DISTANCE LEARNING IN MATHEMATICS EDUCATION BETWEEN TWO PRIMARY SCHOOLS IN CYPRUS

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ABSTRACT
During the school year 2001-2002, the Department of Computer Science of the University of Cyprus, in cooperation with the Department of Education, the Ministry of Education and Culture and the Bank of Cyprus, implemented a distance-learning project on mathematics between two primary schools in Cyprus. Our attention will focus on the development of a hybrid-learning environment, through the use of synchronous communications applications (teleconferencing) and asynchronous educational software (Geometer's Sketchpad). The objective of this paper is to present the methodology for the introduction of synchronous and asynchronous applications into primary school environment, and the promotion of the new role of teachers in the new learning environment.

KEYWORDS
Distance learning, mathematics, education

INTRODUCTION

The introduction of new educational technologies in elementary schools constitutes a decisive factor for the preparation of tomorrow's citizens, who will be called upon to answer the challenges of the new emerging information society.

Information Society will be the new economic and social model in the beginning of 21st century (Anastasiades, 2000a). One of the most important priorities of the developed counties throughout the world is to help their citizens come up to the needs of the new digital era. As part of this endeavour, the role of our educational system is of utmost importance.

The preparation of tomorrow's citizens is incumbent on the elementary schools, which ought to include the new technological applications in the educational process. The integration of new technologies in the sensitive area of a school classroom is not an easy task (Papert, 1997). The use of computers and educational multimedia, the establishment of network infrastructures and the provision of videoconference systems ensure the technological aspect of this endeavour (Harley, 2001). The technological tools and applications is the first step in the transition from the current, conventional educational system, to the new model of the virtual classroom (Norton, 2001) and the hybrid school environment (Rosbottom, 2001). At the same time, it is necessary to develop a pedagogic model, which will constitute the necessary theoretical basis and will mark out the framework where the new educational technologies will be contained.

As part of this framework, the Ministry of Education and Culture of Cyprus and the Department of Computer Science of the University of Cyprus, with the sponsoring of the Bank of Cyprus, implement the first pilot program on distance learning via teleconferencing, called "ODYSSEUS", in two elementary schools of Cyprus.

The main objective of our project was the establishment of a hybrid- learning environment between the students and the teachers of the two schools, through the use of synchronous communication tools. The added value of teleconferencing in the preparation of a science fair emerges from the increased access to new forms of communication and to metacognitive reflection procedures as well as from the capability to cross reference the experimental measurements by distributing them across students at two different sites.

TEACHING MATHEMATICS THROUGH COLLABORATION AT A DISTANCE

Objective of the program

Knowledge towards the Information Society is recognized as the most important productive factor in modern times. Our educational systems seek to measure up to the new reality by modernizing infrastructures, training human resources, testing new teaching methods and ways of evaluation. The new Information and Communications Technologies make possible the development of a totally different educational environment, by means of the "Educational Technologies", as they are called. The process of Open and Distance Learning, the use of educational multimedia and virtual learning environments on the Web bring on the conditions for the development of an open - life long based - learning system. The introduction of the new educational technologies in the primary schools is often restricted to the learning of basic computer applications and the use of a limited number of educational multimedia. The development of a hybrid-learning environment requires a convergence of the conventional and the virtual model of education. The realization of such an environment under the real circumstances of a primary school is a very perplexing matter.

ODYSSEUS program is the pivot of a collective endeavour, with the participation of the Ministry of Education of Cyprus and the Department of Computer Science, University of Cyprus. The students and teachers of the two elementary schools that participated in the program were the main component parts of an open learning environment. In this paper we will address three main issues: a) the development of a comprehensive teaching methodology of mathematics, that will be useful as a prototype model for the introduction of distance learning synchronous communication courses at the primary education level

Targets of the program

The main target of this pilot endeavour is to familiarize students with a step-by-step hybrid-learning environment. By "hybrid" we mean a learning environment where an optimal combination of the new educational technologies and traditional pedagogic methodologies is attempted (Anastasiades, 2002). The methodology applied will enable the students be active components of an interactive learning strategy plan.

