



Face to face or blended learning? A case study: Teacher training in the pedagogical use of ICT

Charalampos Zagouras^{1,2} · Demetra Egarchou¹ · Panayiotis Skiniotis¹ · Maria Fountana¹

Received: 20 May 2021 / Accepted: 26 May 2022

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract

We are experiencing a transitional period in education: from the traditional, face to face teaching model to new teaching and learning models that apply modern pedagogical approaches, utilize technological achievements and respond to current social needs. For a number of reasons including the recent pandemic covid-19 situation, technology enhanced distance learning, seems to gain ground against traditional face to face teaching and in fact, in a sharp way. Acknowledging that changes in education need time, research and careful steps in order to be successfully applied and established at large scale, in this paper we attempt to compare face to face (“traditional”) teacher training with teacher training through a blended learning approach/model. The latest combines characteristics of both face to face and distance learning models. The case study is based on a large-scale in-service teacher training initiative which has been taking place in Greece for over a decade to train teachers in the utilization and application of digital technologies in the teaching practice (i.e. *B-Level ICT Teacher Training*). The B-Level ICT Teacher Training was initially based exclusively on face to face teaching but it was later adapted to a specially designed blended learning model which combined both face to face and synchronous distance sessions, accompanied by asynchronous activities and supported by specific e-learning platforms and tools. The comparison refers to the effectiveness of the two models/ approaches, as it derives from teacher trainees’ performance, especially in the framework of the certification procedure that takes place through nationwide, independent exams that follow the training and assesses the relevant knowledge and skills acquired. Research findings point out better performances of a small or marginal scale for the teachers of various specialties who participated in blended learning teacher training programs compared to those who participated in traditional teacher training programs. Actually, it is shown that blended learning model trainees i) feel more comfortable to participate in the exams for the certification of knowledge and skills acquired, ii) have some better success rate and iii) get a bit higher grades in these exams. Thus, it can be argued that learning outcomes of the blended learning application in this teacher training initiative, overstep those of

Extended author information available on the last page of the article

the “traditional” model in a small scale and with some slight differentiations among teacher specialties.

Keywords Blended Learning · Face to Face Learning · Teacher Training · Teacher Professional Development · ICT in education · B-Level ICT Teacher Training · Certification of Teacher ICT skills

1 Introduction

1.1 The present situation

It seems that we are experiencing a transitional period in education. Actually, a transition from the traditional, face to face teaching model to new teaching and learning models that apply modern pedagogical approaches, utilize technological achievements and respond to current social needs.

In this framework, for a number of reasons (e.g. technology evolution, costing issues, special needs and situations) distance learning seems to gain ground against traditional face to face teaching (Kentnor, 2015; Kemp & Grieve, 2014). In fact, during the current unpleasant situation of the Covid-19 pandemic (Kusmaryono et al., 2021; Dhawan, 2020; Favale et al., 2020) the massive application of distance learning was enforced using digital technologies, in most cases without the necessary preparatory work, even in audiences where such a method is not generally considered as appropriate (e.g. school pupils).

On the other hand, changes in education need time in order to be successfully applied and established, prior research is also needed, whereas careful steps should be followed for the application of any change or innovation at large scale.

The study of a large scale teacher training program which a) was initially designed and successfully implemented for face to face teaching approach and subsequently, b) was carefully transformed for the blended learning approach maintaining some of the valuable trainer-trainees physical/synchronous contact and then, c) applied utilizing synchronous and asynchronous distance learning digital tools, may provide us with some interesting conclusions for the comparative learning results of these approaches and suggestions on how technology can effectively and essentially contribute to the learning process.

1.2 Related work

The term Blended Learning, often seen as used with ambiguous meaning (Hrastinski, 2019) that may signify the combination of two or more teaching or pedagogical approaches, media, contexts or learning objectives and is at times questioned for its aptness as a term (Oliver & Trigwell, 2005), is often described as involving a mix of online and face to face teaching (Graham et al., 2014; Driscoll, 2002). It is with this later definition that Blended learning is being adopted in the current case study, i.e. as a model that combines the characteristics of face to face and distance

learning model and which can be utilized for various educational audiences, including training actions for teachers concerning their professional development. The blended learning approach for the teacher training program that concerns our case study in this paper, as described in detail in Section 2.1, utilizes digital technologies and includes face to face and distance synchronous teaching, as well as asynchronous learning activities.

Actually, training actions, especially those addressing teachers, are implemented either a) face to face (traditional teaching), or b) from a distance, applying synchronous and/or asynchronous teaching and learning methodologies, using digital technologies (online learning), as well as c) combining of all the above-mentioned approaches/ models (blended learning).

Training actions concerning the utilization of digital technologies in school have special characteristics, since the use of digital tools, software and environments is included in the training subject itself, while participants' interaction and collaboration is needed. Furthermore, the knowledge to be gained and the skills to be acquired by the teacher trainees, in order to integrate digital technologies into their classes, are complicated since they effectively combine disciplines, technological media and pedagogical approaches in everyday teaching practice (Psillos, 2014).

These characteristics introduce additional issues, difficulties and challenges when distance education methodologies are selected, that may affect the training outcomes. Thus, some questions arise about the most effective teacher training method in order for participating teachers to meet the learning objectives and acquire the expected skills and competences.

Although many studies have been conducted on the application of distance education methodologies using digital media (online learning) (Moore et al., 2010), research on blended learning is scarce and most commonly addresses six (6) thematic categories: design issues, blended model as an education strategy, factors for effectiveness, evaluation, methodology issues, literature review for various levels of education (Zhang & Zhu, 2017).

Some research referring to specific case studies in various educational frameworks and to the comparison of different models, can be found in the above-mentioned thematic category of methodology issues. For example, comparative study between traditional and blended learning model applied to K-12 pupils in N. Zealand, based on learning outcomes and on the perceptions of both pupils and their teachers for the model they followed (traditional or blended learning model) didn't show any difference in pupils' assessed work between the two groups. On the contrary, there were differences in their perceptions regarding individual learning issues, connectedness, enjoyment and teacher support (Smith, 2013). Other indicative comparative studies concern a) English Language teaching for Mechanical Engineering students in Serbia, where higher "involvement" and higher marks were shown for blended learning model students (Šafranj, 2013), b) A course on Physical Education in Early Childhood in the Democritus University of Thrace, Greece, where significant differences were revealed in students' performance in the case of blended learning (Vernadakis et al., 2012), c) Courses on Medication administration for new nurses, where it was shown that a blended learning approach is useful and effective for this kind of education programs (Sung et al., 2008).

Furthermore, distance e-learning systems and services for covering the educational needs of remote and isolated areas have been developed and successfully tested, for instance: Teaching English Language in Small Remote Primary Schools (Egarchou et al., 2007) and Providing Lifelong Learning opportunities to adults living in small remote regions (Hadzilacos et al., 2009).

It has also been demonstrated “that in recent applications, purely online learning is equivalent to face to face instruction in effectiveness, and blended learning approaches have been more effective than instruction offered entirely in face to face mode” (Means et al., 2013).

More specifically, in studies concerning the application of blended learning model in teacher education or training actions, the feasibility of blending—integrating interactive e-learning and contact learning was shown, especially when learners construct professional knowledge and skills (Kupetz & Ziegenmeyer, 2005). It was also indicated that the combination of different training models (in-labs and on-line training, workshops etc.), was perceived as a challenging innovation by teachers and attracted their interest (Mouzakis et al., 2012). Moreover, specific issues and difficulties have been met for the design of a blended learning model for teacher training on ICT (Dagdilelis, 2014). In parallel, the design and pilot implementation of such a model for teachers of natural sciences (Psillos, 2014) and the respective conceptual design of the model for primary school teachers (Komis et al., 2014) were described and discussed. Regarding teachers’ perceptions on the integration of digital technologies in their lessons, significant difference, i.e. more positive attitude, has been observed among the teachers trained for this subject, through blended learning approaches (Qasem & Nathappa, 2016). Finally, the implementation of blended learning approaches sets specific additional requirements for trainers and trainees as well as for the development of the training material and activities etc., in order to reach the expected results (Byrka, 2017).

