refers to the improvement of his student s mathematical skills:

My aim is students would understand mathematical concepts, angles, arcs, relations between angles. (Teacher 3 interview)

Teacher 4 was the Headmaster of the school at the initiation of ICT use in 1995. He supported the first team of teachers engaged in computer-based activities though he had never taught in the lab. The next year (1996) left the team and the present headmaster substituted for him. After that he had not been involved in ICT implementation within the school. In his interview ascribed it to family reasons and lack of time. However, he has a positive attitude towards computer use. He argues that computers have the potential to facilitate learning in a more friendly way than the textbooks.

The textbook is a bit difficult, a bit scaring ... while in the computer the child can learn by playing. (Teacher 4 interview)

Parents

Turning to the way parents perceive the ICT use, data revealed that all of the interviewees view ICT skills of main importance for the modern society. This comes as a result of the social changes that have taken place over the last years.

Today children have to learn more than we had as students. Nowadays the society demands for more knowledge. (Parent 3 interview)

All of the interviewees have a computer at home or at their offices and two of them noted that their children attend private lessons or special course programs focused on basic ICT applications.

My son has already taken lessons on Word, Excel, Power Point. Now he is learning programmability. (Parent 4 interview)

They follow [e.g. at a private institution] a teaching program which includes lessons on general computer operation, Windows 2000, Excel, Word, Internet. (Parent 3 interview)

As illustrated by their interviews two of the parents seem to accept the use of computer as an information technology subject. Additionally, they argue that the work with computers at the school is not enough for the pupils although data reveals clearly that they weren t adequately informed on the exact ICT use at the school and they seemed to ignore the educational validity of groupwork in Logo-based teaching approaches.

They don t have exercises for homework. They draw houses. I don t think that one can learn by drawing houses. (Parent 3 interview)

There is not adequate infrastructure. As my daughter told me they work three children in each computer. One keeps the mouse, the other writes on the keyboard ... It would be more effective if each child had his own computer. (Parent 2 interview)

However, the other two interviewees seemed to be well informed on ICT use within the school. As illustrated by their words computers present tools for encouraging new ways of teaching and learning. As far as the school use they stressed the importance of communication skills and groupwork:

The most impressive thing was that the school established the cooperative work in the lab. Pupils learn to let

alone their ego and communicate with others. That would be difficult to achieve in the traditional classroom. (Parent 1 interview)

The main advantage of the computer use at school is that a child can learn by playing. My son learnt how to work with other pupils in his team. (Parent 4 interview)

Students

First of all it is noticeable that three of the interviewed students said that they were taking private lessons on informatics. Additionally, data revealed that students perception of what they are doing with computers at school is mainly focused on the mathematical part of the investigation subject:

We learn about geometrical figures, we give comments for drawing rectangles, squares, arcs. We can use variables to find the appropriate distances. (Student 1 interview)

Moreover, they are aware of the different parts of the activity describing them in relation to the final product (drawing) as well as with the process followed for that (cooperation). As expressed in one student's words: *Firstly we chose a topic that we decide to complete all of the groups. Then we start and step by step ... It's good to navigate in the internet finding information you didn't know, cooperate with your team and complete the design you had chosen. (Student 1 interview)*

Additionally, as it data reveals that they are aware of the different uses of ICT through the site. Specifically the newly introduced use of internet in the classroom is perceived to take place within an activity of a specific curriculum subject.

We investigate the old civilization. (Student 2 interview)

Yesterday we visit a museum. We searched for archaeological findings. (Student 3 interview)

3.4 ICT use in relation to innovation

The administrator and the three teachers that were involved in the ICT project, reported the aspect of ICT perceived as innovation in itself and the importance of their school as frontrunner. Teacher 1 who has been actively engaged in the implementation up from the beginning stresses:

It is an innovation. It affected the whole school philosophy. (Teacher 1 interview)

As it was mentioned at an earlier paragraph this is not particularly surprising for the greek educational setting since the use of computers is not an aspect included in the primary national curriculum. Turning to the way school community relates the computer use to educational innovation, data revealed that the more experienced teachers involved in ICT implementation (HT, T1, T2, T3) share a common viewpoint: their opinions on educational innovation focus on the educational elements of the Investigations subject. The same was also mentioned to some parents' opinions on their pupil's benefits from ICT use. Categorising the selected answers the following categories emerged:

