Distance Education: Models and Application: Synchronous, Asynchronous and Virtual Reality

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Abstract

Small and multigrade schools in the Aegean Sea have many particularities and face a lot of problems. In the Departments of Education of the University of the Aegean a strong belief is formed according to which distance education and other applications of Information and Communication Technology (ICT) can provide solutions to many of these problems. Within this context, various models are designed, developed and applied in school environment and experimental data is collected. The parameters - mainly pedagogical, technical and organisational- that influence students' cognitive outcomes are examined.

This work investigates two models that are expected to meet the teaching needs of small and multigrade schools in the light of the experience acquired during multiple experimentation periods (sessions). The first model that concerns the application of synchronous methods relies on the use of teleconference, including data transfer and the shared use of applications. For the second model, the use of web pages is selected for the application of asynchronous teaching methods. During its implementation, proper guidance of pupils is needed, but chances for initiatives are open and are encouraged. Comparisons are made between these two and also against traditional teaching approaches and the results of experiments from both distance education methods are discussed. It is worth noticing that the results are promising. Promising is also the fact that there are prospects for improvements in any teaching methodology by means of ICT.

In an attempt to present such prospects for improvements, the last part of this work is devoted in proposing a third model, which involves the use of Virtual Reality. The paper examines the advantages of such an approach and discusses issues concerning its implementation.

1. Introduction

In Greece, small, multigrade and single-teacher schools are an unavoidable necessity. The reason may be directly found in the big number of low-inhabited, difficult-to-approach and isolated villages in mountainous regions or in the small islands of the Aegean Archipelago in connection with the goal "education for all". This combination of geographical conditions and educational policy targets creates the need for the existence and operation of schools in areas with a very small number of students and under conditions that form a far-from-ideal educational environment. Sustaining a large number of small and multigrade schools is a difficult task. On one hand, the necessary economic means must be available to keep schools fully equipped and in an acceptable operational condition. On the other hand, adaptations must take place in the school curriculum; to fit in the way teaching is conducted in multigrade schools. Under such circumstances, it is difficult to consider as unjustified the belief that educational quality in such schools is inferior, compared to the quality of education in the rest of the schools [1] [2].

A partial solution to the problem could be to merge neighboring schools. But mergence is not always possible: It may not be easy in mountainous areas of the mainland and it is not an option at all, in cases of small islands in the Aegean Sea where there is just one school on an island (Table 1) which should be kept operating at any expense, while constant and multidimensional support must be provided to assist teachers in their everyday duties. This is the field where the Department of Education of the Aegean University plays a vital role. The university is located at the same region, with departments in five islands and has an advanced network infrastructure. By mobilizing this infrastructure and with a number of interventions (projects, actions etc) we believe that we can provide practical and easy to use solutions to a range of problems in these schools.

	Schools	Schools with 6 or less teachers	%
Greece	5975	3990	67
Cyclades	88	69	78.4
Dodecanese	116	77	66.4
Aegean archipelago	204	146	71.6

Table1. Small schools in Greece

2. Problems of remote small and multigrade schools in the Aegean Sea

In general, small remote schools in the Aegean Sea, face problems that can be epitomized in three categories: infrastructure, didactic and socio-cultural. As far as infrastructure is concerned, problems are not so intense despite the fact that school buildings are quite old and renovation is scarce. With respect to equipment, the majority have a photocopy device, TV and video as well as some chemistry and physics instruments. More than half of the schools are equipped with computers and complementary equipment. The main problem is that the majority of teachers do not use them due to lack of knowledge [3]. Half of the schools are connected to the Internet and only a small fraction with ISDN lines.

There is a constant mobility of teachers. Harsh conditions and the limited incentives offered to them, leave no other choice to teachers than to apply for transfer to less remote schools. In many cases a new teacher is appointed for a class every year. This has a negative effect in the continuity of teaching and confuses students.