Nonetheless, there are still limited studies concerning the implementation of blended learning model in teacher education or training and thus, more empirical studies are needed as they could help to stimulate reflections on effective strategies for such a model design and implementation (Keengwe & Kang, 2013). This need becomes more imperative especially since the effectiveness of various schemas / structures for blended learning models depends on the specific characteristics of the program, the implementation conditions and the pedagogical approaches applied (Kim et al., 2015). Moreover, multiple parameters affect a successful implementation of a blended learning model such as the subject matter, the competences of the instructors, the quality of educational material and learning activities, the support provided for the learning procedure etc. (Lim, 2002).

1.3 About this paper

The implementation of the *B-Level ICT in-service teacher training in the utilization and application of digital technologies in the teaching practice*, a large-scale training action, taking place in Greece for more than ten years, allowed us to compare in this research, the traditional training model with the blended training model as it

was designed and implemented in this framework, and to evaluate their results. This comparison refers to the effectiveness of the two models/ approaches, as it derives from teacher trainees' performances, especially in the framework of the certification procedure regarding the knowledge and skills acquired, through exams that follow the training.

The following sections of this paper include: a description of the research environment, referring to a) the design and implementation of the B-Level ICT in-service teacher training through both the traditional / face to face and the blended learning model, b) the certification procedure which follows, as well as c) the research methodology and d) information about the data that were used (Section 2), the results of the two models comparative study in the present framework (Section 3) and finally, conclusions of our work in this research study (Section 4).

2 The research framework and methodology

2.1 The B-Level ICT teacher training, the “Traditional” and the blended learning model

The “*B-Level ICT Teacher Training*” or “*In-service teacher training in the utilization and application of information and communication technologies (ICT) in the teaching practice*” (full title) is a long-lasting and popular teacher training program of the Greek Ministry of Education, offered to Greek teachers since 2008 (<https://e-pimorfosi.cti.gr>, <http://b-epipedo2.cti.gr>).

This teacher training, in the form it was implemented from 2010 until 2015 where this study refers to, addressed teachers of the main specialties i.e. Language, Mathematics, Natural Science, Informatics, Primary School and Kindergarten teachers.

The main aim of B-Level ICT teacher training is to provide teachers with the knowledge and skills needed and to help them create a certain stance towards:

- the pedagogical utilization of digital technologies (e.g. educational software and tools, educational platforms, school digital infrastructure etc.) in the classroom
- being able to adapt new technology developments into their educational practice (i.e. not depend on specific tools and technologies)

Training content and objectives put special emphasis on the design of educational activities and scenarios, since their role in the integration of ICT in class is considered as significant and necessary. Furthermore, the “*in-class application of ICT*” phase of the program, during which trainees put into practice the knowledge and skills they acquire, by implementing educational activities using ICT in their classes with their pupils, constitutes a mandatory and integral part of the teacher training itself.

The training program had a duration of 5–6 months, including 96 teaching hours, accompanied by 24 more hours of supporting meetings for the preparation and review of “in-class application of ICT” activities Fig. 5. Trainers who undertook training sessions, are highly qualified teachers, i.e. coming from teachers' community themselves, selected through an open process, in order to attend a specialized

long educational program (380 h) in Universities and subsequently become certified for the role of “B-Level ICT Teacher Trainer” through demanding exams.

At the beginning, the *traditional training model* was followed, including entirely face to face sessions in Training Centers (Fig. 1), which are usually schools that provide for that purpose their computer labs, as well as support staff (e.g. technical support, program administration) during after school hours. In this framework, 2,057 training programs were implemented between 2010 and 2015, each of them addressing a group of 10–12 teacher trainees of the same or similar specialty.

However, through that method, it was not possible to cover the training needs in small remote and isolated areas, where there aren’t enough trainees (of the same specialty) to form a group or there is no trainer or training center available and thus, there is no possibility for implementing traditional – face to face training programs.

Thus, for covering remote or isolated, hard to reach areas (e.g. small islands, mountainous areas), as well as in the case of lack of training facilities, a *blended learning model*, appropriately designed to serve the specific training needs and objectives, was applied to a number of B-Level ICT training programs.

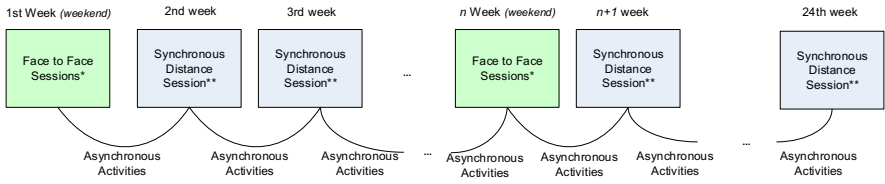
Interaction, effective communication and collaboration between trainer and trainees, as well as among the trainees themselves, constitute a significant asset of the B-Level ICT teacher training program, mainly achieved through the face to face contact and direct interaction during the lessons in the Training Centers, taking place twice a week, in case of traditional training programs. The pedagogical approach of the training program and the nature of its content, which includes lab classes and workshops (e.g. educational software and tools’ learning), discussions, exchange of experiences, ideas and opinions on educational scenarios etc., as an integral part of the learning process, make the above elements extremely necessary. This frequent contact, the discussions, the exchange of experiences, ideas and opinions contribute to building a team spirit and finally, to the creation of a learning community of practice, which usually remains active even after the end of the training program.

In typical distance education models the above elements are absent or difficult to be achieved. However, they are considered as crucial for the effectiveness of the B-Level ICT teacher training and thus, in the design of the blended learning model emphasis was put on keeping them, through regular (at least, on a weekly basis) synchronous distance learning sessions, using special tools (synchronous distance learning platform), as well as through a few number of face to face training sessions (Fig. 2).

Every blended training program consisted of a group of 10–12 teachers of the same or similar specialty and had a duration of 24 weeks. Training sessions were



Fig. 1 Snapshots from the implementation of B-Level ICT Teacher Training—Face to Face sessions



* Face to Face sessions are distributed across the 24-week training program in 4 weekends, each one including 2 Face to Face sessions (one 3-hour session in Saturday and one 3-hour session in Sunday)

** Synchronous Distance 3-hour sessions are taking place on a weekly basis through a synchronous distance learning platform (Blackboard Collaborate)

Fig. 2 Schematic representation of the B-Level ICT Teacher Training

taking place either face to face in the Training Center or synchronously from a distance (through the synchronous distance learning platform) and were accompanied by asynchronous activities across the course. In the same way as in the traditional B-Level ICT teacher training model, after the first 8 weeks, “in-class application of ICT” activities were introduced through the weekly “supporting meetings”, where the trainees were coached by their trainers for the implementation of educational activities using ICT in their classes with their pupils, and/or they were discussing on the outcomes of them after their application at school Fig. 5.