1. Cooperation. The head master views as the main advantage of ICT use in investigation projects the cultivation of children's collaborative abilities. Additionally, he notices that this initiative can be a motivation for changes in the traditional classroom. As he said:

In the Investigation pupils always work in groups. They have the ability to work together, to take initiatives. It is something really new for the school and forms an example of how work in the traditional classroom should be modified. They work collaboratively, constructing something. (Headmaster interview)

Similarly, teacher 2 believes that the most important educational outcome of the investigation process is that of cooperation among pupils. According to his view this resulted to improvements on pupils' relations in the classroom. As illustrated by his words:

In my opinion the most important thing in this process is that pupils learn to cooperate and reach any conclusion after discussion among their team. From the beginning that was our aim: To have groups of two or three children who would work together. (Teacher 3 interview)

As it was earlier mentioned two of the interviewed parents were informed on ICT use in the school as well as the elaborated tools like Turtleworlds. Both they referred to the improvement on their children collaborative and communicative skills when asked about the benefits stemming from student's involvement in computer-based projects. As illustrated by their words:

I saw him [e.g. her son] excited with the work in the computer lab. They worked as a team. They said our team

finish first. It is impressive that teachers achieve collective work in the lab. If you have the chance to communicate with your partner and work together surely that the outcome would be better. (Parent 1 interview)
He learned to cooperate and work with two or three other children. (Parent 4 interview)

2. Experimentation. A main characteristic of the investigation projects is that they take place using a Logo-based environment of exploratory nature. This framework encourages the implementation of educational activities in the core of which can be pupils experimentation with the provided tools. As teacher 2 said:
In the Investigation pupils have to experiment and reach the knowledge by doing experiments. It is very important that sometimes they come to conclusions independently. (Teacher 2 interview)

Additionally teacher 1 refers to the fact that sometimes unexpected children's abilities emerge through experimentation in computer activities:

There are some children who discover many things through experimentation. Some of these children are low ability students in all the other subjects. They have abilities that come to light while working with computers. It is surprising. (Teacher 1 interview)

3. Improvement of the performance of low ability students

The collective work of pupils in the lab supported changes in the status of the pupils' performance in the lesson. It is noticeable that all of the teachers focused on the improvement of the low ability students' performance in the computer lab. Two of the teachers said:

The low ability students usually hesitate to express their opinion. We noticed that in the lab these students could think more relaxed and try things. This is very encouraging for them. (Teacher 1 interview)

Who benefits more? Everybody. We [the teachers] were interested to encourage the low ability students (Teacher 3 interview)

4. Expansion of group-work in the traditional classroom. The fact that students work in groups in the lab was an additional motivation for some of the teachers to try similar innovative approaches to their teaching in the traditional classroom. This is not a widespread practice within the site but it is of main importance since such an approach is new within the national educational system. Teacher 1 refers to her need to introduce group-work in the traditional classroom after the experience in the lab. In her words:

Personally speaking I felt the need to match the lesson in the lab with the one in the classroom. So, to one extent nearly 60% of the time in the classroom- pupils work in groups during the last years. (Teacher 1 interview)

3.5 ICT in the classroom

During the visit of the research team at the school five teachers were observed in twelve teaching sessions. The observed teachers can be divided in two groups: a) those who had investigation experience (T1, T2, T3) and b) new teachers who work in the school from the beginning of the school-year (T4, T5) T3 this year works in another school but he teaches once a week in one class. T4 who was interviewed he doesn't participate in ICT activities. The organised computer-based activities were not based on specific units of the national curriculum although some of them were indirectly linked with school material. In three of the teaching sessions (T3: Environment, The human body, T1: Investigation in grades 6 and 4a) T1 and T3 taught in classes that belong to newer schoolteachers and the lessons were instructive for their familiarization with the group-work in the lab. The new teachers were also present as well as the computer lab technician.

Investigation

The general framework in which the Investigation takes place was described at an earlier paragraph. The involved teachers acknowledged the role of Logo in student's learning and its place within educational process. As expected all the observed activities had a similar structure based on groupwork. Specifically there were three parts of classroom activity: a) Whole class discussion about the general topic and each group's task, b) groupwork on the given task and sometimes c) presentation of each group work to the class.