Geographic isolation is the cause of socio-cultural problems. The villages in which schools operate are isolated communities with little, if any, cultural activities. Students are not provided with the necessary means to maximise their socio-cultural development.

When it comes to multigrade and single-teacher schools, not only the above-mentioned problems are more intense, but also there are several additional problems equally important [4], making teaching in that kind of schools a difficult task. The approach adopted in general is that when the teacher teaches one grade, the rest of the pupils work by themselves or in groups. The most common instructional methods consist of peer teaching, with one or two of the best students acting as teaching assistants, cooperative learning and elements of self- learning. Working hours are extended and some of the breaks are skipped so that more teaching time is gained, though the truth is that in these cases, no matter the effort, the teacher spends less teaching time per grade, than in an ordinary school. Since the schoolbooks are the same as in any other school, there is a considerable work for the teacher who has to deal with different classes. The increased demands of the instructional duties, apply extreme pressure to teachers.

In multigrade schools, usually there is no headmaster but a teacher “acting as headmaster”, having the double role of manager and teacher. This means that besides teaching duties, multigrade schoolteachers have a great deal of administrative work.

The vast majority of teachers in that kind of schools are newly appointed or employed on a contract basis (not a permanent job). In such cases, they have very little experience, if any, and they are not trained for multigrade teaching. Studies for multigrade schools do not form part of the academic courses of nearly all Greek Universities and no specific in-service training is provided for multigrade

schoolteachers. Finally, in a single-teacher school, since there is no help from any colleague, the teacher has to face any arising problem alone.

3. Applying ICT

Taking into account the problems faced by small multigrade schools, the models that were designed and implemented at the University of the Aegean, are based on the assumption that Information and Communication Technology (ICT) and in particular the techniques and methodologies of Distance Education (DE) could improve educational quality, if adapted appropriately. All of the participating schools had some computer infrastructure (computer labs), were connected to Internet and their teachers and pupils had a basic background in ICT. Since both models were applied under the same conditions, relative comparisons are allowed concerning implementation and results.

The main targets underlying the design and implementation of these models were the following:

- Propagation of the use of computers in school and teachers' training in ICT. Active participation of teachers is assumed as being a key factor in any effort to apply distance education at schools. Acquaintance and familiarization with ICT helps teachers to appreciate the capabilities of ICT and thus to become active participants in experimental projects at first and regular users of computers in exercising their everyday teaching duties later.
- Simplification and standardization in designing and revising educational material. The attempt to use simple, cost effective tools, as well as standardised procedures and methods is considered very important.
- Continuous evaluation of the methods and appraisal of their advantages and disadvantages. Analysis of the results from the application of the methods contributes in identifying gaps, miscalculations and weaknesses. Efforts were concentrated in improving these methods.

The following matters were investigated:

- Technical issues: Inadequate infrastructure is considered a main obstacle for the materialization of distance education lessons. Equally significant obstacles are the limited financial means available in schools, the bureaucratic administrative structure, and mostly the lack of technological knowledge.
- Didactic issues concerning differentiations in the instructional process. Distance education requires a change in the attitudes and roles of teachers and pupils and this requirement is worth investigating.
- Organisational issues. The lack of technical resources against the demand for educational quality, create the need for innovative solutions. This leads to new ways of doing things in order to meet in a hierarchical order as many as possible requirements.
- Effects of ICT on local communities. The school is an important institution in a small community. Apart from its role in educating children, it is practically and potentially in a constant interaction with the society. For that matter, the ways by which ICT can help the community are also investigated.

4. Experiments with Synchronous Teaching Methods (STM)

Synchronous teaching methods (STM) relied on a wide use of videoconference. Experiments with SMT were made in three schools totalling a number of 85 pupils. Each videoconference experiment consisted of four hourly phases. In the first hour, teaching was conducted basically in a traditional way and the class teacher was helped in his/her job by the use of multimedia. In the second lesson the same teacher was teaching, but this time he/she used videoconference as a means for delivering the course. The third and fourth lessons were conducted by a distant teacher, not familiar to the students, using videoconference, while the class- teacher was present in the classroom acting as a tutor- facilitator. The reasons for following this scheme were: (a) to examine whether acquaintance with the person delivering a videoconference course is or is not a significant factor [5] and (b) to allow for comparisons between the different teaching methods.