Face to face training sessions were taking place in four (4) weekends (3 h on Saturday and 3 h on Sunday, each weekend). Synchronous distance training sessions were taking place on a weekly basis, through the synchronous distance learning platform Blackboard Collaborate (Fig. 3), while the asynchronous activities were

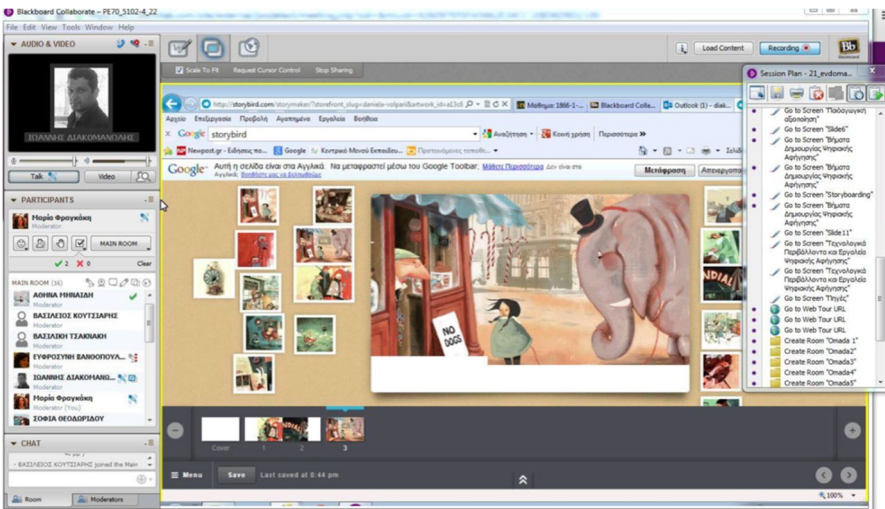


Fig. 3 A Snapshot from a synchronous distance B-Level ICT Training session—Screenshot of the synchronous distance learning platform supporting the B-Level ICT blended learning model

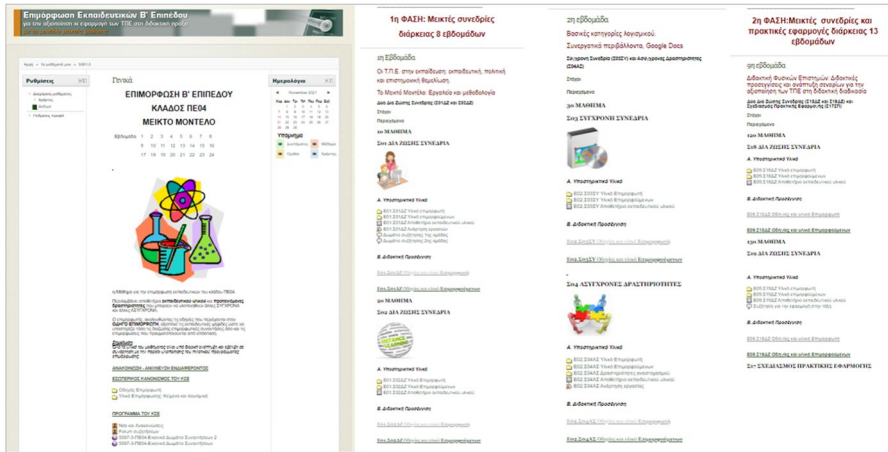


Fig. 4 Screenshots of the Learning Management System supporting the B-Level ICT Blended Learning Model (course materials, asynchronous activities etc.)

The B-Level ICT Teacher Training Program Implementation models

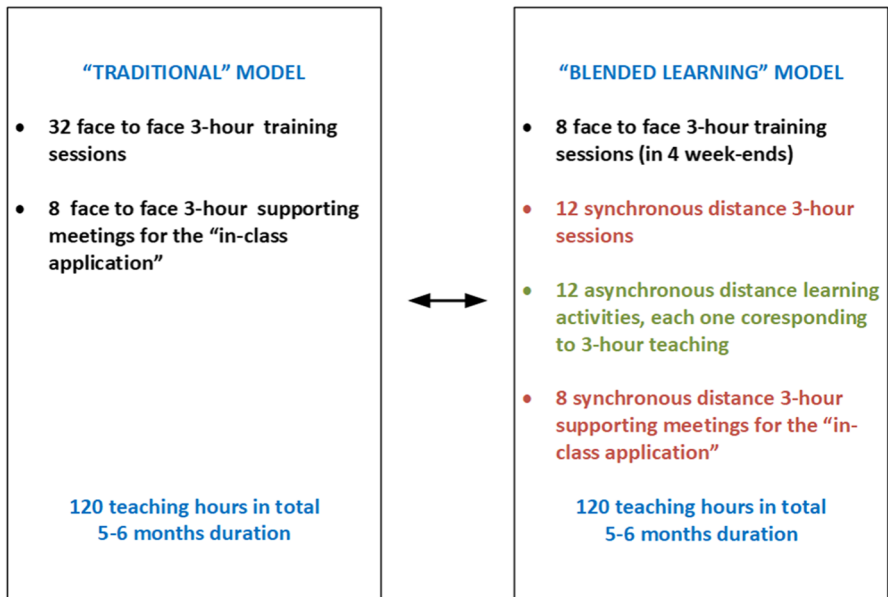


Fig. 5 The B-Level ICT teacher training program—implementation models

carried out using the Learning Management system (LMS) Moodle i.e. assignments, upload of work, assessing and grading, communication and collaboration etc. (Fig. 4). LMS was also used for the delivery of the training material. Tools for virtual class management and operation like video conferencing, application sharing,

whiteboard, chat, voting, recording etc. were also available by the synchronous distance learning platform.

Technical support was offered to the trainers and to the trainees by the technical staff of the training center during both the face to face meetings and the synchronous distance sessions. Help was also provided for various preparatory actions e.g. educational tools and software installation in trainees' laptops, connection to the platforms.

Consequently, the trainees of a blended training program were participating in face to face meetings of a total duration of 24 h, distributed in the course appropriately (at the beginning, in the middle and before the end). That way the contact and interaction elements that were previously mentioned, could create conditions towards ensuring the effectiveness of the distance communication and collaboration in the weekly synchronous sessions and asynchronous activities that followed, given also the technical support offered by the training center staff (Fig. 5).

The *B-Level ICT Blended Training model* was applied in a small number of programs, in two phases, in 2013–2014 time period. First pilot phase included ten (10) programs (two for each teacher specialty), that were implemented in order to test and improve the methods, the tools and the training material (formative evaluation). This phase was followed by a second one, including forty-five (45) programs, in order to offer the possibility of a further study of the results, before applying the model in a wider scale.

2.2 The B-Level ICT certification

Teacher Training is followed by a *certification process* regarding the knowledge and skills acquired by teacher trainees, through special, *independent, nationwide, digital exams* which take place in University Computer Labs acting as Certification Centers (Fig. 6).



Fig. 6 Snapshot from a B-Level ICT certification program (Teacher trainees sitting digital exams)

The aim of the certification process is to find out whether the teachers who attended the B-Level ICT Teacher Training, have gained the theoretical knowledge regarding the pedagogical utilization of ICT and have acquired the skills needed to be able to organize their teaching (in their specific specialty subjects) using digital technology tools.

The right to participate in the exams was offered only to the trainees who had successfully completed the training program, according to specific prerequisites regarding their presence in lessons (at least 90%), the “in-class application” activities using ICT, as well as, especially in the case of blended training model for the period studied in this paper, the elaboration of specific project activities (e.g. the development of educational scenarios using ICT) at the asynchronous phase of the course.

The computer-based exams (Fig. 7) have a duration of 4 h maximum and include two parts: a first part with automatically graded questions (e.g. multiple-choice questions) and a second one, concerning the development of an educational activity – scenario on a specific topic of a discipline in relation to their specialty (an essay, anonymously graded by a body of assessors consisting of B-Level Teacher Trainers) utilizing ICT.

In the first part of the exam, a test is assigned to each candidate who is asked to answer a number of questions of graduated difficulty on the training cognitive subjects. The questions are answered through a specialized certification software application and they are automatically graded. The development of questions follows specific rules and quality assurance processes, in order for a big test item bank to be constructed, which feeds the tests (Christakoudis et al., 2011). Some questions and their alternative answers are extremely simple while other ones are more complicated i.e. concerning a combination of concepts, understanding of specific situations, scenarios for software applications etc. Each candidate has to take a separate test i.e.