As far as the teachers' role is concerned there were differences on their teaching approaches. Teacher 1 adopted a more directive role especially in the lesson of the 4a grade in which pupils were at initial stages of learning Logo. The lesson was introductory to the use of basic Logo commands. In that class she often acted as an explainer during the whole process, by intervening and giving detailed instructions on what commands each group had to write for a square construction. However, in the more experienced classes her practice in the investigation appeared less instructive. In the lesson at 6th grade, for example, pupils were doing experiments with arc procedures. T1 started the lesson by giving out hand outs of photos of old traditional local houses and

churches buildings. The photos were taken by the children during an excursion. The core part of pupil activity was the design of doors and windows that include arc construction. It is noticeable that the constructions were completed with procedures of high complexity effectively the provided.

Teacher 2 perceived the Logo activities as an opportunity to work on pupils' mathematical process. She focused on the communicational aspect of mathematics, stressing the importance of pupils' ability to argue and explain. She underplayed concepts to do with rectangles construction and she was predominantly interested in the use of variable in Logo. Her method for pedagogical intervention was focused on drawing pupils' attention on specific aspects of how things behaved on the screen. For this reason sometimes asked pupils to show by their bodies the turtle's movements. Focus on the gradual development of mathematical meanings through discussion was apparent from the way the activity evolved. The lesson included respective periods of work on the computers and whole-class discussions in a circle-like configuration. During the latter pupils had opportunities: a) to report their difficulties, b) to plan their next steps and c) to draw conclusions.

Internet

As displayed in Table 1 the use of internet in school B is intended to be integrated within teaching of other disciplines like history, english, music, geography etc. From the observed teaching sessions two main uses appeared: the first had to do with visiting web sites for more information on a subject; and the second with using educational programs in a site as active textbooks. The investigation teachers show a tendency for the first use trying to integrate navigation in further educational activities (Olympic games, Environment) while new teachers were mostly involved in the second use.

Specifically, teacher 5 (T5) is a new English teacher in the school. The theme of her observed lesson was Present Perfect and Continuous. Pupils worked in the English Club environment, an educational program chosen by the teacher and installed on the computers by the technical specialist. Children often chose groups of pictures (e.g. zoo) and then appeared special question forms asking for the correct names. The program also checked whether each of the answers were correct or not. During the lesson T4 followed a whole-class teaching practice visiting the groups of pupils and giving instructions on the correct filling of the exercises on the active textbook. The same practice was also observed during the music lesson of teacher 6 (T6). All of the groups visited the same web page in which they could listen to different types of violin and viola sounds. The teacher kept the control of the time each sound file could be played. Pupils seemed enthusiastic by the experience but T5 was the only one who was giving explanations on the characteristics of the sounds.

On the other hand T2 integrated navigation within the investigation subject. Her approach to the activity included visiting web sites for information on subtopics emerging from the main one. In her interview reported her intention to connect all the different parts of the activity to the main investigation planning.

Each investigation lasts nearly three months. Now we have decided to be engaged to the Olympic Games. This is the general topic. After discussion with the pupils we divide into subtopics like: Olympic Games in the ancient times etc. Each group can choose one subtopic and then is looking for relative information on the web. The drawing of each group is the result of this process. Some choose to design a football ground, a beam or the sign of the Games etc. I always intend to connect this part of the activity with the mathematical one, so I ask pupils to use in their constructions for example rectangles or circles. (Teacher 2 interview)

According to T3's view familiarization of students with the internet is realized through specific educational activities and does not present an aim per se. From this point of view internet use had the dual purpose: firstly it formed a resource of material additional to the school book; secondly it provoked rich pupil communication. One of T3's lessons in the lab focused on environmental problems. At the beginning teacher discussed the problem with the students sitting in a circle-like configuration. Then pupils were encouraged to visit some suggested sites so as to select information on different subtopics. When the selection of information was completed T3 gave priority to the organization of the data in word files (i.e. copy and paste extracts, photos etc.) T3 insisted that the product of that process is a body of knowledge that is expanded to the whole class. As he explained in his interview:

Let's have as an example The Constantinopolis Conquest. We started the lesson in the traditional classroom. Then we went to the lab where each group of children had to select information on different subtopics (i.e. The first ten days, How the town was that period of time etc.). We printed all the files out and a body of additional information was created. This thing was given out in the classroom. The knowledge was expanding. (Teacher 3 interview)

