

Costs of Low-Scale Distance Learning Programs

A Case of Distance Learning Courses in the Aegean Islands

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C. Tsolakidis and P.Fokiali

University of the Aegean, Rhodes, Greece

Abstract—The advance of Information and Communication Technology (ICT) and the reduction of cost in digital applications motivate course designers to develop new applications of distance learning programs so as to meet the increasing educational needs in the knowledge-based society. As a consequence, distance learning courses are increasing in number, credibility and acceptability all over the world. The question is whether these programs are efficient in terms of costs. The main theme of this work is to investigate cost behaviour and estimate cost efficiency of distance learning courses applied in low-inhabited, remote islands. The target group consists of high school students of Grade I. The distance learning course that is designed uses several scenarios of the “what-if form” and reaches the conclusion that cost of such solutions is far lower than that of any traditional course, even at the absence of scale economies.

Index Terms—Cost efficiency, cost effectiveness distance learning, remote islands.

I. INTRODUCTION

In the modern world Information and Communication Technology (ICT) has penetrated dynamically in the field of education, supporting wide categories of educational programs that range between those entirely depending on technology and those based on traditional teaching and learning approaches. In the former case ICT provides a tool “sine qua non”, while in the latter ICT is used as a tool that supports traditional educational methods in order to upgrade quality and improve the programs’ effectiveness.

An important category of programs that depend critically on ICT is that of distance and online education. In its contemporary sense, it consists of innovative instructional applications in which the teacher and the learner are separate in space and, possibly, in time, while technology - including the Internet- is engaged to act as the mediator that facilitates communication and interaction between the learner and the distant teacher [1].

Despite the fact that technology is becoming increasingly important in education, and although the promises of distance learning are to a great extent financial in nature, cost issues in relation to ICT have not been studied as extensively as other matters referring to distance education [1]. It is only after the mid-1990s that cost issues in distance learning have attracted the interest of researchers. Even then, opposite to other areas of distance education, research in cost issues has not shown any spectacular explosion. The delay could be attributed to the fact that research questions concerning cost efficiency of distance learning are worth investigating only if the battle for rec-

ognition, credibility and educational effectiveness of this approach is won.

II. DISTANCE LEARNING IN THE CONTEXT OF LIFELONG LEARNING

The development in the early sixties of the human capital theory that has clarified the links between education, productivity and economic development can be considered as a major explanatory factor of the dramatic increase in macro- and micro-demand for education [2]. Supply of education, on a lifelong level, reflects the continuous attempt to meet this demand. In this context, in the relevant literature there is a wide consent that the dynamic development of lifelong learning has been helped enormously by the development of ICT and especially the distance learning techniques [3], [4], [5]. By allowing potentially anyone to have access to knowledge, distance education technology has accelerated production of diverse lifelong learning activities that aim to serve identifiable learning needs [6], [7]. Within this frame, the numerous case studies through which the relevant field is investigated show that distance learning is continuously gaining appreciation in many parts of formal, non-formal and informal education as described below.

A. Formal education

The objective of improving educational quality in a knowledge-based economy and society implies the transformation and modernisation of formal education systems, a process that involves the active adoption, support and development of e-learning, and distance learning [8].

In respect to primary and secondary education, the cases of substitution of face-to-face teaching by distance learning are expected to be rare, particularly since the school plays not only an educational but also a social role, contributing to the children’s preparation for their future life. However, even in these educational levels, e-learning and distance learning have attracted the interest of educational designers who seek for tools and methods to supplement traditional approaches and upgrade educational quality. This situation is expected to last at least until the cognitive, pedagogical and social effects of distance learning courses are fully investigated and researchers are able to answer the question whether and up to what extent distance education can substitute traditional methods.

A significant field in which distance education is well accepted is that of multigrade primary schools [9],[10]. These are small schools, usually situated in remote, rural, low-populated areas, in which one educator teaches pupils of different age and educational level, in one single classroom. Although these schools are marginal cases in an educational system, the perpetuation of their operation in

almost every country is a strong argument in favour of them [11]. For multigrade school pupils, e-learning can be an important tool in support of the learning procedure, upgrading educational quality, hence meeting educational as well as social targets [12], [13], [14].

Distance learning and e-learning are recognised as offering opportunities to advance the benefits of tertiary education to populations that are dislocated by time and place and are difficult to reach [15]. At this educational level, distance learning is connected with the institutionalization of open universities and the supply of distance courses on undergraduate and postgraduate level. In such applications, distance learning is addressed to students that, for professional, family, economic or other reasons, cannot attend courses offered face-to-face [16].

