Distance education: Synchronous and asynchronous methods.
A comparative presentation and analysis

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Abstract:
In the University of the Aegean, for the past years, distance education is an object of intense research. Various models are created and applied in school environment and experimental data is collected. Didactic, technical and organisational parameters are examined. The dominant model concerning synchronous methods relies in the use of teleconference, including data transfer and the shared use of applications. The use of web pages is selected as a model for the asynchronous teaching methods. During its implementation, proper guidance of the pupils is needed, but it also leaves chances for initiatives. This paper is an attempt to discuss and study results of experiments from both distance education methods. Comparisons are made between these two and also against traditional teaching approaches.

Key words: *Distance Education, Synchronous, Asynchronous, Primary Education*

1. Introduction

The current complex social, economic and cultural environment, as well as the technological advances in modern society, call for changes in the targets and methodologies of the educational system. In this new scene there is an urgent need for acquisition of more knowledge, specialization, life long education and flexible instructional methods. Distance education (DE) seems to offer viable solutions to these needs.

The two groups of DE methods, synchronous and asynchronous, provide a dynamic arsenal for the selection of the proper strategy. These tools should be accompanied by quantitative and qualitative changes in the design and implementation of teaching. Yet, such changes combined with teachers' lack of technological background and their unwillingness to adopt innovations create a scepticism with respect to the usefulness of these methods.

In the University of the Aegean during the past years DE is an object of intense research [1], [2], [3], [4]. A number of experimental DE models have been designed and implemented in school environment with the purpose of evaluating their effectiveness and assessing their parameters. This work deals with two experimental models, referred to as Aegean Distance Education (ADE) Models that were applied, one using Synchronous Teaching Methods (S.T.M.) and the other Asynchronous Teaching Methods (A.T.M.), in schools of similar profile. Since both models were applied under the same conditions, relative comparisons are allowed concerning their implementation and results.

2. Purposes of DE experimental models

The main targets underlying the design and implementation of ADE models were the following:
- Propagation of the use of computers in school and teachers' training in Information and Communication Technologies (ICT). Active participation of teachers is assumed as being a key factor in any effort to apply DE at schools. Acquaintance and familiarization with ICT helps teachers to appreciate the capabilities of ICT and become active participants in experimental projects at first and regular users of computers when exercising their everyday teaching duties.
- Simplification and standardization in designing and revising educational material. The attempts to use simple, cost effective DE tools, as well as standardised procedures and methods is considered more important than collecting experimental data.
- Evaluation of DE methods and examinations of their advantages and disadvantages. Analysis of the results from the application of DE methods, contributes in identifying gaps, miscalculations and weaknesses. Efforts are concentrated in improving these methods.

The following matters are investigated:
- <u>Technical issues that have to be addressed</u>. In almost all cases inadequate infrastructure is an obstacle for the materialization of DE lessons. Equally important obstacles are the schools limited financial means, administrative structure, and, mostly, lack of technological knowledge. Any selected solution should take into account these limitations.

- Didactic issues concerning differentiations in the instructional process. DE requires a change in the attitudes and the roles of teachers and pupils and this requirement is worth investigating
- Organisational issues. The usual lack of technical resources and the pedagogic demand for quality, create the need for innovations in implementation. This leads to new ways of doing things to satisfy all the necessary parameters.

3. Area of application selection of experimental groups

The area where the ADE models were implemented, i.e. the Aegean islands, belong to an unusual geographic region. The Aegean region consists of a large number of islands, at a distance from the mainland and from each other, each suffering up to some extent from geographic isolation and serious communication problems. In most of the islands, infrastructure and services provided are limited and below the national standards. Schools on these islands are isolated, teachers are young, mostly inexperienced and need all the help they can get. At the same time, the Aegean University has been developed in this area in such a way as to fit in this peculiar environment. Being by its structure a "network" University with departments in five islands and offices in Athens, it serves regional development purposes in parallel to its academic and educational ones. In order to resolve many of its functional problems, originated mainly from its dispersion, this University uses state of the art technology; this technology combined with the appropriate know-how and organisational and research skills is frequently used in support of the small islands communities [5] [6].

The DE methods and models that were developed in this University take into account the area's educational characteristics. Thus, the ADE models were designed with the aim to help to small multigrade schools, a type of school that is frequently met in most of the Aegean islands.

Thus, schools that participated in ADE models were two kinds:
   a. Small multigrade schools (a teacher teaches more than one grade in a classroom).
   b. Larger schools in the area

All of them had some computer infrastructure (computer labs), were connected to the Internet and teachers and pupils had a basic background in ICT. Large schools had at their disposal a video projector to use for videoconference.