CD-Rom use

The use of CD Rom in the classroom was integrated after the establishment of the new computer lab. Observational data reveals that the CD-Rom based activities took place through a whole-class teaching approach without distinct differences between teachers. In fact, the main part of the activities was devoted to the presentation of the included CD topics in a narrative way. The mode of communication with students has been characterized by teachers' interventions in groups so as to overcome difficulties with the CD use. The above can be explained if we take into consideration two parameters: a) the observed lessons were introductory to the use of CD-Rom in the classroom, b) many of the teachers weren't familiar with CD-Rom use, so these lessons were introductory for the teachers too. It is noticeable that the more one teacher was not familiar with CD use the more instructive his/her teaching approach was. However, more detailed data needs to be selected if we intend to reach some more general conclusions on CD-Rom based activities and the roles shaped by the participants.

4. Main hypotheses

Hypothesis 1

As revealed from the data, the use of ICT in the school presents an educational innovation in the sense that it aims not only to help students cultivate ICT skills but also to encourage new learning environments for teachers and students. Although group-work and collaborative teaching practices do not constitute general characteristic of the school it is reported that group-work within the lab was a requisite for some of the engaged teachers to try innovative approaches in their traditional classroom (i.e. separation in teams, discussion, investigation etc.) In this context they consider that new technology did function as catalyst so as to focus on elements of the teaching and learning process such as the experimentation, the active participation of children in making a decision as well as the academic improvement of low ability students.

However, in some cases technology was mainly perceived as an additional resource. For example, less experienced schoolteachers with little educational training seemed to use ICT tools (i.e. educational programs taken from the web) as active textbooks that can enrich the existing teaching material. This category of teachers accent in the use of computer as means of more attractive presentation of the lesson. New challenges and domains of research emerged if trying to have a clearer picture of the interrelations between ICT use and educational innovation. Some implications are made below in the discussion of hypothesis 2.

Hypothesis 2

As presented in section 2 the introduction of ICT use in the school was a result of the school's participation to a project. A catalyst in this procedure was the co-operation with the university research team that took the responsibility for the teachers' training on using exploratory software in the classroom. At the beginning school administrators seemed to receive ICT implementation most as an important administrative task for which they need detailed instructions rather than an innovation itself. However, more information is needed to investigate the interrelations between the research teams' and schools' intentions, as well as the way these influenced the shaping of the project. Turning to the way ICT use was adopted by the teachers, data revealed that there were no resisters in the school. Even the teachers who were not engaged in the project believed in the major importance of ICT skills for the future. Moreover, the computer introduction seemed to be an initiative that could form an indication of the school's high quality level among all the other local schools.

As far as the characteristics of the ICT diffusion are concerned we can distinguish the following points:

a) Experience and training are factors that influence the diffusion. This is mirrored to the group of teachers engaged. Some of the new teachers who work in the school only for one year probably have taken only contemporary training on computer use since the educational foci is not always part of the provided training in Odysseas project. On the other hand teachers who participated to YDEES, a project of much smaller scale, appeared to have more training experience on the educational use of exploratory software in the classroom. b) It is noticeable that -except a number of three or four teachers - the majority of all the other old teachers ones keeps regularly distances from anything related to ICT use. School policy is mainly focused on the new teachers

but more data is needed to have a clear view if that was a result of or one reason for the explanation of the current situation. The group of teachers who left the initial project after the first year made points on lack of time. However, it is a research issue to explore in depth teachers attitudes towards their engagement in ICT use. c) As far as the teaching practice is concerned old teachers were closer to group-work approaches while new teachers viewed computer as an attractive medium complementary to the whole-class teaching in the everyday classroom. However, when in the lessons included internet or cd-rom use teaching practices reminded of a teacher presentation to the classroom, which maybe owed to the introductory nature of the specific tools both for teachers and students. However, some of the old teachers appeared more flexible to integrate the use of internet or cd-roms in an interdisciplinary framework.

Hypothesis 3

As mentioned in section 3 the presence of the technical specialist in the lab during the lesson ensures unobstructed implementation of the computer-based activities. This seems to have functioned encouraging for the engagement of new teachers with ICT use. Moreover, problems on technical issues were not reported since the equipment is newly installed. However, the innovative uses of ICT such as collaborative learning and use of real time data do not appear as a result of the provided support. Some of the teachers used to organise their lesson following whole-class practices. It s a case of study the relation between the pedagogic support of these teachers and the challenge to reflect upon their practices since their training experience is inadequate and mainly related to the informatics.