The experimental lessons specifications were as follows.

- In every experiment the fifth grade was the target group.
- Lessons of Geography and History were taught.
- The material used at school for these courses, could be transformed from printed to electronic form rather easily; it could thus become suitable for videoconference at low effort, without differing substantially from that of the relevant school textbook. The most important transformation was the division of each section in smaller subsections. The texts and images remained the same and were presented in the same order, enriched with some, carefully selected, extra multimedia material (photographs, diagrams etc). Consequently, the students were taught the same lesson provided by the school- textbook in a different manner.
- The school's curriculum was not modified, and care was taken so as to keep the usual duration of each course in general.
- The time devoted to videoconference teaching in some cases inevitably exceeded that of a regular instructive hour, though by no more than five to ten minutes.
- There were no modifications of the usual teaching methodology, i.e. the division of time between homework assessment, delivery of the new course, oral comprehension questions and evaluation was kept the same.
- Local teachers functioned helped in many ways (organising the lesson in the first place, making sure of the good condition of the infrastructure, keeping order, explaining the procedures, etc)

With respect to the teaching approach that was followed and the role that the instructor had, it should be mentioned that it was a teacher-centred one, thus closer to traditional teaching methods. This means that the teacher directed the course of the lesson and regulated the degree of coverage of the content (usually taking into account the class's average). The reasons underlying this approach towards cognitive material and didactic methodology were: (a) To keep a videoconference lesson as close as possible to that of a common and widely accepted form of teaching and (b) to eliminate as far as possible the (expected) students' enthusiasm for the medium and the new way of teaching, which could influence the results [6].

Immediately after each lesson, students were given two questionnaires with the aim to examine the quality and effectiveness of videoconference courses. The first questionnaire included formulated questions about the technical completeness of the courses (quality of sound and picture, speed, size of pictures, etc). The technical factors that influence the effectiveness of the course were located in this way, according to the opinions of students. The second questionnaire was a part of the evaluation of the method's efficiency. In fact efficiency assessment was attempted in two phases. The first part consisted of oral comprehension questions from the remote teacher. Questions and answers appeared in the slide presentation program. The written test (i.e. the second questionnaire) was in a form familiar to students (corresponding figures, completion of spaces, multiple choice etc). The written tests were collected and corrected later by the remote teacher.

For the conduct of the experiments, in every case, the following hardware was used: A computer, a camera that was connected to the computer, a 55,6 Kbps modem and a simple telephone line or an ISDN line, a microphone and speakers and finally, in some schools a video projector with projection surface of 1,5 by 1,5 metres, in others a 25" television and in very small classrooms computer monitors. In the side of the remote schoolteacher, a similar system was used, without the video projector. There was an attempt not to use technology that its cost would be unbearable for the financial means of an average Greek primary school. Correspondingly, the programs used were very widespread, such as Windows, Netmeeting for the communication between the remote teacher and the students and for the transmission of picture and sound and PowerPoint as a slide presentation program.

It was known in advance that the connection speed would be a cause of problems. The highest connection speed with the use of 55.6 Kbps modems was not to exceed 33, 6 Kbps (in practice the connection speed oscillated between 22 and 30 Kbps). In case of the ISDN lines, the transmission speed was constantly 64 Kbps. For that matter, it was judged essential to make some adjustments for the reduction of volume of data along the following axes:

- Reduction of the size of picture files, with reduction of the colour depth and increase in the rate of compression.
- Reduction of the number of colours per transparency in PowerPoint.
- Avoidance of extensive use of multimedia elements (sounds, video and images). The designing team did not use very impressive multimedia features when presenting the educational material since this would result in delays in transmission and distract pupils' attention from the teaching material to the presentation medium
- Low use or total elimination of slides animations in the transparencies of PowerPoint.
- The remote teacher spoke slowly and clearly. She/He was asked not to make abrupt and fast movements.
- The settings of Netmeeting for the transmission of picture were set in favour of speed and at the expense of video quality (not meaning that quality was reduced in an obvious way).