4. Models and techniques used

The ADE model that used S.T.M. relied in the use of teleconference, including data transfer from one point to another and the possibility of shared use of applications. Under certain technical and pedagogical assumptions, this is a form of instruction closer to traditional teaching and can be applied in almost any group of trainees.

Limited resources (low data transfer rate), imposed restrictions to the implementation of the method and required special treatment of the procedures adopted. One of the most obvious characteristics of that, was the reduction of the files' size and the alteration of the quality of video transmitted.

It was applied in three schools totalling a number of 55 pupils. Three lessons were taught. Distance teaching was performed in the computer lab. 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 on the feeling pupils had about the procedure

The A.T.M. model used web pages and web forms. It was applied in two schools totalling a number of 58 pupils. Three lessons were taught. Distance teaching was performed in the class. The evaluation of the pupils was achieved by filling questionnaires (on paper) at the end of the lesson. One referred to the understanding of the subject and the other on the feeling pupils had about the procedure

It is essential to differentiate A.T.M in elementary schools from those used for adult teaching. When it is addressed to adults the attention is drawn more to the 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 in 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.

In both cases there was an ongoing effort to balance the ideal with the limitations of reality. This was achieved using several technical and methodological tricks, making a large number of tests and keeping always in mind that the quality of the didactic material had to be preserved at any cost.

5. Comparison of S.T.M. and A.T.M.

In order to compare S.T.M. and A.T.M. methodologies, the ADE models were implemented in different schools of similar profiles with respect to size of the class and age groups. The subject that was taught was the same for both types of ADE models, namely geography of the fifth grade.

5.1. *Infrastructure and technical issues*

The technological infrastructure in both methods was the same, with one exception referring to the use of a Web camera for the needs of teleconferencing. Popular computer programs were used, specifically (a) Windows Netmeeting for the communication between the remote teacher and the students for the transmission of sound, video and for sharing applications, (b) PowerPoint as a slide presentation application, (c) FrontPage for the construction of web pages and, finally (d) ToolBook for the creation of small multimedia applications and games. Simple dialup or ISDN lines were used for Internet access.

The selection of "low cost" solutions in both cases created the need to use "smart" technical tricks that would allow adequate quality and transmission speed.

- Extensive use of multimedia elements was avoided. The designing team did not use very impressive multimedia features when presenting the educational material, since this would distract the pupils' attention from the didactic material to their presentation medium
- The size of the image files was reduced by decreasing resolution, colour depth and/or by compacting them. Animation and resolution colour depth were also decreased in PowerPoint slides.
- The teacher spoke slowly and clearly. He/she was also asked not to make abrupt and speedy gestures.
- Netmeeting was set-up for more speed and less video quality.
- In order to achieve additional reduction of the transferred data volume, some necessary files were sent via e-mail some time before the actual teaching. The teachers had to install them in the computers in advance; hence applications were running directly in these computers and were not transmitted.
- The students' side was sharing the applications to the remote teacher. Time delay occurred form the teacher's side and not from the students' side. The remote teacher was aware of that fact, but knowing in advance the sequence of slides was able to adjust the pace of his talk. This was not percept by the students.
- The only information that the remote teacher had to transmit, besides sound and video, was commands for slide changing.
- In some cases, if the available infrastructure allowed, a second telephone line was used for voice transmission.

	Method	
	Synchronous	Asynchronous
ISDN/dialup	✓	✓
Reduction of multimedia elements	✓	✓
Reduction of video quality	✓	—
Reduction of file size	✓	✓
Files sent in advance	✓	✓

Table 1. Comparison of infrastructure and technical solutions

5.2. *Didactic methodology and organization of cognitive material*

For the ADE model that used S.T.M. the final form of the cognitive material had no significant differences from the one in the textbook. In fact, it was the same material, divided in many small subsections and reorganized. The texts and images were the same and were presented in the same order, enriched with some carefully selected, extra multimedia material (photographs, diagrams etc). Stu-

dents were taught the actual school lesson in a different manner. In some cases, distance lessons were taught by the class teacher who was not in the school building. In this case, the remote teacher was familiar to students. Moreover, there was no change in the school time curriculum. Care was taken not to form to students the impression that they exceeded the difficulty level, the time boundaries and the general structure of an ordinary lesson.