5. Projection to the future

As mentioned in the section 2 in school B there has been a core group of three more experienced teachers with one of them having the responsibility for the general use of ICT in the school and the training of the new teachers. This group is completed every year by the new teachers who do not have a permanent position in the school. This year four new teachers participated in the project. Though the majority of the most experienced old teachers are not engaged in ICT use the integration of ICT within other curriculum subjects in the context of Odysseas project. The headmaster as well as the head teacher 1 seemed to adress mainly to new teachers and encourage them to organize activities related to a variety of subjects. This tendency appears more imperative since in the next year these two key persons would retire and two other teachers from the core team will remove to their permanent position in another school. The next face of the ICT use in school B is concerned with the new teachers who will replace the most experienced members of the core team.

An encouraging point for the future is that teacher 1 is planning to continue her engagement in ICT from another position (i.e. as a member of a local council for the introduction and extension of ICT to schools in the region). This year she was selected from the ministry of education to attend a special training seminar at the university of Athens for such educators. However, she confirmed her intention to find ways to continue teacher training in the school for the next years. Her planning for ICT use in the school for the next year is concentrated on the more systematic use of communication technology in the classroom. As far as the expansion to other schools is concerned the indications showed that teachers who were involved in ICT use and remove to another school tried to continue or to start sometimes without much support by the school community- the integration of ICT in the curriculum.

APPENDIX A

Consistent with the methodology described in the Workbook for Organisational Case Studies (OECD/CERI) a short-term explanatory case study has taken place in the school in order to compile a corpus of information that would allow a rich description of the ICT integration within the site. The data collection was completed in a three day visit of two researchers of the four who participate in the ICT team of the Center For Educational Research. Classroom observations were conducted in the school as well as interviews with the staff. The purpose of classroom observations was: (a) to validate how ICT is used in the lessons and (b) to gather evidence for how lessons are taught. The overall time of observation was 12 sessions of 45 minutes. The scheduling of the observations in school B shown at the Table 1 - was arranged in collaboration with the head master nearly

three weeks before the visit.

Teacher	Subject	Grade	Number of observations	ICT use
T1	Investigation	4b	1	Turtleworld
T1	History	4a	1	CD-Rom
T1	Investigation	6	2	Turtleworld
T2	Investigation	5a	1	Internet
T2	Investigation	5a	2	Turtleworld
T3	Environment	4b	1	Internet
T3	Human body	5b	1	CD-Rom
T3	History	6	1	CD-Rom
T5	English	6	1	Educational program (Internet)
T6	Music	5b	1	Internet

Table 1: Classroom observation plan

For the observational data collection one video-camera was used - occasionally moving to capture instances of the classroom atmosphere. Concurrently with the video-recordings, observation notes have been taken describing the overall classroom activity and focusing on potentially significant details and episodes in teacher practice, student groupwork and student communication. During our visits to the school 14 interviews were conducted: 1 with the head master, 4 with teachers (one not engaged in the ICT use), 4 with students, 4 with parents and 1 with the technical support specialist. The average time of each interview is shown at the Table 2.

Interviewee	Time (min.)
Head master	60
Teachers	50
Parents	40
Students	30
Technical specialist	45

Table 2: Average interview time

Background data was also collected (i.e. students written presentations of their work) that served as complementary information to the video-recordings and observation notes, which formed the main corpus of our observational data. Verbatim transcriptions of all interviews were made.

APPENDIX B

Table 1. Familiarisation of teachers with computer applications

How comfortable are you with using a computer to do each of the following?	Very comfortable	Comfortable	Somewhat comfortable	Not at all comfortable
1. write a paper	3	7	4	3
1. search for information on the World Wide Web (WWW)	3	4	4	6
1. create and maintain web pages	0	1	5	11
1. use a data base	2	1	5	9
1. develop a data base	1	1	5	10
1. send and receive an e-mail	4	2	2	9
1. write a program	1	1	3	12
1. draw a picture or a diagram	3	3	5	5
1. present information (e.g. use Power Point or equivalent)	1	1	6	9