The technological background of the two schools in the program

The two elementary schools, chosen to participate in this program, were Agia Fyla School in Limassol and Zinon Primary School of Larnaka. The children in both of these classes were acquainted with teleconference, through a different educational program, named "OIKADE – Electronic Journeys to mother country". OIKADE is an ambitious program aiming to bring closer Greek students from various places in the world, through the most advanced use of telecommunication and information technology.(www.oikade.gr).

The technological equipment from "OIKADE" was used in the new program. Specifically, this equipment included three ISDN lines, one internet connection line, a TV, a teleconference camera, a VCR, one Personal Computer and a telephone for each participating schools. Technical support was provided by technicians who were in deal with the Bank of Cyprus in order to offer their services to the program whenever it was necessary.

METHODOLOGY

In the last thirty years various discussions have been taken place and many theories have been developed related to the pedagogical model of distance-learning, which is considered substantially different from the traditional model of teaching. For instance, we refer to the methodology of independent studies (Wedmeyer, 1977), the idea of autonomous learning (Moore, 1972, 1994) and the theory of interactive learning (Holmberg, 1989). Although the importance of these concepts cannot be denied, a comparative analysis reveals their inadequacy to be considered a fully integrated pedagogical model (Keegan, 1993).

In recent years, distance learning becomes more decentralized and more student centered and often is being offered in conjunction with traditional academic studies. Furthermore the traditional education utilizes in an ascending mode new educational technologies. As a result, traditional education and distance learning converge with the pass of time (Picciano, 2001, pp. 67, Keegan, 1996). We have to mention that the medium is not the message, and that the substance or content is most important in learning (Clark, 1983). In line with this trend, it can be inferred that there is a need for a pedagogical model supporting this convergence

The adoption of Clark's suggestion reveals a special view of the concept of hybridic educational setting. The transition from the dominant model of the traditional classroom to the new hybridic educational setting is not as simple as it might seem, because there seem to be a lot of new factors, which may possibly encumber the process of enrichment and change of the existing conditions (Anastasiades, 2002). The phases of effectuation are build in a great extend to the acceptance of the model of American Distance Education Consortium (ADEC, 1996).

Designing
The levels of implementation of the designing of the program can be distinguished chronologically into the following:
Part A: Preparation period – actions design.
Part B: Implementation of actions.
Part C: Designing of an informative prospectus.
Part D: Development of audiovisual material.
Part E: Webpage design.

In this suggestion we will refer as analytically as we can to part A
Part A: Preparation period – actions design

A1: Development of the team: The project team constitutes of the following sub teams:
Project design and implementation team: This team has to propose the teaching methodology, the project time management and deliver the acts. (Mr. Anastasiades P - Scientific coordinator of the project - Costas Hambiaouris, Elena Papadopoulou, Soteris Georgiou, Kallistheni Papachristou, participating teachers of the project.

Exploratory team: According to the agreement that was signed by the implementation parties of "ODYSSEAS", an exploratory team is developed and contributes to the scientific ground of the introduction of new teaching levels and cognitive materials. Part of this team is Mr. Christou C, Associate Professor at the Department of Education of the University of Cyprus.

Observation team: The task of this team is to concentrate on the observation of the actions of the implementation sector having the supervision of the general design. The members of this team participate with their current authority and duties: Minister of Education, Director of Primary Education Department, School Inspectors, School Principles, President of IT Department at the University of Cyprus, Bank of Cyprus.

Project supporting team: It is made out of four students from the Primary Education Department of the University of Cyprus as a part of a project for the course "Introduction to the IT Science". These are Tofarou S, Andreou I, Demetriou S and Agapiou N.
A2 Actions Design – Development of the timetables
At this stage the actions are design and become a part of an agreed timetable.
A3: Decided teaching methodology.
A3.1: Choice of introductory model of the long distance teaching.
The student will come in touch with the new teaching model step by step, in order to be paced with as easy as possible to the new teaching environment. This well be accomplish with the implementation of the three faces meaning teleteaching, virtual class and teleconferencing. (Anastasiades, 2002a)
A3.2: Choice of methodology for the participating audience.
In order for all the participating kids selected to take place in the propose setting, a discriminatory methodology of the audience it immerges dividing it into active and passive. The active audience constitutes of eight (8) students sitting at a parallel shape with the teacher on top with the board. The active audience students switch along the way of the teaching cycle, in order to gain the experience of the pilot program. With this all the kids are part of the process.