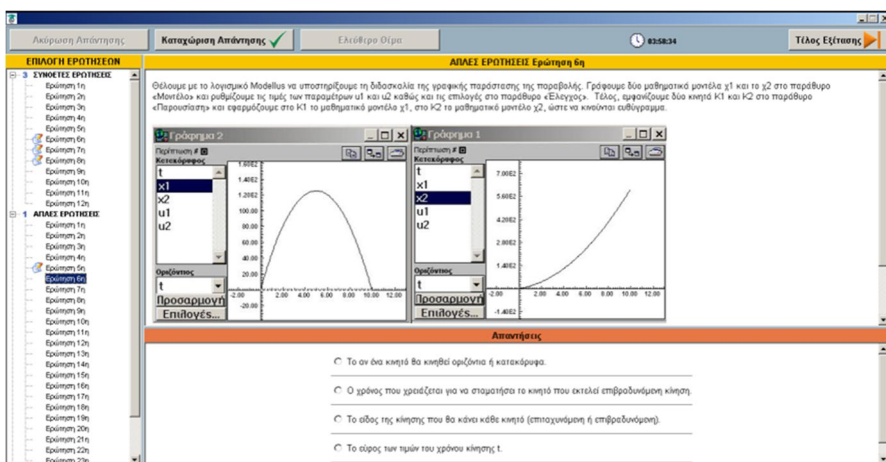


Fig. 7 Screenshot of the software application supporting the B-Level ICT certification process—digital exams

including different but equivalent questions selected randomly from the above-mentioned bank in a way that assures entirety, variety in types of questions, representation of the specific cognitive subjects, objectivity for the process, diversity of the tests while keeping the same difficulty level (Zagouras, 2005). The test item bank is frequently renewed following a specific process which includes: a) the addition of new questions in each new certification period, b) the removal of questions after their usage in a specific number of tests, c) improvement or replacement of questions according to a formative evaluation of the test results.

In the second part of the exam, the candidates are asked to free-write an essay on a specific theme concerning a lesson plan and its in-class application using ICT. This theme addresses all concepts that the teacher trainees faced during the training, mainly through the projects and activities they carried out. It mainly concerns educational scenarios and activities where educational or other software tools and environments were used as a significant part of the B-Level ICT Teacher Training process. These themes are only used once in the exams and are totally renewed for each new certification period.

The final certification grade derives from the formula: $G_{cert} = 0,40 * G_{partA} + 0,60 * G_{partB}$, where G_{partA} and G_{partB} refer respectively to the grades of the first and the second part of the exam, as described above. The participation of a teacher trainee in the exams is successful so that she/he is considered to be certified for the specific B-Level ICT knowledge and skills, if the final certification grade she/he got is at least 60 in 0–100 scale.

2.3 The methodology

This research was carried out by scientific staff of the organization responsible for the implementation of B-Level ICT Teacher training on behalf of the Greek Ministry of Education. It was carried out as part of a broader attempt to compare the B-Level ICT “traditional” and “blended learning” models, before proceeding with the application of the Blended learning model at a wider scale, acknowledging that changes in well-established education processes should be gradually and carefully applied in order to be successful.

The aim of this specific research is to study whether the approach/model i.e. the methodology followed for the implementation of the teacher training (traditional or blended learning model), affects the “performance” of the trainees, in the framework of their participation in the training program and more specifically, in the certification process of the knowledge and skills acquired that follows the training. In this framework the research questions attempted to be answered include: a) How are the rates of the trainees who successfully completed the training program affected by the different training approaches (i.e. the traditional versus the blended learning model)? b) How are the percentages of the trained teachers who participated successfully in the training program and then sat the exams compared in between the two approaches? c) How the success rates at the certification exams of the above two approaches are compared? d) How are the grades achieved at the exams compared in between the two categories of trainees? e) How is certain “poor” performance of the

trainees compared in between the two models? f) Is there any difference on the above “performance” factors between the various teacher specialties?

Therefore, the data examined as *indicators for the “performance” of the teacher participants* in the training and certification process refer to (Fig. 8): a) the successful or no completion of the training program, i.e. to the fulfillment of the minimum requirements such as the presence in the training sessions, the implementation of “in-class application” activities using ICT etc., in order to get the right to participate in the certification exams, b) to the participation in or abstention from the exams, as well as to c) the grades achieved at the certification exams (automatically graded questions and free-writing theme/ essay on an educational scenario / activity utilizing ICT).

For measuring and comparatively processing the above indicators, we used data from all the B-Level ICT Training programs implemented in 2010–2015 time period (of both traditional and blended learning model) all over Greece, where 23.689 teachers of “basic” specialties (Language, Mathematics, Natural Science, Informatics, Primary School and Kindergarten Teachers) participated.

Actually, it was not only a sample of data concerning a number of teacher trainees that was examined, but all the data concerning the trainees who participated

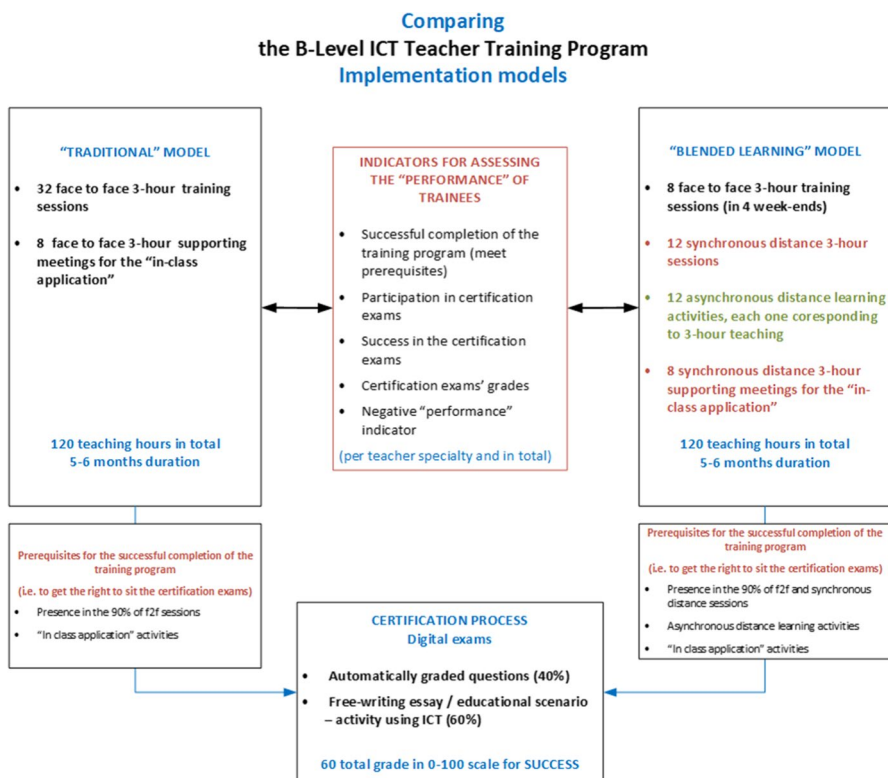


Fig. 8 Comparing the B-Level ICT teacher training program implementation models

in the above-mentioned training initiative in total. The authors of this paper, coming from the organization responsible for the implementation of B-Level ICT Teacher training, were able to access all the data needed for this research, through the Management Information System (MIS) supporting this large scale initiative. In specific, they collected and analysed the following data per teacher specialty and training model: a) the total number of trainees registered in the teacher training course, b) the total number of trainees who successfully completed the training course, c) the total number of trainees who participated in the certification, d) the grades of the trainees in these exams (and consequently the certification result: success or fail).

Based on the above data, the aforementioned indicators were examined through the comparison of the corresponding parameters presented in the following table (Fig. 9).

The comparative study of these parameters and indicators in between the two models (traditional and blended learning model) both in total and per teacher specialty, actually answers to the corresponding research questions above, and leads to the results of this research as presented in the following section.

INDICATORS FOR ASSESSING THE "PERFORMANCE" OF TRAINEES	CORRESPONDING CALCULATED PARAMETERS	
<ul style="list-style-type: none"> Successful completion of the training program (meet prerequisites) 	$a_1 = \frac{t_c}{t_r} (\%)$	where, t_c = Number of trainees who successfully completed the training program,
<ul style="list-style-type: none"> Participation in certification exams 	$a_2 = \frac{t_p}{t_c} (\%)$	t_r = Number of trainees who registered to the training program
<ul style="list-style-type: none"> Success in the certification exams 	$a_3 = \frac{t_s}{t_p} (\%)$	t_p = Number of trainees who participated in the certification exams,
<ul style="list-style-type: none"> Certification exams' grades 	$a_4 = \frac{\sum_{i=1}^{t_p} g_{t_i}}{t_p}$	t_s = Number of trainees who succeeded in the certification exams, g_{t_i} = grade of the t_i trainee in the certification exams, $i=1$ to t_p (in 0-100 scale)
<ul style="list-style-type: none"> Negative "performance" indicator 	$a_5 = \frac{t_{fc} + t_{fs}}{t_r} (\%)$	t_{fc} = Number of trainees who failed to complete the training program t_{fs} = Number of trainees who didn't succeed in the certification exams
(calculated per teacher specialty and in total, and compared in between traditional and blended learning model)		

Fig. 9 Indicators for assessing the "performance" of trainees and corresponding parameters calculated and compared in between traditional and blended learning model

3 Comparative assessment of the trainees' "performance" – results

The results of the research are presented below per indicator and per teacher specialty, as well as in total, for all teacher specialties.