Table 2. Importance of computer-related skills for teaching

How important is each of the following computer-related skills for your teaching?	Very important	Important	So-so	Not important at all	No answer
1. write a paper with a word processor	6	8	1	2	
1. search for information on the WWW	9	4	1	3	
1. create web pages	6	7	1	3	
1. use a data base	6	8	0	3	
1. develop a data base	6	6	1	3	1
1. send and receive an e-mail	7	5	2	3	
1. write a program	5	6	2	4	
1. draw a picture or a diagram	7	7	1	2	
1. present information (e.g. use Power Point or equivalent)	7	5	1	3	1

Table 3. Frequency of use of computer applications

During the past school year, how often did your students on average do the following for the work you assigned?	Several times each week	Several times each month	A few times a year	Never	No answer
1. use the World Wide Web	0	6	2	8	1
1. create web pages		0	2	13	2
1. send and receive an e-mail	0	2	2	12	1
1. use a word processing program	0	1	2	10	1
1. use a computer to play games	6	0	4	12	1
1. use a spreadsheet	0	0	4	12	1
1. use a graphics program	0	1	4	11	1
1. join in an on-line forum or chat room	0	0	1	15	1
1. use a presentation program (e.g. Power Point)	0	0	1	14	2
1. use an instructional program (including simulations)	0	0	1	15	1
1. other computer uses (specify)	0	1	2	11	3

Table 4. Teachers ability to use computers

	Good	Fair	Poor
30. How would you rate your ability to use a computer	12	5	0

Table 5a. Experiences and policies concerning ICT use

Answer questions 31-38 based on experiences or policies from the last school year	Yes	No	No answer
31. Was student computer use ever evaluated for grading?	1	15	1
33. Did you create or modify a Web site with any of the classes that you taught?	2	14	1
37. Did you participate as a student or instructor in a virtual course through the Internet/WWW?	1	16	

38. Did you involve your students in collaborative learning over the Internet/WWW with students from other classes?	5	12	
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Table 5b. Experiences and policies concerning ICT use (continued)

Answer questions 31-38 based on experiences or policies from the last school year	No restrictions	Some restrictions	Designated sites only	No answer
32. If you assigned WWW searching, how much freedom did you allow students in locating sites to visit?	4	4	6	3

Table 5c. Experiences and policies concerning ICT use (continued)

Answer questions 31-38 based on experiences or policies from the last school year	All	Most	Some	Very little	No answer
34. What portion of the computer use in your classes was directly related to the course content?	1	1	7	6	2
35. What portion of the computer use that you assigned was done by students individually?	1	2	6	5	3

Table 5d. Experiences and policies concerning ICT use (continued)

Answer questions 31-38 based on experiences or policies from the last school year	Almost every day	Several times a week	Several times a month	A few times a year	Never	No computer
36. If you have a computer at home, how often did you use it for preparing for teaching ?	1	2	1	2	3	8

Table 6a. Computer use for communication

	Yes	No
39. Are you currently using technology to collaborate with other teachers?	0	17

**Table 6b. Computer use for communication
(continued)**

	More than 12	6-11	1-5	None
40. How many e-mail messages do you send each week on average?	0	2	3	12

Table 7. Advanced uses of computer

How many of the following have you ever done?	Yes	No	No answer
41. make changes to a computer s hardware	1	14	2
42. updated an application program (word processor, graphics program, etc.)	1	14	2
43. recovered a damaged file	0	15	2
44. created a web site	0	15	2
45. developed a data base	3	11	3

[1] *YDEES: Development of Popular Computational Tools for General Education: The Computer as Medium for Investigation, Expression and Communication for All in the School, YDEES #726, E.P.E.T. II, General Secretariat for Research and Technology, 1995-1998.*

[2] This piece of software - called Turtleworlds - is built with e-Slate (<http://e-slate.cti.gr/>). E-Slate is a system for authoring exploratory software which consists of a desktop environment and a set of software components. These can be connected in creative ways to make microworld environments which are a combination of Logo³ like symbolic expression software and dynamic manipulation software for geometry.

[4] The Information Technology subject is offered - under the authority of the Ministry of Education - only to greek secondary schools.

[5] The teachers who work as deputy in a school only for one year or less.

[6] Intercultural Microworld courseware for Exploratory Learning (I.M.E.L.), European Commission, Socrates, Open and Distance Learning, 1996-1998.

[7] Investigations with Tools for learning Fractions and Ratio , Schools for Experimental Implementation of Educational Programs, Pedagogical Institute, EPEAEK, Ministry of Education, 1998-1999.