B. Non-formal education

Distance education is gaining acceptability in non-formal education. Professional training, and in particular in-service training, is facilitated enormously by distance learning approaches [17]. Organizations of both, the private and public sector, no matter whether big, medium or small in size, can either design and develop or simply adopt and apply distance learning training programs [18], [19]. These programs allow employees to meet their needs for personal and professional development and give opportunities to organisations to become more efficient. Teachers' training is a specific case in this context [14], [20].

C. Informal education

The truly lifelong process whereby every individual acquires attitudes, values, skills and knowledge from daily experience and the educative influences and resources in his or her environment is helped enormously by ICT and distance learning technology. It is accepted that such techniques support individualized knowledge acquisition as a modern source that can be added to the traditional sources of informal knowledge, such as the family and the neighbors, the work and play, the market place, the library and the mass media [21].

In conclusion, distance learning has gained solid grounds in any form and level of education, forming its own "market" of innovative diversified products as well as an interesting field of on-going research. Under such circumstances, it is not surprising that its economic behaviour, and especially its cost structure and efficiency, became an issue worth investigating [22], [7].

III. RESEARCH IN COST OF DISTANCE LEARNING

A. Typology

The vast diversity of distance learning programs creates difficulties in forming a typology for the works referring to cost issues. An attempt is presented below, using as criteria the programs' contents, the central concept adopted, the methodological approach applied and the conclusions derived from the relevant works.

With respect to the contents, it is noted that research works in cost matters are based on three types of comparisons [23], [24]: (a) between institutions that offer similar programs using different approaches (e.g. [23],[25]); (b) between programs, in the same learning institution, applying traditional approaches on the one hand and distance

learning techniques on the other made (e.g. [26],[27]); and (c) between distance learning programs that differ in the applied technology (e.g. [28]).

With respect to the central concept:

- a) The majority of studies focus on cost issues *per se*, avoiding reference to benefits [29].
- b) In the studies in which an integrated cost-benefit approach is adopted, researchers prefer to evaluate cost independently from benefits, mainly due to the lack of consensus on the definition of returns and the non-availability of relevant data [25], [24].
- c) Some studies attempt to quantify cost effectiveness in a wide sense, using techniques for measuring the relationship between the total inputs and outputs, expressed not necessarily in monetary terms, while some other prefer to make estimates of costs and benefits in financial terms, approaching efficiency by means of a rate of return [16].
- d) Focusing on the benefits, some studies consider as benefit the quantitative and qualitative result that learners get from the program, while some other concentrate in estimating the learning institution's profit.
- e) Focusing on cost, there is a wide consensus about the main cost categories in the learning institution's budget that should be considered in a distance learning course. Such categories are the costs of developing e-materials, the e-delivery costs, overhead and infrastructure costs [30]. Each of these categories is further analysed in several cost items. It is important to characterise cost items as fixed or variable and/or as recurrent, non-recurrent and, in some cases, as semi-recurrent [31]. These distinctions help in analysing the behaviour of cost functions and derive conclusions about cost efficiency if one or some factors (e.g. the number of learners) change.

With respect to the methodology, the relevant research works in their majority present case studies, mainly due to the programs' diversity. This creates difficulties in making generalisations of the results [24].

With respect to the results:

- a) Almost all studies accept that there are great limitations in approaching cost efficiency [32]. These limitations refer to the programs' diversity, difficulties in modelling programs, methodological problems, lack of adequate and reliable data on cost variables etc [30], [33].
- b) Cost efficiency of distance programs is reported to be high -in many cases higher than that of conventional programs, in cases of high number of learners attending the course. As some cost categories are shared by many learners, as the number of attendants increases, scale economies emerge, decreasing unit cost per learner [35].
- c) Cost efficiency of learning organisations is reported high in cases of high number of distance programs. As some cost categories are shared by many programs, as the number of programs increases, scale economies emerge, decreasing unit cost per program and learner.
- d) The initial fixed cost of distance courses is reported to be relatively high, due to the fact that for launching a distance program, it is necessary to make some non recurrent expenses for equipment, initial training

and basic connections. Such costs are not necessary if a face-to-face approach is selected.