3.1 Successful completion of the program

As aforementioned, in order for a teacher trainee to have successfully completed the B-Level ICT Training program and thus be eligible to participate in the respective certification exams, it is required that he/she is present in 90% of the training sessions (face to face and synchronous distance ones) as well as to have carried out a number of "in class application" activities using ICT. Especially in the case of the blended training model, a number of homework activities (e.g. the development of educational activities/ scenarios utilizing ICT) in the framework of the asynchronous part of the program, were also necessary.

The percentage of the teacher trainees who successfully completed the training program per teacher specialty and training model (parameter α_1 in Fig. 9), is presented in the following Table 1 and Fig. 10.

The percentage of the trainees who successfully completed the training program is high, over 93% for all the teacher specialties. However, we can see some small differences between the trainees of blended training programs and those of traditional ones, indicating a small lead of the blended training model for the Primary School, Physics and Language Teachers (up to 3,5 percentage units, in the case of Primary Teachers), as well as a small lead of traditional training model for Kindergarten, Informatics and Mathematics teachers (up to 4,2 percentage units, in the case of Kindergarten teachers).

3.2 Participation in certification exams

The teacher trainee who successfully completes the training program gets the right to participate in the certification exams. As this certification contributes to the professional development of the teachers and their placement in higher positions of responsibility (as a criterion), teachers who successfully complete this training program wish, in general, to get the B-Level ICT certification and thus, they sit the

Table 1 Percentage of teacher trainees who successfully completed the training program

Teacher specialty	Traditional training model	Blended training model
Language	96,85%	97,06%
Mathematics	93,79%	93,41%
Natural Science	94,41%	95,60%
Informatics	97,22%	96,13%
Kindergarten	97,97%	93,75%
Primary School	96,55%	100,00%

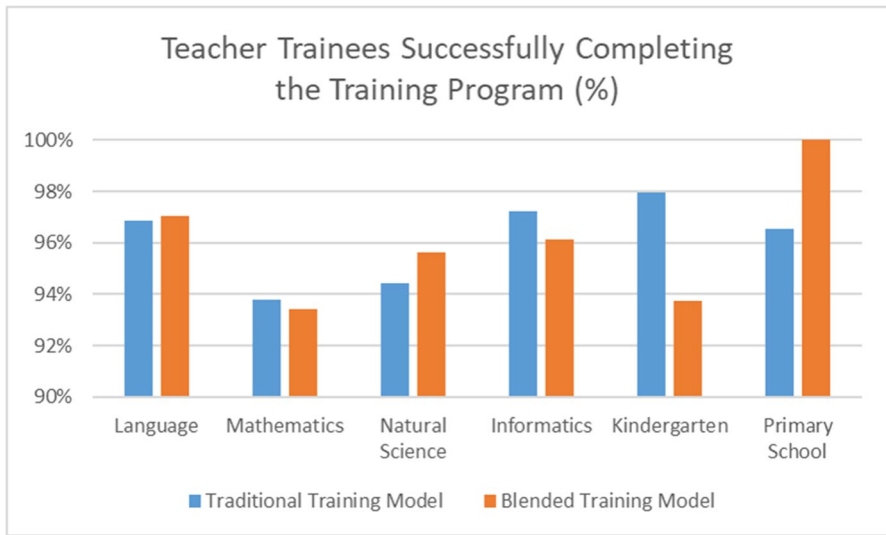


Fig. 10 Percentage of teacher trainees who successfully completed the training program

respective exams. The abstention from the exams may show that the trainee feels insecure and unconfident regarding the respective knowledge and skills expected to have been acquired, and for that reason this element was selected as one of the indicators of the trainees' "performance".

The percentage of the teacher trainees who participated in the certification exams (parameter α_2 in Fig. 9), per teacher specialty and training model is presented in the following Table 2 and Fig. 11.

The percentage of the teacher trainees who sat the exams ranges from 78 to 90% in the case of the traditional training model, and from 85 to 97% in the case of the blended training model. Thus, a noticeably higher percentage was found in the case of the trainees of blended learning programs for all teacher specialties, with the Primary School teachers on top, with a difference of 10,54 percentage units, followed by the Mathematics teachers, with a difference of 7,69 percentage units and the Language teachers on bottom, with a difference of 3,11 percentage units.

Table 2 Percentage of teacher trainees who participated in certification exams

Teacher specialty	Traditional training model	Blended training model
Language	86,28%	89,39%
Mathematics	78,19%	85,88%
Natural Science	81,78%	85,06%
Informatics	82,80%	87,92%
Kindergarten	90,96%	96,67%
Primary School	85,15%	95,70%

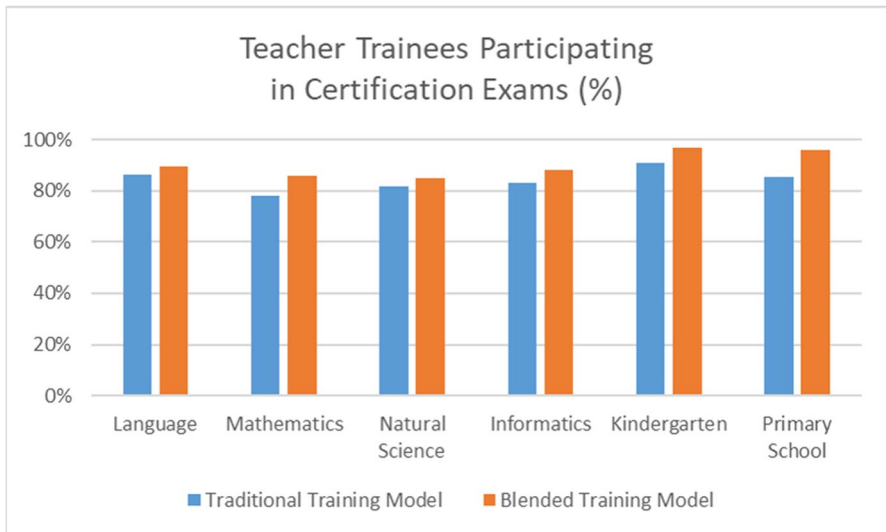


Fig. 11 Percentage of teacher trainees who participated in certification exams

3.3 Success in the certification exams

As aforementioned, the participation of a teacher trainee in the certification exams is considered as successful if the final certification grade, deriving from the grades of the first part (automatically graded questions) and the second part (free-writing theme/ essay on an educational scenario / activity utilizing ICT) of the certification exam, she/he got is at least 60 in 0–100 scale.

The percentage of the teacher trainees who succeeded in the certification exams (i.e. those who got final certification grade ≥ 60) per teacher specialty and training model (parameter α_3 in Fig. 9) is presented in the following Table 3 and Fig. 12.