At the same time, automatically, elements with regard to the quality of the telephone line, the speed of data, sound and picture transmission, were recorded from the program. This data was straightforwardly comparable with the data collected from the questionnaires of technical completeness of the courses and gave an objective and not a subjective impression for the quality of the electronic means and programs of videoconferencing.

In the second round of videoconference experiments, additional techniques were used in order to achieve better results.

(a) If available, a second telephone line was used for voice transmission.

(b) In order to further decrease the volume of transmitted information, some necessary files of the courses were sent with e-mail few days before the conduct of the corresponding courses. The schoolteachers had to install them in the hard disks of the computers of their schools. Hence, applications - namely PowerPoint- was running directly in these computers and the distribution and the shared use of application was from the side of the school and not from the side of the remote teacher. This had the following positive results:

- The transparencies were presented in students immediately, because they were in the hard disks of the schools' computers.
- The only information that was transmitted from the remote teacher, besides speech and video, was the command to change the transparencies.
- The remote teacher knew in advance that the delay of transmission was going to occur in her/his side. But she/he also knew beforehand the line of the slides and the structure of the lesson, so that it was possible to arrange the flow of course. The above did not become perceptible from the students.

Attention should be drawn to the fact that there was an ongoing effort to adapt to limitations of reality. This was achieved using the above-mentioned technical and methodological tricks, making a large number of tests and keeping always in mind that the quality of the didactic material and the flow of teaching had to be preserved at any cost.

5. Experiments with Asynchronous Teaching Methods (ATM)

The A.T.M. relied in the use of web pages and web forms. It was applied in three schools totalling a number of 55 pupils. Four lessons were taught. The first was a traditional lesson and the rest were DE lessons. Distance teaching was performed in the computers lab. It is essential to differentiate asynchronous teaching in elementary schools from those used for adult teaching. When it is addressed to adults, the attention is drawn more to contents than to the way of presentation, while when addressed to children presentation of the content is as important as the content itself [7], [8], [9]. Lack of knowledge and absence of basic skills in the use of computers, distraction of attention, reduced self-

control of pupils must be taken into consideration. In contrast to these characteristics some of the pupils "assets", such as their strong memory, enthusiasm and playful attitude, should be taken into account as well.

The specifications of the experimental lessons were as follows.

- In every experiment the fifth grade was the target group.
- Lessons of Geography were taught.
- Teaching material had minor differences from that of school's textbook. The most important difference was that in certain subsections there were key-words that led to further explanations of the underlying term -either by text, picture or both. Again, cognitive material was enriched with some, carefully selected, extra multimedia material. The total amount of text was reduced by leaving out portions that had no didactical significance, allowing students with reading difficulties to easily follow the pace of the rest of the class. Apparently in A.T.M. as in S.T.M. students were taught the same school lesson in a different manner.
- Ergonomics, functionality and user interface were very important parameters due to the lack of experience in computer usage by the students [10]. Special care was taken so that they could easily identify hyperlinks and the way to return to a previous page. A navigation bar to the left of the screen helped navigation through the various subsections. There was also a standard way in presenting text, maps and pictures throughout all the web pages.
- The school's curriculum was not modified. Time devoted to A.T.M. teaching in some cases exceeded that of a regular instructive hour, and in some did not.
- There were some modifications in the usual teaching scheme. For instance, there was no homework assessment. Because there were no oral comprehension questions, small game-tests were used in an interactive way and that was considered as an approach for assessment of the students' comprehension of the subject.
- Local teachers were prompted to give technical assistance to those students that have difficulties during their navigation to web pages. There were no instructive interferences.