- e) In distance courses the marginal cost added whenever the learners' group increases by one attendant is relatively small. This is so because the size of an e-class can be large, since each distance educator can address its teaching to relatively large numbers of learners. On the contrary, in traditional programs, the size of a face-to-face class cannot be large. Since the number of learners per educator is an index of educational quality, teaching costs are expected to vary with the number of learners.

From the above analysis it may be derived that distance learning becomes economically interesting in cases of large-scale programs. Evidence supports the view that when the number of learners is small, face-to-face courses are economically more efficient than distance ones; however, there is a critical number of learners over which distance courses become more efficient than traditional ones in terms of cost. This situation is depicted in Diagram 1, In this, line D1 and line F represent the cost of distance and face-to-face approach respectively. At low numbers of learners line F exceeds D1. However there is a critical number of learners, represented by point A after which distance learning becomes more efficient than the traditional approach (see [35]). The distinction between variable and fixed cost is critical in explaining this frame.

B. The Proposed Frame

The question that arises is whether the general frame of cost behaviour described above depicts a constant situation in the distance learning market, with no exemptions. In an attempt to answer this question, two major factors were considered justifying reservations.

The first factor emerges if one examines chronologically ordered research works containing estimates of distance courses cost efficiency. Studies that were carried out up to the mid-nineties reach the conclusion that cost efficiency of distance courses is comparable to face-to-face approaches, yet not significantly higher [1], [33], [36]. Later studies, however, seem to be more definite about cost efficiency. In these it is well clarified that cost efficiency in distance courses is well above cost efficiency of those delivered in a face-to-face approach [37], [33], [31], [38], [17]. In other words, it is observed that there is an interesting gradual differentiation in cost efficiency of distance learning programs, showing that this has improved over time.

The second factor reflects the attempt to explain this differentiation, by looking at the trends in the market prices of the main cost items of distance courses. In the typical cost structure of a distance learning course, it is suggested that the relative cost inefficiency at low number of learners is due to the high contribution of some cost items for the initial launching of the program, such as purchase of technological equipment and software, cost for a high resolution telephone line connection and initial training of educators and learners in ICT [16]. These items were relatively expensive in the past.

However, it needs but a comparison of some market prices in the past and now to understand that the initial cost for launching a distance learning program has now decreased substantially. Thus, the trend of prices of ICT hardware and software is constantly diminishing, particu-

larly if affordable, mainstreaming applications are selected. Moreover there are many cases in which computers and other electronic equipment are already available for other purposes in a learning organization. The same applies for the cost of the Internet connection. Also, the cost for initial training in the use of ICT of both educators and learners is not as high as in the past, since the expansion of the culture for ICT as well as the increasing degree of friendliness of ICT applications have minimized such requirements. Finally, this initial cost for infrastructure, training etc is not an exclusive characteristic of distance courses. Given the penetration of ICT in traditional education, the same cost is required for launching a face-to-face program.

Of course not all cost items have decreased. Teaching costs have increased. Also, a cost category that has not followed the diminishing trend of ICT infrastructure refers to administration cost. This many times was not factored in the cost structure [30]. The importance of administration in a distance learning course is big, given that administrative quality offsets the absence of face-to-face communication.

Overall, it may be supported that the total cost of distance courses, if holistically viewed, is no longer represented by line D1 in Diagram 1. The reduction of cost for launching distance courses results in changing the slope as well as moving downwards the line representing cost of distance courses of this Diagram. If cost reduction (hence also the downwards movement of the line) is adequately extensive, then the cost of distance courses is lower than that of face-to-face courses, irrespective of the number of learners. The new line representing distance learning cost is now D2. If this situation holds, there is no longer a point of intercept between the new line of distance learning costs (D2) and face-to-face costs (F), in other words distance courses are expected to be more efficient in cost terms, even at low numbers of learners. This situation represents a revised frame of comparison of cost efficiency in distance learning and traditional approaches.

This new hypothesis is similar to the one proposed in a recent study of Morten Paulsen, in the field of small and medium-sized enterprises (SMEs). It refers to distance training experiences from case studies in eighteen enterprises in eight European countries programs and concludes that there are many e-learning programs which are cost efficient irrespective of the size of the organization that uses them [18].