The percentage of the teacher trainees who succeeded in the certification exams is generally high ($> 91\%$), regardless of the teacher specialties and the training model. Besides, in the case of the blended training model a minor overstepping is observed

Table 3 Percentage of Teacher Trainees who succeeded in Certification Exams

Teacher specialty	Traditional training model	Blended training model
Language	99,34%	99,44%
Mathematics	91,24%	95,89%
Natural Science	95,00%	95,95%
Informatics	96,77%	96,95%
Kindergarten	99,84%	100,00%
Primary School	97,99%	97,75%

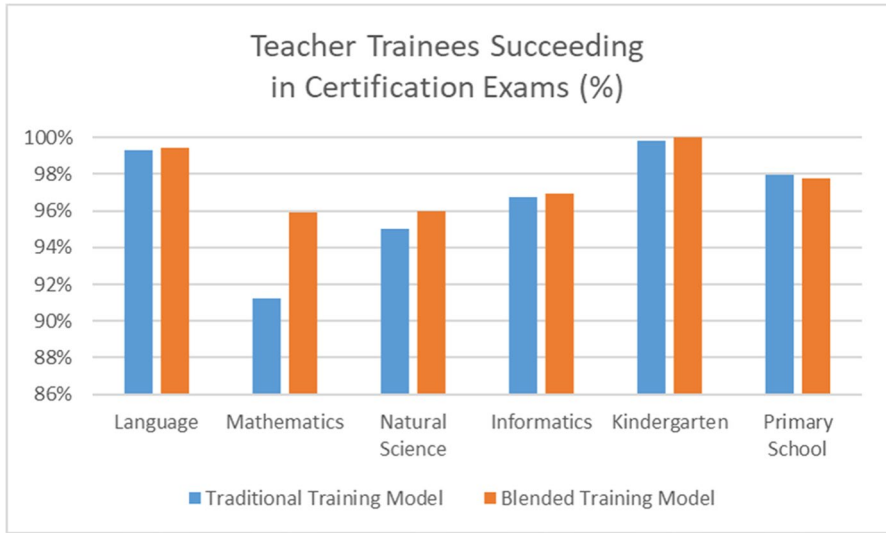


Fig. 12 Percentage of teacher trainees who succeeded in certification exams

(less than one percentage unit), with a positive exception at the Mathematics teachers where the percentage is 4,65 units higher and a negative exception at the Primary School teachers, where it seems that the percentage for the traditional model is marginally greater (0,24 percentage units).

3.4 Certification exams' grades

The grades achieved by the teacher trainees in the certification exams and more specifically, both the final certification grade and the grade of each part of the exam (automatically graded questions and free-writing theme) distinctly (since each part corresponds to different knowledge and/or skills – competences), were the next indicators considered appropriate to be examined.

For that reason, the average (AVG) of grades of all the trainees who participated in the certification exams, was calculated per teacher specialty and training model.

The average of all trainees' *final certification grades* (regardless of the final result), per teacher specialty and training model (parameter α_4 in Fig. 9) is presented in the following Table 4 and Fig. 13.

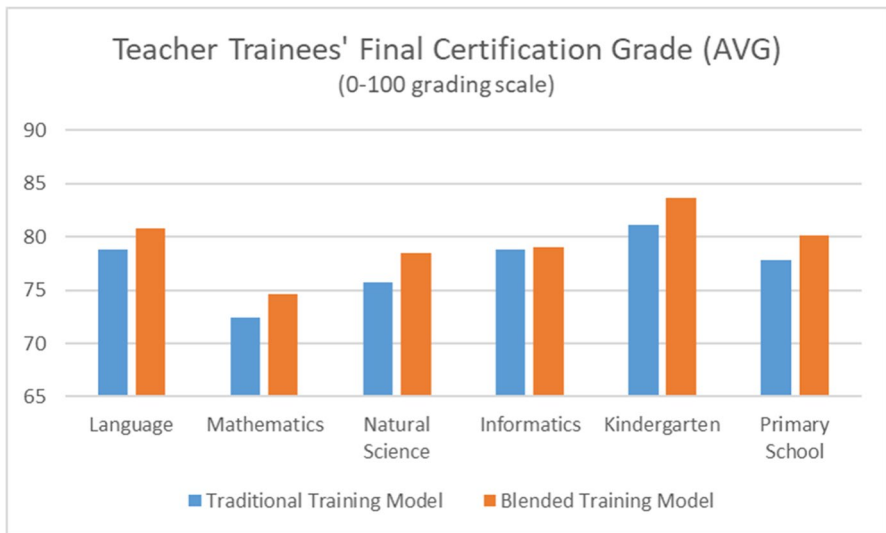
It is noted that the blended learning model trainees got 2–3 units better *final certification grade* on average (in scale 0–100), with an exception in the case of Informatics teachers, where this difference is only 0,16 units.

Below, the average of all trainees' *grades corresponding to the first part (automatically graded questions)* and to the *second part (free-writing theme/ educational scenario – activity utilizing ICT)* of the certification exam are presented distinctly, per teacher specialty and training model (Table 5, Fig. 14, Table 6, Fig. 15).

Table 4 Average of teacher trainees final certification grades

Teacher specialty	Traditional training model	Blended training model
Language	78,85	80,79
Mathematics	72,44	74,57
Natural Science	75,71	78,43
Informatics	78,83	78,99
Kindergarten	81,09	83,67
Primary School	77,83	80,18

According to this data, the situation with the averages of all *trainees' grades for the first or the second part* seems similar to the one of the final certification grades, as no essential differentiation to this is observed. More specifically, both first and second part average grades are similarly 2 – 4 units higher (in scale 0–100) in the case of the blended learning model trainees, with a positive exception at Kindergarten teachers for the first part of the certification exam where a higher overstepping in blended training model is observed (6,75 units difference) and for the second part of the certification exam, negative exceptions at Informatics and Kindergarten teachers where a marginal overstepping of the traditional training model is observed (0,16 and 0,21 units differences, respectively).

**Fig. 13** Average of teacher trainees final certification grades

3.5 Negative “Performance” indicator

Table 5 Average of teacher trainees’ grades in part a of certification exams (Automatically Graded Questions)

Teacher specialty	Traditional training model	Blended training model
Language	85,42	87,69
Mathematics	78,51	80,45
Natural Science	74,16	77,93
Informatics	83,74	84,37
Kindergarten	81,83	88,58
Primary School	81,27	83,82

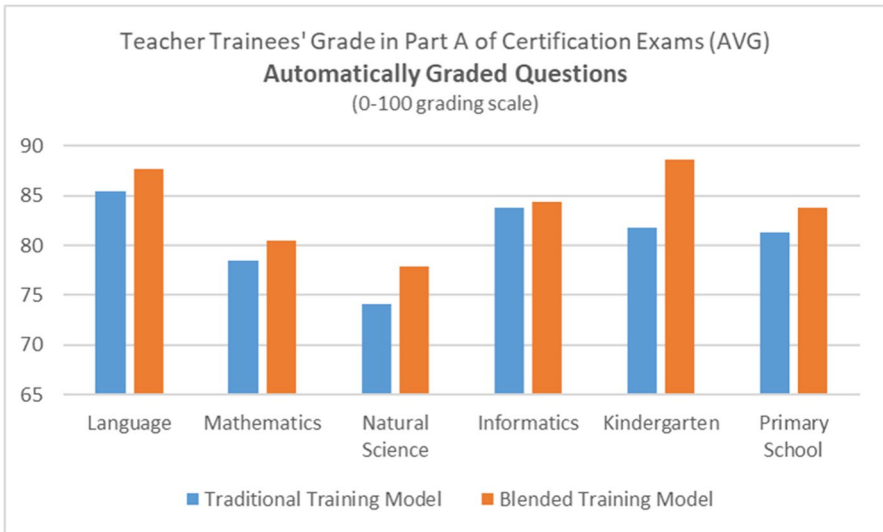


Fig. 14 Average of teacher trainees’ grades in Part A of certification exams (Automatically Graded Questions)

Table 6 Average of teacher trainees’ grades in Part B of certification exams (Essay—Educational Scenario)

Teacher specialty	Traditional training model	Blended training model
Language	74,48	76,20
Mathematics	68,40	70,64
Natural Science	76,72	78,77
Informatics	75,56	75,40
Kindergarten	80,61	80,40
Primary School	75,53	77,75