Videoconferencing lasted more or less one didactic hour. Furthermore, the general class activities were kept intact (the hour was divided into four parts, examination of the previous lesson, teaching of the new, comprehension questions and evaluation). In other words, students were taught Geography according to the school's curriculum. With respect to the role of the instructor, it should be mentioned that S.T.M. is teacher-centred, thus closer to traditional teaching methods. This means that the teacher directs the course of the lesson and regulates the degree of coverage of the content (usually taking into account the class average).

In S.T.M., student evaluation initially was achieved using oral comprehension questions from the remote teacher. Questions and answers appeared in the slide presentation program. The written examination that followed was in a form familiar to the students (corresponding figures, completion of missing words in a paragraph, multiple choice, etc). The papers were collected and afterwards corrected by the remote teacher.

For ADE model that used A.T.M., an attempt was made to keep the main body of the cognitive material the same as the one provided by the curriculum. Again, the material was broken apart in many small subsections and reorganized. Every web page included only the essential text, facilitating students with reading difficulties to concentrate in the main parts of the cognitive subject. Important terms were clarified with the extensive use of keywords. The keywords were linked to short but meaningful explanations using text, images or both.

In contrast to STM, 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, A.T.M. lessons included optional texts for "further study". Students willing to learn more had the chance to decide by themselves the extent of the acquired knowledge. The total text quantity was determined, selected and planned in advance in order to cover a wide range of student needs. This created the impression of exploration and discovering but in reality everything was available in the Web site of the project.

Each text paragraph formed an entry on the navigation bar on a new frame. Hypertext structure even though hierarchical-linear was designed in such way that appeared to be non-hierarchical, non-linear. The various subsections followed the linear school text arrangement. But because of a fixed navigation bar, students could follow a non-linear course. Care was taken to avoid disorientation, which is one of the basic drawbacks of a non-linear hypertext formation.

In A.T.M. a very simple game (a ToolBook application) was included in the web pages. The purpose of this game was self-evaluation of students in order to repeat (by revisiting web pages) parts of the lesson. Web forms were used for comprehension questions in another section of the web site. They followed the same organization structure as in S.T.M. and they were connected to a database. Each lesson even though directly connected to each student's pace lasted nearly one didactic hour.

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.

5.3. Cooperation
It is certain that both methods assume some changes 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 ATM leading to more spectacular changes.

The teacher can be coordinator, he can teach students in a distance or can develop material in a very different way than before. For the purposes of these experiments, the extent up to which the intervention of the coordinator was admissible during a DE lesson was kept to a minimum. The coordinator solved technical problems and gave technical assistance to students. In ATM, the coordinator was the class teacher.

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.

Teachers (remote or web designers) participating in the experiments had to be experts in the use of computers and information technologies. Selection and adjustment of the content of each lesson seems to be laborious and time consuming. It is something that cannot be done in every day practice and it helps a lot to have ready material available.

	Method		
	Traditional	**Synchronous**	**Asynchronous**
Teaching Material (main)	textbook	textbook	textbook additional sources
Additional material	✓ (optional)	✓ (necessary)	✓ (necessary)
Quality of teaching aid and additional material	depending by the school infrastructure and teacher willingness	carefully selected planned organized	carefully selected Planned organized
Traditional teaching outline	✓	✓	—
Didactic methodology	teacher centered	teacher centered	personalized or group work
Extent of the acquired knowledge	determined by the teacher	determined by the teacher	determined by the student
Exploratory character of the lesson	✓ (optional)	✓ (optional)	✓ (by it's nature)
Course of the lesson	linear	linear	linear semi-linear free
Capability for repetition of part of the lesson	✓ in real time limited	✓ in real time limited	✓ anytime not limited
Student evaluation	oral written	oral written	self-evaluation written
Duration of lesson	1 didactic hour	1 didactic hour ±5 minutes	1 didactic hour +10 minutes

✓: Holds/ Needed, —: Does not hold /is not needed

Table 2. Comparison of didactic methodology and organization of cognitive material

In both methods students have a role that differed from the usual. Although in S.T.M. it seems that there are no great changes, there is a necessity for more self-control and discipline. Before the S.T.M. experiments students were briefed for the procedures, emphasizing that this is a new and impressive way of teaching. Their response was good, in particular after the first lesson. During the first lesson it was expected (and turned to be true) that their attention was concentrated in the medium, which meant that they were highly impressed.

In A.T.M. changes are more apparent and significant. It is already mentioned that this approach implies a relatively high degree of self-control and 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.

Before the actual teaching with A.T.M. students had the basic skills that were required for an adequate use of computers and for the navigation in web pages. Again, during their briefing for the new procedure, care was taken to show that there is not divergence from the school' s curriculum. As was expected, after the first lesson their attention focused more to the content and less to the medium. It is a matter of great importance to mention that personalization of teaching, self-evaluation and initiatives operated almost instinctively. The lessons were taught in the school lab.