With respect to the teaching approach that was followed, it should be mentioned that it was partially work in groups, collaborative learning and partially self-learning, in other words the whole approach was not close to traditional teaching methods. The reason underlying this is found in the very nature of A.T.M. By default A.T.M. is a student-centred teaching method. As such, it is proved that students with more control over the teaching process tend to be more positive to the procedure of knowledge acquisition [9] [11]. In A.T.M. hypertext structure is the element that determines whether student's control over the cognitive material would be successful. On one hand the structure should allow students to learn with their own pace and visit the pages they want, at the order they want, but on the other hand, it should not permit disorientation.

For the above reasons, the hypertext structure was designed in such a way as to help students not to lose their track while navigating through various web pages. Specifically, it was decided to present the hypertext structure (though hierarchical-linear) as free-not linear. The design of the sub-sections, followed the linear structure of the textbook. Choices on the menu bar however, allowed students to follow a non-linear path; for example they could read first for the lakes and then for the rivers, or first for the Mediterranean Sea and later for Northern Europe. Lesson units were independent from each other so far as contents are concerned, thus it was not necessary to read first a unit in order to comprehend the next one.

The evaluation of the pupils was achieved by filling questionnaires (on forms on web pages) at the end of the lesson. One referred to the understanding of the subject and the other to the pupils' perceptions about the procedure. The forms were transmitted automatically to a database and processed later.

Internet access was achieved via simple telephone lines, 56 Kbps being the highest connection speed. Even though it was possible to provide schools with special equipment and upgraded connec-

tion speed, such a thing would create ideal experimental situation and would not assimilate real conditions. Internet Explorer was used as a web browser and Microsoft FrontPage for the creation of web pages. Asymmetric Toolbook was used for the creation of small game-tests.

As in S.T.M., in order to avoid delays from the connection speed, all the files were pre-installed to the computers that the students were going to use. The only transmission of data was the questionnaire forms. This freed from restrictions in file size and image quality.

6. Outcomes - Comparisons

As already mentioned, for the assessment of students' performance traditional evaluation tools were used in both methods. These were adjusted according to each method's requirements and compared to the grades that teachers give for each student. The results were within the range of our expectations. Students' performance was nearly as good as in conventional teaching with a difference of about 10 percent. This difference can be interpreted either as an imperfection of D.E. methods or as a weakness in the assessment methods. The meaning of the above statements deserves further analysis.

It was observed that the results from the first test in each method were not so good. This can be attributed to pupils' first surprise and astonishment, which created distraction of attention. Also, in a videoconference lesson there was a connection failure and interruption of sound and video transmission. Although the malfunction was corrected shortly after it occurred, the interruption fatally deranged the flow of the lesson and the result was reflected in impressively low scores in the comprehension questionnaires. Excluding these cases from the evaluation process, a small difference between D.E. and traditional lessons still remains. The explanation is that the questionnaires were not corrected by the class teacher but by the university's team in an objective and impersonal way, since the members of this team did not know the students. It is assumed that teachers knowing well their students, are aware of their abilities, hence their grades tend to reflect a balance between true performance, personal preferences and motivations. For these reasons, we think that the 10 percent difference is of no significance.

Finally, it is worth noticing that evaluation results from the large schools were not statistically different from the results of the other schools.

On the positive side of both methods we can site the following:

- Students in both methods have mentioned that what they liked most was the fact that they understood the lesson better than in traditional teaching, that the content was "explained better". Reorganizing and breaking in small subsections the educational material of each lesson (in both methods) the use of key words and text "for further study" (in A.T.M.) helped in the generation of this impression.
- Multimedia elements contributed to the experiments' efficiency.
- The playful-exploratory character of A.T.M. was one of the most positive elements.
- The duration of D.E. lessons created various impressions to pupils. Especially for the A.T.M. lessons the impression pupils had, was that time passed very quickly. This is also an indication of the success of this method.