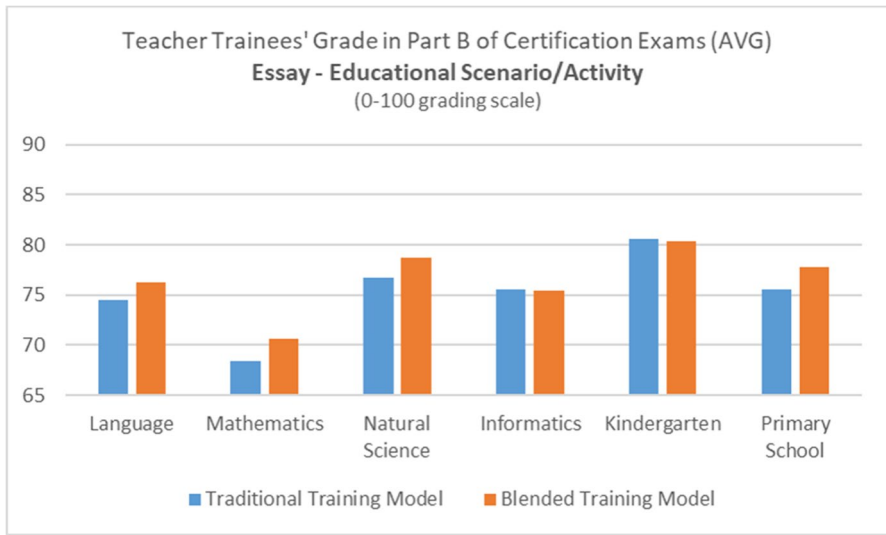


Fig. 15 Average of teacher trainees' grades in Part B of certification exams (Essay—Educational Scenario)

Obviously, unsuccessful completion of the training program or unsuccessful participation in the certification exams mean a negative “performance” for the respective training participants. Thus, the sum of the *percentage of the teacher trainees who didn't successfully complete the training program* and the *percentage of the teacher trainees who didn't succeed in the certification exams* could be an indicator of “negative (poor) performance” for all the training participants (Negative/ Poor “Performance” rate) and for that reason, it was also examined per teacher specialty and training model.

The percentage of the teacher trainees who either didn't successfully complete the training program or didn't succeed in the certification exams (i.e. they got a final grade < 60 in scale 0–100), per teacher specialty and training model (parameter α_5 in Fig. 9), is presented in the following Table 7 and Fig. 16.

This indicator, corresponding to “negative/poor” performances of the B-Level ICT Teacher Training, is generally displayed with low values. In traditional training model the values range from 2,2% for Kindergarten teachers to 12,6% for Mathematics Teachers. In blended training model these values appear a little lower, ranging from 2,1% for Primary School Teachers to 9,9% for Mathematics Teachers, indicating in general, a marginally better performance for the blended learning model trainees. However, the higher values of this indicator for Informatics and Kindergarten teachers (a difference of 1,1 and 4,1 percentage units, respectively), present in contrary a better performance of the traditional training model in these cases.

Table 7 Negative "Performance" rate (unsuccessful completion of the training or failure in certification exams)

Teacher specialty	Traditional training model	Blended training model
Language	3,70%	3,43%
Mathematics	12,64%	9,89%
Natural Science	9,45%	7,69%
Informatics	5,38%	6,45%
Kindergarten	2,18%	6,25%
Primary School	5,10%	2,15%

3.6 Overall teacher trainees' "performance" (regardless of teacher specialty)

In addition, the above mentioned "performance" indicators were examined for all the teachers who participated in traditional training programs or in blended training program, as a total, i.e. regardless of teacher specialty.

In the following Table 8 and Fig. 17 there are presented for all the B-level ICT teacher trainees, regardless their teacher specialty (per training model): a) the percentage of the trainees who successfully completed the training program (parameter α_1 in Fig. 9), b) the percentage of the trainees who sat the certification exams (parameter α_2 in Fig. 9), c) the percentage of the trainees who succeeded in the certification exams (parameter α_3 in Fig. 9), as well as d) the indicator of negative/poor performance corresponding to the sum of the percentages of the trainees who didn't complete successfully the training program and them who didn't succeed in the certification exams (parameter α_5 in Fig. 9).

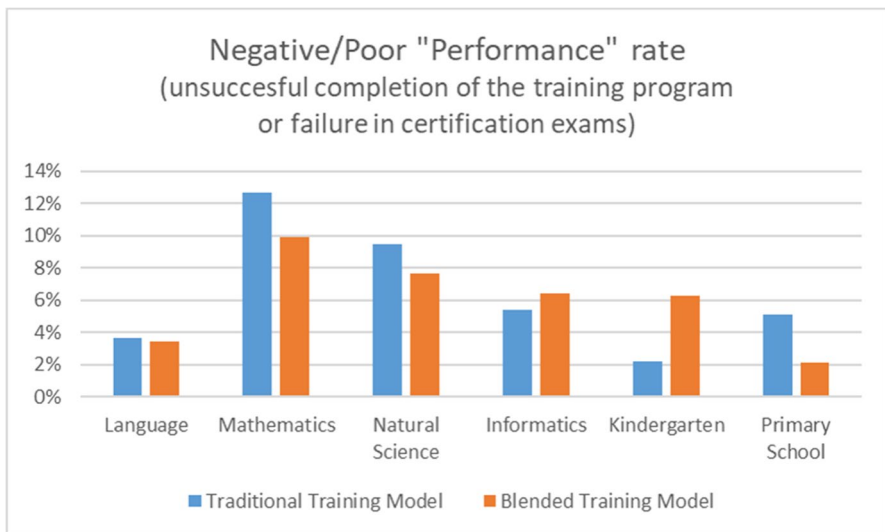
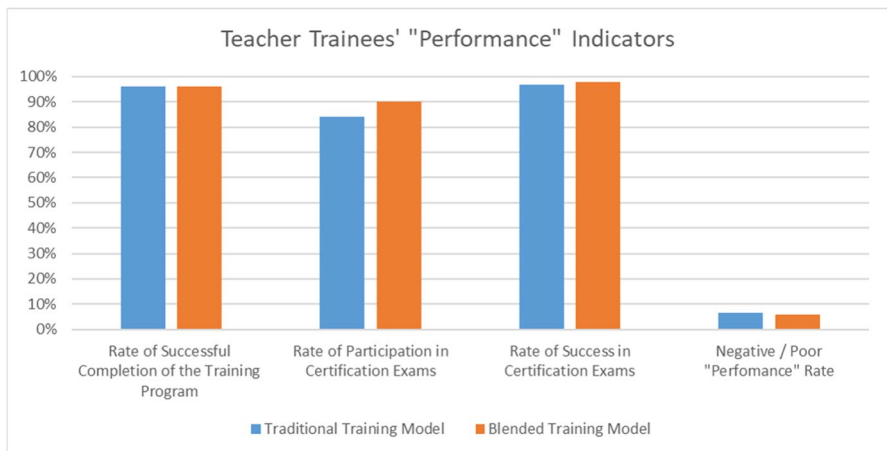


Fig. 16 Negative "Performance" rate (unsuccessful completion of the training or failure in certification exams)

Table 8 Teacher trainees' "Performance" indicators

Teacher trainees' "Performance" indicator	Traditional training model	Blended training model
Rate of Successful Completion of the Training Program	96,13%	95,99%
Rate of Participation in Certification Exams	84,20%	90,10%
Rate of Success in Certification Exams	96,70%	97,66%
Negative / Poor "Performance" Rate	6,41%	5,98%

**Fig. 17** Teacher trainees' "Performance" indicators

In the above data a slightly better performance appears among trainees of the blended learning model, as we can see 5,91 units overstepping at the percentage of the trainees who sat the exams and 0,96 units overstepping at the percentage of the trainees who succeeded in the certification exams, as well as 0,43 percentage units decrease to the negative/poor performance indicator. A minor increase of 0,14 units to the percentage of the traditional model trainees who successfully completed the training program, is also noted.

Finally, the grades achieved by the trainees in the certification exams, were studied overall, regardless the teacher specialties.