	Method		
	Traditional	**Synchronous**	**Asynchronous**
Local teacher's role	teaches coordinates supervises supports	coordinates supervises supports	coordinates supervises supports
Remote teacher's role	—	teaches	creates the material
Student's role	attends few initiatives	attends few initiatives	selects the pace many initiatives
Need for physical presence of a tutor	✓	✓	✓ (desirable)
Preparation time	usual	increased	increased (more)
Computer skills needed for teacher/tutor	—	✓	✓
Computer skills needed for students	—	—	✓

Table 3. Comparison of the human factors

5.4. Effectiveness of the methods

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 the results were satisfactory. The marks of each pupil were added to produce the total marks of the class for each lesson. The total mark of the class was compared with a total mark produced in a similar manner after a conventional teaching in the class. The differences were nearly as good as the conventional teaching with a difference of about 10 percent.

There were two exceptions though:
(a) The results from the first test in each method were not so good. This was attributed to the pupils' first surprise and astonishment, which created distraction of attention
(b) In a specific S.T.M. application, the students failed to get good scores. This was attributed to a connection failure that resulted in the interruption of sound and video transmission. Although the malfunction was corrected in ten minutes, this time was enough to fatally derange the flow of the lesson. Students lost their interest and much time was consumed for restoring order in the class. It should be noted that all methods utilizing technology are vulnerable in such breakdowns.

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 formation of this impression. Multimedia contributed too, but did not seem to be the most significant factor. Furthermore, the playful-exploratory character of A.T.M. was one of the most positive elements.

The duration of each lesson created various impressions to pupils. Especially for the A.T.M. lessons, the impression pupils had was that time passed very quickly. This is an indication of the success of this method.

The most important negative element of each method 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 an unsettlement of the school routine that affected negatively the DE lesson. In A.T.M., the same unsettlement occurred during the period of adaptation, ie 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 that 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.

In both cases (A.T.M. and S.T.M.) evaluation results from the large schools were not statistically different from the results of the other schools.

6. Conclusions
S.T.M. and A.T.M. can be used for DE under the same conditions. However, the philosophy, methodology and application of each one are very different. Comparison of the two methods is possible only when the participants and the way of organizing the teaching meet certain criteria.

Even thought the collection of opinions of teachers was not the purpose of this work, it appeared from discussion with the teachers involved that they felt about these experiments as follows:

Teachers who wish to keep a high degree of control over their classes and regard DE as a supplementary teaching method, more easily accept S.T.M. being teacher-centred and much closer to traditional teaching. It seems natural to them to transfer their didactic duties to another (remote) teacher but they should be assured that they could keep in touch, 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 methods 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/single 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 suspicious for the quality of the lesson and the applicability of the method

In both S.T.M. and A.T.M. 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 classroom. In A.T.M. he/she acts more like a coordinator.

S.T.M. is more or less a traditional teaching method. The student has to passively attend the lesson, ask questions; answer comprehension questions and is slightly more disciplined than usual. The scene dramatically changes in A.T.M. The student becomes the centre of the lesson, participates actively in selecting the cognitive material, and chooses the path to follow. In this case personalization /collaboration are the dominant teaching methods.

Choosing between S.T.M. and A.T.M. seems to be meaningless when it comes into student's evaluation results. Both methods give good results, similar to those of traditional teaching methods.

The medium plays a vital role in both methods. The term "medium" here is defined as the organization of the content, the multimedia character and for the way of delivering it. Multimedia elements even though restrained were the cause for the initial attractiveness of the lessons (what caught the eye). Reorganisation of the contents and segmentation were causes of success. The way of delivering created the difference between the two methods.

Both methods are sensitive in technological malfunctions. Taking in consideration the "live" character of S.T.M. this method is more vulnerable than A.T.M. The effects of a breakdown may be devastating for the specific lesson. In A.T.M. the asynchronous character of the method and the pre-installation of files leaves room only for local malfunctions (malfunction of a computer) that can be easily overcome.

The ergonomics of the methods are also different. In S.T.M. a video projector seems to be required. In A.T.M. the ideal would be one or two students per computer according to the educational task to be performed.

The number of DE lessons was small. With a larger number of cases (lessons, schools, pupils), over longer period of time, when the initial enthusiasm of students settles down, it is anticipated that results can be very encouraging. The increasing culture about ICT and education on the subject, help towards this goal. The efforts presented here indicate the first feeling on the matter.

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