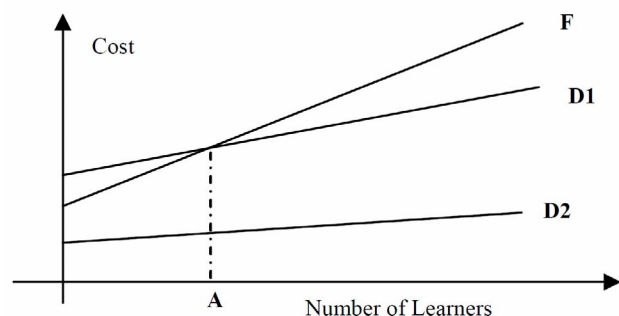


Diagram 1. Cost comparison between distance and traditional (F) approach. Existing (D1) and proposed (D2) frames

IV. THE CASE OF COST EFFICIENCY EVALUATION OF A DISTANCE COURSE ADDRESSED TO PUPILS IN SMALL ISLANDS

The revised frame proposed above is investigated in this work in the form of a case study that refers to planning and organizing a pilot distance-learning course for pupils of lower secondary school that live in remote and isolated low-inhabited Greek islands of the Aegean. The study is cost-centric and concerns evaluation of cost efficiency of the distance course in comparison to the traditional face-to-face approach.

The reason for designing this program is founded on the fact that in some very small islands, the number of pupils is so small, that the operation of a face-to-face class for is economically and practically very difficult, if not impossible. Such a case is not rare in the Aegean islands: Thus, for the year 2009-10, in the island of Pserimos, there is only one pupil that should attend Grade I of lower secondary school. For the same period, in some neighbouring islands, the number of pupils is very low –not exceeding five.

For a secondary school to operate on the island, it needs at least three teachers to stay there and work on a full-time basis. This is practically and economically difficult, if not impossible. In front of such a situation, the options available for the pupil are:

Not to attend high school, a situation against the Greek Law of a 9-year compulsory education and an equivalent to abolishing the learner's right to have access to education.

To leave the island either on his/her own or with his/her family; this is a difficult decision not only on individual grounds (given the young age of the student, the lack of proper infrastructure to cater for such a problem) but also for social reasons since it leads to a gradual de-population of the island.

To attend a distance learning course organised on purpose; this is the option examined here as the initial scenario.

The proposed pilot program is based on the cooperation of the University of the Aegean, one secondary school in Rhodes (city that hosts the university) and the learner(s). The program is supported by the Ministry of Education that plays the role of a catalyst since it is institutionally responsible for issuing the required permits for such an operation. The collaboration of other institutions, such as the Prefectural Administration, and the Municipalities is important in facilitating the launching and operation of project.

The course covers the modules of lower secondary grade I. According to the organisational frame, the remote learner(s) can register in a secondary school situated in the City of Rhodes that hosts the University. This school has the required equipment and infrastructure and the appropriate human capacity for the operation of the program. Preferably, this should be an evening school which has a relatively light program. The institutional and legal part is covered by recalling the Greek Law that provides regulations for studying at home, if specific circumstances hold; under such circumstances, distance learning is also accepted as an appropriate approach.

A blended method (synchronous- asynchronous) is proposed with teleconference applications in a wide range.

The program provides also some limited face-to-face teaching in specific subjects that is expected to be covered in short visits of the instructors to the island.

It is proposed that the instruction needs are met by high school teachers who either will be employed for this purpose on an hourly basis or are already working and will do distance teaching overtime. The latter case is preferable since the distance teachers could be the ones working in the school where the learner is registered.

Though not necessary, it is purposeful that the learner visits the secondary school at the beginning of the school year so as to be introduced to the instructors and to get informed about the program. It is necessary to visit the school at the end of the school year, so as to participate in the exams.

The University of the Aegean has an important role to play. It is the coordinator and animator of the project, and provides know-how as well as administrative and technical support.

On the island, the distance course will be hosted in the premises of the primary school. The technological infrastructure includes: (a) a broadband connection to the Internet, (b) at least one personal computer (according to the case), (c) cameras, printer, and a Data Projector.

V. COST ESTIMATION

The evaluation presented here uses different scenarios of a "what if" type. The initial scenario examines a marginal case in which the e-class consists of one learner in one island. It should be noted that economic theory often refers hypothetically to such marginal cases, for analytical and methodological reasons, as for example in the model of "one consumer-one producer" scenario. As already mentioned, however, such a marginal case is not hypothetical in the case of education in small Aegean islands.