STAGES OF PROJECT IMPLEMENTATION

General features
Teaching Unity: Circle (Math 6th Grade – Student Book, part C, unit 6, pp 68-73)
Class: Grade 6th
Means – Materials: Computers, educational software, teleconference system, calculator, whiteboard, means with circles, school manual, work paper, paper, eraser, color pencils, ruler, compass, geometric organs, circular objects, string.
Educational software: "The Geometer's Sketchpad"

Lessons' description
Lesson 1
Subject: Basic Geometrical Concepts (point, line, circle) – Teleteaching
(The lesson took place 13.3.2002 and was taught by Mr. Costas Hambiaouris)

The educational objectives of the first lesson aimed to introduce students to educational multimedia and the use of the tools of the educational software "The Geometer's Sketchpad". Furthermore, the objective of the first lesson was the comprehension of the geometrical concepts point, line, circle and the measurements of the lines.

The teaching model that followed the lesson was teleteaching which was presented by Mr. Costas Hambiaouris at the 19th school of Ayia Phyla. Children from the Elementary School "Zinon" in Larnaka, observed the lesson through the teleconference system. At the beginning there was a general briefing to the children about the programme 'Odysseas 2002" and how they had to work. Then followed a first introduction and acquaintance among the participating children and teachers.

Then the teacher, addressing to both group of students, referred on the concepts: point, line and circle and presented the educational software "The Geometer's Sketchpad".

Consequently, the teacher addressing the students of the acting audience, urged them to get comfortable with the tools of the software through different activities. The students, in couples, created and named points, circles and their centers, lines and their outermost points. Moreover, they learnt how to measure lines ad how to create lines with specific measurements. The students in the passive audience were encouraged to do the same activities with pen and pencil on the prepared work paper. The teleconferencing lasted for about 25 minutes. After the teleteaching was interrupted, the educational activities continued with the energetic audience changing places with the passive audience. Thus all children had the opportunity to work on the computers and the educational software "The Geometer's

Sketchpad", learning to use the basic tools of the programme and the basic geometrical concepts: points, line, circle.

Lesson 2
Subject: The elements of a circle (centre, circumference, radius, diameter) and the relationship between radius and diameter –Virtual class. (The lesson held on 20/3/2002 by Kallistheni Papachristou and Elena Papadopoulou)

The aims of the second lesson were the students to understand the meaning of circumference, radius, and diameter in order to create a circle. They had to place the above elements on it and discover their relationship. In addition, with the use of Geometer's Sketchpad, computer software, the students had to acknowledge that all radius of a circle and their diameters have the same length and that the circle has infinite radius and diameters.

The virtual class was the teaching model that was followed for the lesson 2. The students of the active class worked on computers, and the students of the passive class on a special prescheduled worksheet. Then, classes took turn in order to perform all activities both with computer and paper. This was happening on every lesson.

At the beginning, the teacher from Larnaca introduced to both classes the meanings of the circumference and radius. Then the teacher encouraged the students to make their own circle and name the centre. Also, the students coloured the circumference, in order to understand the meaning of it and made three segments from the centre to circumference (i.e. radius). In addition, they measured the radius they had made and found that all of them were equal. Furthermore, the students who worked with computers enlarged the circle and they ascertained that the length of the radius was increasing but the relation between them was the same. They performed also the opposite, decreased the circle, but still the radius remain equal. Finally, students concluded that the radius were always equal.

The lesson continued by the teacher from Limassol with similar activities. The students were guided to understand that the diameters of a circle are the segments that start and end on the circumference of the circle by passing from the circle's centre, and concluded that all diameters are equal. Then with the use of a computer and the guidance of the teacher, the students saw the radius and the diameter of the circle to rotate round the centre and ascertain that the circle has infinite radius and diameters.