On the negative side the following stand:

- The most important negative element of both methods was noise in the classroom. This was expected due to the re-arrangements that have taken place. Thus in S.T.M., the classroom layout had to be rearranged while computers and the rest of the equipment draw the students' attention creating a disruption in the school routine that affected negatively the DE lesson. In A.T.M. the same unsettlement occurred during the period of adaptation i.e. while students were learning how to work by themselves or in teams.
- Another negative factor was the need for students to use the keyboard in order to write the answers in the evaluation forms. Although this need was minimal, the fact that the students were not

familiar with the keyboards' symbols resulted in delays. Unlike these negative aspects of A.T.M. the user interface proved to be functional and no incidents of disorientation were reported.

- Another difficulty concerned the number of computers. In S.T.M. and particularly in very small schools, with just one or two computers, students had to observe the lesson from one or two monitors divided in small groups or from one 25" television. This was not very comfortable for the students that were sitting in more than two meters away from the monitor/TV. In the large schools the use of a video projector and a big screen (1.5X1.5 m) averted such problems.

It is certain that both methods assume some change in the long-established roles of teacher and students, thus produce a new scene in the classroom. The scale of change depends on the method applied, with A.T.M. leading to more spectacular changes.

In both methods students have a role that differed from the usual. In S.T.M. it seems that there are no great changes. The student has to attend the lesson passively, ask questions and answer comprehension questions. However, the experiments have shown that there is a need for more self-control and discipline. In A.T.M. changes are more apparent and significant. It is already mentioned that this approach implies a relatively high degree of initiative, personalization of learning and self-evaluation. These elements set students in command of their efforts and make them responsible for covering the contents, understanding and controlling time.

In S.T.M. the final form of the cognitive material had no significant differences from the one in the textbook. In contrast, A.T.M. is based on personal learning. Students participating in such lessons tend to be more self-provided and self-supported. For that matter, we decided to include optional texts for "further study", so that students had the chance to decide by themselves the extent of the acquired knowledge. Exploration and discovering was encouraged, but in reality, everything was available in the Web site of the project.

The capability given to students to repeat whenever and whatever parts of a lesson they wanted, resulting from the personalized nature of the method is an important factor in A.T.M. This capability is very limited in traditional teaching or in S.T.M. mainly because of time restrictions.

In both methods, the role of teacher changes, but not to the same extent. The local teacher becomes a tutor/coordinator but not with the same responsibilities in each case. In S.T.M. the local teacher has a strong presence in the classroom. In A.T.M. he/she acts more like a coordinator.

Those teachers who wish to keep a high degree of control over their classes and regard D.E. as a supplementary teaching method accept S.T.M more easily since STM are teacher-centred and much closer to traditional teaching. It seems natural to these teachers to transfer their didactic duties to another (remote) teacher but they want to be assured that they keep in touch with the teaching process, retaining the right to intervene whenever they consider it necessary.

A.T.M. gives high degree of independence to students and alters the traditional structure of a class. Therefore such approaches are not easily accepted from teachers of the above-mentioned category. The personalized nature of the method makes impossible the close observation of the students' progress as a whole; i.e. the class can hardly be considered as a single integrated entity. The remote teacher is invisible; the local teacher has to work hard in order to offer instructive assistance to every student and this can make him question the quality of the lesson and the applicability of the method

Before the experiments remote teachers communicated and co-operated with the local class teachers. In doing so the remote teachers were aware of the conditions in every class; they even had to know the names of the students. This had beneficial results in the attitude of students towards the lessons since they did not feel alienated.

For the A.T.M. lessons there was again a close collaboration between the class teachers and the web page developers, which contributed in the modulation and configuration of the didactic material as well as in the selection of the additional material. During the development of the web pages the contents and presentation have been discussed thoroughly. There were corrections and feedback until the material was considered satisfactory. The web page designing team consisted of teachers too.