Once cost efficiency is estimated for this marginal case, the critical assumption of one learner is relaxed and the case of two, three, up to N learners is approached. For every change in the number of learners, a different cost evaluation occurs, following the assumptions about the behaviour of each cost category and cost item. Once a maximum estimated number of learners in one island is reached, the assumption of one island is relaxed, and the process is repeated for a second, third, up to M islands. In this way, numerous scenarios may be produced and conclusions may be drawn concerning the program's cost efficiency, based on the assumptions about cost behaviour.

The different scenarios are presented in Table 1 and Diagrams 2 and 3. In these there is an estimation of cost issues by cost category (see [30]) and by contributor (public-private). Eight different cases are examined concerning respectively the launching of a distance learning course in one, up to four islands. For each island two scenarios are presented, differing in the number of learners.

An estimation of the main cost categories is given analytically in Table 1. It reflects the market prices in year 2009. Some of these costs items are expected to be funded by the public sector (e.g. Prefecture, Municipality, other) and some by private sources. Given the social character of the program the greater part is expected to be financed by the public sector (see also [39]). Diagram 2 depicts the behaviour of total cost in the different scenarios of distance courses and diagram 3 compares the distance learning scenarios to the cost of traditional approaches.

COSTS OF LOW-SCALE DISTANCE LEARNING PROGRAMS:
A CASE OF DISTANCE LEARNING COURSES IN THE AEGEAN ISLANDS.

Some remarks and findings from Table 1 are as follows.

- a) Public expenditure is much higher than private expenditure, in correspondence to the social character of the program. Private expenditure could be diminished further in case that some cost is funded by the public sector (e.g. this year PCs were offered to grade I pupils).
- b) With respect to infrastructure costs, it is likely that the host secondary school has already the required e-equipment. However the fast depreciation of such equipment justifies replacement costs.
- c) Technical support includes also continuous training in technical issues of the participating teachers
- d) Some cost categories as e-delivery and e-administration costs have the highest contribution in the structure of expenditure. This supports the view that distance learning is is no longer resource intensive [40].
- e) The unit cost per learner is higher at the extreme case of one pupil on an island. Even in this case however, given that the lowest teacher's salary is more than 20.000 euros per year, the total cost approached above is far lower than the cost necessary for employing three full-time teachers, necessary for the operation of a face-to-face course.
- f) As the number of pupils in the same island increases, the program's total cost rises too. However, as expected, the rise in cost is not proportionate to the number of learners and this is so because cost of infrastructure, administration and overhead, cost for educational material and teaching costs decreases indicating the presence of economies of scale.
- g) Compared with the cost of employing three teachers for operating a full-time course on the island, the distance method seems highly efficient.
- h) As the number of islands to which the program addresses increases, total cost for launching increases too, although the total rise is not proportional to the number of islands. Equipment cost at school remains fixed, administration costs increase slightly mainly due to the rise in travelling costs and some more hours spent on administrative and technical support. Teaching costs remain constant up to the case of fifteen learners (three islands). Once this number is exceeded, teaching costs are expected to increase so as to ascertain educational quality.

As with previous scenarios, in the case of the third scenario, the distance learning course provides a far more efficient method, in economic terms, than the operation of a similar face-to-face course.

TABLE I.
COST ESTIMATION IN DIFFERENT SCENARIOS

Scenario	1	2	3	4	5	6	7	8
No of islands	1	1	2	2	3	3	4	4
No of pupils	1	5	6	10	11	15	16	20
Cost category								
PC (type I)	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7
PC (type II)	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Camera	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Printer	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Data projector	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Infrastructure	1,9	1,9	1,9	1,9	1,9	1,9	1,9	1,9
Technical support	5,6	5,6	6,4	6,4	7,2	7,2	8,0	8,0
Administration	3,2	3,2	4,0	4,0	4,8	4,8	5,6	5,6
Overhead	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Initial training	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Travel expenses	1,2	1,2	2,4	2,4	3,6	3,6	4,8	4,8
Maintenance	0,5	0,5	1,0	1,0	1,5	1,5	2,0	2,0
Administration	12,5	12,5	15,8	15,8	19,1	19,1	22,4	20,0
Educ. material	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Teaching	10,1	10,1	10,1	10,1	10,1	10,1	14,5	14,5
PC	0,5	2,5	3,0	5,0	5,5	7,5	8,0	10,0
Travel expenses	1,3	6,5	7,8	13,0	14,3	19,5	20,8	26,0
Learner's expenses	1,8	9,0	10,8	18,0	19,8	27,0	28,8	36,0
Total cost	26,8	34,0	39,1	46,3	51,4	58,6	68,1	75,3
Total public cost	25,0	25,0	28,3	28,3	31,6	31,6	39,3	39,3
Total private cost	1,8	9,0	10,8	18,0	19,8	27,0	28,8	36,0