Later on the lesson, the students made a circle, named the circle "o", draw a radius and a diameter and measured their lengths. Then, they compared the length of the radius with the length of the diameter and they found out that diameter is twice the length of the radius. Further, the students moved the centre o and increased or decreased the circle and noticed that by increasing or decreasing the radius as well as the diameter their relation was stable i.e. always the length of the diameter was twice the length of the radius. By performing those, they have concluded and observed the relation of the radius and the diameter by their owns. Finally the passive class change place with active class and activities were repeated.

Lesson 3
Subject: The construction of a circle when given the radius or the diameter- A Virtual Class
(The lesson took place on March 27th 2002 and was taught by Mr. Soteris Georgiou.)

The main objective of this third lesson was to enable students to construct circles in different ways, when given the length of the radius or the diameter of the circle. A secondary objective was to help students identify the relations between two or more circles, according to their position to each other (concentric, tangent, intersecting circles), as well as to name and construct these circles. Furthermore, another aim of this lesson was to train students in using the knowledge and skills acquired from the teaching unit "The circle" to solve various problems and exercises.

The teaching model applied in the third lesson was that of the Virtual Classroom. At the beginning of the lesson, the teacher from Larnaca, asked the children of both classes to construct circles, to draw the radius and the diameter of their circles and then to measure them. In this way, children revisited the concepts of the radius and the diameter, that had been taught in the previous lesson.

Subsequently, the teacher asked the children to consider how they would construct a circle given the radius. He then provided them with the length of the radius and asked them to construct a circle that featured this radius using the knowledge they had acquired until then. Children worked in pairs, explored the problem and tried to find a solution. Finally, they announced the results of their attempts.

Children discovered two of the three ways to construct a circle given the radius. A group of them drew a segment, adjusted it to the length of the given radius and then constructed a circle- using a circle tool on the computer - by keeping the one point of the segment as the center of the circle and then by enlarging the circle so that its radius was equal to the segment they had drawn. This was the first way.

Another group constructed a circle- (using the same circle tool on the computer)- and then instructed the computer to measure its radius. Finally, they enlarged or reduced the circle so that the length of its radius agreed with the length given to them by the teacher.

After announcement and discussion of these ways , the teacher asked students to construct a circle with a specific diameter by using the first way and then to construct another circle of a specific radius by using the second way. In the first case, children used the relationship between diameter and radius (diameter=2 Radius), in order to find the radius.

Next, the teacher showed the students another way to construct circles given the radius. After drawing a segment equal to the given radius, the students selected one of its ends as the control point and gave instructions to the computer to construct a circle by keeping the selected point as the center and the selected segment as a radius. In addition, for motivational purposes, children learned how to color the area of the circle they constructed.

Next, the teacher helped the students to distinguish the relationship between two or more circles, according to their position, by using visual aids, that is, concentric, tangent, intersecting circles, and to move circles constructed on the computer, in order to make them concentric, then tangent and finally intersecting circles. So, the students discovered the relationships among the concentric, tangent and intersecting circles and constructed them.

In the last activity, the teacher asked the children to solve various problems-exercises, applying their acquired knowledge. More specifically, he asked them to construct concentric circles with specific radius, tangent circles with specific diameter and the intersecting circles of the symbol of Olympic Games, coloring them appropriately. Students worked with a lot of interest and solved successfully those exercises.

Then, the active and passive audience exchanged roles and repeated the activities, both with the worksheets and on the computer.

Lesson 4
Subject: Circle circumference – Number "π" – Virtual Class
(The lesson took place on the 3rd of April 2002 by Mr.Costas Chambiaouris)

The objectives of the fourth lesson were for the pupils to discover number "π" through investigation, after they observed the quotient of the circumference to the diameter, in various examples, to calculate the length of a circle circumference when the radius or diameter is known and to solve relevant problems.

The instructive model followed in this fourth lesson was the Virtual Class Model like in the previous two lessons.