Finally, an important point that concerns planning of each course and the creation of cognitive material should be pointed out. Creating such a material turned to be a laborious process. For each course, roughly three hours were dedicated for the preparation of an one-hour course. Even if this time is admissible when it is for experimental purposes, it is impossible to be dedicated by the schoolteacher in meeting the class' daily duties.

7. Towards a third D.E. teaching model

The main drawback of both S.T.M. and A.T.M is that they offer "third person" experiences to students. By the term "third person" we mean that between the cognitive material and the student, a third person (teacher) or a machine (computer) intervenes, that acts as a medium [12]. In contrast, in the case of "first person" experiences, an individual has direct access to knowledge. To give an example, first person experiences are the emotions we feel while watching a film while third person experiences we have when someone else explains to us the way that images and sound reach our eyes and ears or the plot of the film.

First person experiences are quite important because they give us a new perspective on how knowledge is acquired and constructed. The importance of in the field of education is supported by the principles of constructivism. Constructivism, though not a single and recollected theory, provides the background that explains how knowledge is built [13] [14].

In an attempt to combine DE teaching with constructivism, three are the main points are worth mentioning:

1. Each individual creates his/her own representations of the surrounding world based on his/her own experiences. Hence, a unique and right representation does not exist.
2. Individuals learn with their own way via active exploration. Learning occurs when a student explores and finds inconsistencies between the existing representation of knowledge and his previous experiences.
3. Learning occurs within a social frame. The social environment is the one that provides the tools of knowledge, which is socially and personally determined. Interactions between students, as well as between students and instructors are an integral piece of the training process.

It is considered that in order to achieve the above using a computer, (a) the interface should be absent; in a way, the computer should be "invisible" and (b) in the learning environment interactions should not be pre-constructed, but all kinds of interactions should be possible [15].

The meeting point of constructivism and technology can be found in virtual reality (V.R.). It is not the purpose of this paper to analyse all aspects of V.R. What concerns us most is (a) how a graphically intense computer environment such as V.R., can be used in D.E. and (b) what are the possible cognitive outcomes.

As far as delivering the content is concerned, after studying a number of possible configurations, we came to the conclusion that a modified game engine suits our needs. For that matter, the necessary software should be pre-installed (a solution that is already used in both D.E. models). Since ISDN telephone lines are becoming common in Greece, and DSL is already available, we have the first part of the solution to the problem of data volume that must pass through the network. The second part of the solution is the way that game engines generate and handle network traffic. There is no constant

transmission of graphics and sound, but a steady flow of the coordinates that a player has within the game. So, data volume is minimal and therefore a typical ISDN dial-up connection is sufficient.

As for studying the results of VR, we are currently planning a set of experiments that will use a network delivered, collaborative virtual environment, designed to teach road safety education to students. The whole project will be based in desktop V.R. in order to be (a) easily applicable, (b) consistent with the configuration of computers that school labs already have and (c) as cheap as possible.

8. Conclusions

The solution to the quality problems of small multigrade schools in Greece is a complicated matter. This paper has tried to indicate that nowadays-mainstream technology provides alternative instruments and means through which many important problems faced by these schools can be overcome. As with any multidimensional issue, once we come to evaluate comparatively different approaches in education using ICT, it is not easy to reach clear conclusions as to which ICT approach is the best. This is why experiments should go on and the teaching models should be appropriately transformed to reach better results.

What seems important is that technology provides a potentially endless number of approaches; hence the quality problem in multigrade schools may seek for solutions in a combination of approaches rather than in one of them. Equally important is the fact that technology is the main source by which the drawbacks of ICT educational methods will be corrected.

With the above in mind, the problems of small multigrade schools are, up to a certain point, problems of deciding whether and up to what extent technology should be introduced in such schools. This is a critical matter of decision-making in the hands of educational and regional policymakers.

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