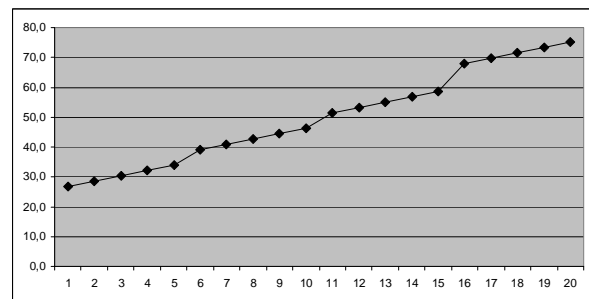


Diagram 2. Distance Education in small islands –Behaviour of total cost

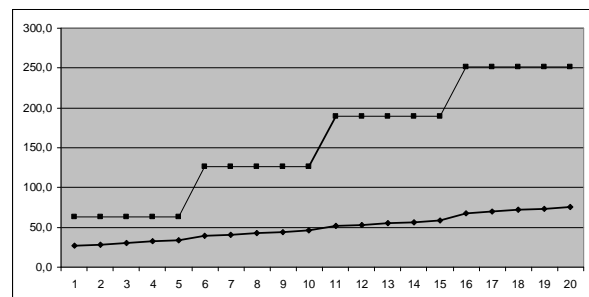


Diagram 3. Distance vs traditional education in small islands – Behaviour of cost

VI. CONCLUDING REMARKS

It is a challenge to design distance learning programs that can be addressed to learners in remote sites [1], [11], [14]. The challenge concerns two main criteria, educational effectiveness and cost efficiency. With respect to educational effectiveness,

With respect to cost efficiency -which is the subject of this work- this can be approached by reference to the major categories that constitute the expenditure of a distance course. Such categories are the educational material, teaching – tutoring, administration, infrastructure and access to the web [30]. The behaviour of these categories in time helps in providing a new cost structure that ascertains cost efficiency. Thus in the nineties and the beginning of the two-thousands it was well accepted that costs are driven by a series of factors among which the course population, the number of courses offered and the length of the course [30]. If the number of learners was small, then scale economies did not emerge and distance learning was expected to be less efficient in economic terms than face-to-face learning [35].

It is impressive up to what extent these costs have changed over time: Nowadays, ICT equipment is relatively cheaper, and most of the times already available in the learning institution. Viewing from the learner's aspect, while in the past joining a distance learning course was often connected with purchasing electronic hardware and software, now these are often part of the household's equipment. The same applies for the access to the web, which compared to the past is cheaper, more efficient and most of the times available in both, the learning organisation and the learner's household.

Furthermore, nowadays the need to train instructors and learners in the use of the computer and the web is many times a redundancy. Even if some instructions are required, the already existing background of knowledge by the participants limits significantly the time, hence also the cost, needed for this.

Given the behaviour of most cost categories, it is not surprising why distance learning courses prove to be competitive, even at very low number of remote learners, as is the extreme case that concerns courses designed for pupils of low-inhabited islands of the Aegean.

In spite of the simplified assumptions that were set, some of which should be further investigated, the study gives a schematic but realistic estimate of the cost structure of the designed distance course that promises to provide solutions to major educational problems at low cost. The major finding is that the cost of such solutions, under certain conditions, is far lower than that of any traditional course, even at the absence of scale economies. Of course, if the program is addressed to more pupils and/or more than one islands, the emergence of scale economies further increases the program's efficiency, thus multiplying its benefits.

It seems that the potential that distance learning provides is Among otthe work shows that in extreme cases of very small numbers of pupils, a situation often met in the small islands in the Aegean Sea, distance learning may solve the educational problem by providing education of good quality in a socially acceptable, but also economically efficient way.

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AUTHORS

Costas Tsolakidis, Assistant Professor, University of Aegean, 25 March 1, Rhodes 85100, Greece, (e-mail: tsolak@aegean.gr)

Persa Fokiali, Assistant Professor, University of Aegean, 25 March 1, Rhodes 85100, Greece, (e-mail: persa@rhodes.aegean.gr)

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