In the beginning of the fourth lesson, the teacher from Limassol referred to the children of both classes, Larnaka and Limassol, and made a short revision of all points brought up previously. He especially mentioned the measurement of a segment, a radius and a diameter of a circle.
He then asked the children to investigate and discover the relationship between the circumference and the diameter of a circle, using the potential of "The Geometer's Sketchpad", that is an educational software, and other compatible means. In order to help them in their investigation, he gave the children working as an active audience a work sheet with the instructions and commands they should give the computer, while the children of the passive audience followed the instructions of their book.

The children of the active audience, that worked on the computers, followed the next procedure: First, they constructed a circle and measured its circumference by giving the right command to the computer. After that, they constructed the diameter and measured it with the correct command. Then, they found they quotient of the circumference to the diameter using the computer's calculator and they set the three values in a table on their screen.

The children of the passive audience, following their book's instructions, used circular objects and measured their circumference with a piece of thread and their diameter with the ruler. They next completed a table with the values found. Afterwards, they used their calculator to find the quotient of the circumference to the diameter and they also inserted it in the table.

After the investigation there was discussion and announcement of their observations in front of the whole class. The children intimated that, although the groups working on the computers constructed circles with different circumference and diameter and the groups of the passive audience measured the circumference and diameter of different circular objects, they all came to a quotient equal to 3,14 when divided the circumference with the diameter.

At this point, the children compared the ease provided by the computer in measuring the circumference and the diameter to the compatible means - thread and ruler – and raised accuracy in the calculations, since the children working on the computers found quotient 3,14 while the others found values close to 3,14.

To continue, the children of the passive audience kept on dealing with some more circular objects writing down their calculations whereas the children of the active audience changed the size of the circle – enlarging and diminishing it – and completed the new values on the table. It was a common outcome that, the quotient of the circumference to the diameter remained 3,14.

The teacher then mentioned "π", its history and a number of researches carried out about it. After discussing and expressing thoughts, the children came up with the formula for calculating the circle circumference, if the radius or diameter is given (Circumference = diameter$\cdot\pi$ or Circumference = 2$\cdot$radius$\cdot\pi$). In order to penetrate, there were some more problems about calculating the circumference, the diameter or the radius of a circle. At the end, the children worked individually with similar problems in their book.

Finally, there was alternation of the active and passive audience and repetition of the same activities.

Lesson 5
Subject: Problem solving based on the relationship between the circumference and the diameter or radius of a circle – Telecooperation
(All the participant teachers in "Odysseas 2002" carried out the lesson).

The objective of the 5th lesson was for the children to use the knowledge acquired in the previous lessons cooperatively and supportively. Another aim was also to calculate the radius or the diameter when the circumference is given or vice versa.

The instructive model of telecooperation was applied in this 5th lesson. The active audience was divided into two parts. The 1st active audience consisted of two children from each school, who cooperated with each other through videoconference, having a common aim, solve a given problem using the computers. At the same time, the rest of the children, consisting the 2nd active audience, worked in pairs to solve the problem and reinforced the efforts of the 1st active audience like the passive audience did, who worked with work sheets.

In the beginning of the 5th lesson, there was a short revision of everything taught about the circle in the previous lessons. The points mentioned were: constructing a circle (center, radius, diameter, circumference), measuring the radius, the diameter, the circumference, "π", the relationship between radius and diameter and the relationship between radius or diameter and circumference.

Then a problem was given asking the students to construct on computer a figure with tangent and intersect circles. The children only knew the circumference of the largest circle from which they could found the length of the radius of the largest circle as well as the length of the radius of the smaller circles. In addition, the problem was asking to compare the length of the radius and diameter of the small circle with the length of the radius and diameter of the large circle. Finally, they were asked to write their observations.

The students worked in groups creatively, as mentioned above, using the potentials of the educational software "Geometer's Sketchpad" or other compatible means (paper, pencil, ruler, compass, and calculator). They constructed the figure at original dimensions, by corporation and wrote their observations.

Then, the first active group announced the way they worked and their observations and finally they displayed their figure. The second active group did the same as well as the passive group. A discussion for the way they worked and their observations followed.

Upon completion of the fifth and final lesson, the students and teachers wished goodbye, fully satisfied of their corporation and the results of the program "Odysseas 2002".

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