In the following Table 9 and Fig. 18, for all the B-level ICT teacher trainees, regardless of their teacher specialty (per training model), the following data are presented (in reference to parameter α_4 in Fig. 9): a) the average of all trainees' grades corresponding to the first part (automatically graded questions) of the certification exams, b) the average of all trainees' grades corresponding to the second part (free-writing theme/ educational scenario – activity utilizing ICT) of the certification exams and c) the average of all trainees' final certification grades (deriving from the grades of the above two parts).

Table 9 Teacher Trainees' Certification Grades

Teacher trainees' certification grades (Total Average, 0–100 scale)	Traditional training model	Blended training model
Grade in Part A of Certification Exams: Automatically Graded Questions	80,82	83,81
Grade in Part B of Certification Exams: Essay—Educational Scenario/Activity	75,22	76,53
Final Certification Grade	77,46	79,44

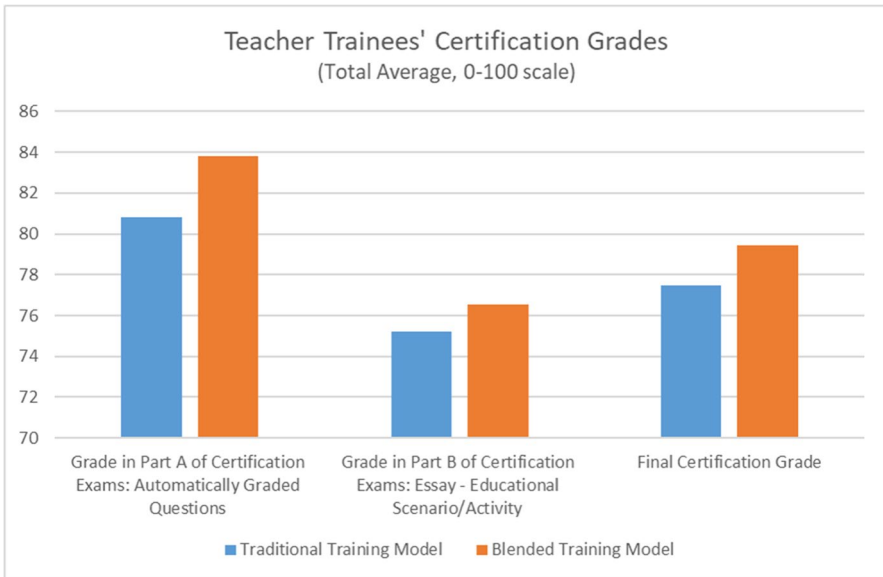


Fig. 18 Teacher trainees' certification grades

Concerning the final certification grade, according to the above data, higher grades for the trainees of blended learning programs are clearly observed (by 2 units, in 0–100 scale). This difference inheres obviously in the grades of the first and the second part of the exam, where higher grades, by 3 and 1,3 percentage units respectively, appear. This better performance for the trainees of blended learning programs, especially in the second part of the exam (essay/ educational scenario—activity utilizing ICT), could result from the increased involvement of the participants with the training subjects, carrying out relevant projects and activities in the framework of the asynchronous part of the blended training program.

4 Discussion—conclusions

In this paper we attempted to compare “*traditional*” *teacher training* (taking place entirely through face to face sessions) with *teacher training through blended learning approach/ model* (including both face to face and synchronous distance sessions accompanied by asynchronous activities), as it was designed and implemented in the in-service teacher training for the utilization and application of digital technologies in the teaching practice (B-Level ICT Teacher Training) that has been taking place in Greece for more than ten years. In response to a need for further research towards this direction (Garrison & Kanuka, 2004; Watson, 2008), this comparison refers to assessing the effectiveness of the two models/ approaches, as it derives from teacher trainees’ performances, especially in the framework of the certification procedure regarding the knowledge and skills acquired, through exams that follow the training.

In the present research we haven’t dealt with the various elements of the two training models, but we based their comparison on the final results, focusing on the learning outcomes of the trainees, as they derive from the final certification process (nationwide-independent digital exams).

Research findings show better performances of a small or marginal scale for the teachers who participated in blended learning teacher training programs compared to those who participated in traditional teacher training programs, in consistency with relevant research that reports blended learning as offering a slight advantage regarding overall student success and withdrawal rates (Dziuban et al., 2018; Means et al., 2010; Youngers, 2014).

Furthermore, some other aspects could be considered as factors that have influenced trainees’ improved performance in the blended training model, such as: a) the fact that the training activities in the technology enhanced blended training model were designed in a way which allowed a satisfying continuation and a strong link between face to face training sessions and synchronous distance training sessions with asynchronous activities, thus a strong integration between the two (Casanova & Moreira, 2017; Dagdilelis, 2014; Komis et al., 2014), b) the flexibility of the technology enhanced blended training model that enabled the trainees to experience a more personalized learning experience, which strengthened their confidence in sitting the certification exams (Casanova & Moreira, 2017; Dagdilelis, 2014; Komis et al., 2014), as well as c) the impact that technology had on the learning process, in the current blended training program (Casanova & Moreira, 2017).

Looking closer, B-Level ICT Teacher Training is a popular and successful training action for the Greek educational community and thus, both the percentage of trainees that successfully complete the program and the percentage of trainees who succeed in the certification exams, was always very high as long as the traditional training model was followed (96% and 97%, respectively). So, these too high percentage values don’t allow any major upward differentiation for the case of the blended training model. However, it seems that there is a minor lead at the blended training model percentage values referring to the trainees’

success rate in the certification exams (by around one percentage unit), as well as to the respective certification grades (an average of 2 units in 0–100 scale at the final certification grades and 1–3 units at the grades of part A and B of the exam). In addition, there is a difference at the percentage of the trainees who sat the exams (approximately 6 percentage units), which could mean that the participants of blended training programs feel better prepared for the exams, because of their greater involvement with the training subjects through carrying out projects and educational activities (e.g. educational scenarios-activities utilizing ICT etc.), especially in the framework of the asynchronous sessions of the program.

Studying the various teacher specialties separately, it's worth noting some better "performance" values in the case of the blended training model a) for the Mathematics teachers, both the percentage of the trainees who sat the exams, which appears about 8 units higher than the one in the case of traditional training model and the percentage of the trainees who succeeded in the certification exams, which appears about 4,65 units higher, with higher average grades as well (by 2,12 units) and b) for the Natural Science teachers, the certification grades which appear about 3 units higher (bigger difference of all specialties). In addition, the case of Informatics teachers seems interesting, as in essence there is no difference at the trainees' "performance" between the two models, while a few more blended learning model trainees drop out and do not successfully complete the training program (a difference in the order of 1%). Similar picture with the one of the Informatics teachers, with a little bigger difference at the percentage of the blended learning model trainees who do not complete the training program, appears for the Kindergarten teachers. Besides, it's worth also noting that the success rate in the certification exams for the Kindergarten teachers is extremely high (approximately 100%) and remains the same in both models. This is in line with other research findings on the perceptions and practices for the utilization of ICT addressing Kindergarten teachers who have attended B-Level ICT teacher training, where their satisfaction from the training and their positive attitude for integrating ICT in their everyday teaching practice, are highlighted (Komis et al., 2015). Finally, it is impressive that in the case of the Primary School teachers, the percentage of blended learning model trainees who sat the exam are more than 10 units higher than the one of the traditional model trainees. This difference, similarly to the case of Kindergarten teachers, is not reflected in the success rate of the certification exam, which remains at the same high level (approximately 98%).

Consequently, the research findings lead to the basic conclusion that the application of the blended learning model in a teacher training action regarding the utilization of digital technologies in the teaching practice, for instance the combination of face to face training sessions and synchronous distance training sessions with asynchronous activities (supported by digital technologies), presents greater effectiveness of a small or marginal scale (depending on the teacher specialty) than the traditional training model which entirely consists of face to face sessions.

As described in the summary of references in previous related research studies included in the introduction section of this paper (Section 1), the results and the basic conclusion of our research in general is in line with related published findings and conclusions (Dziuban et al., 2018; Means et al., 2010; Youngers, 2014).

However, recently, especially in the era of pandemic covid-19, where on line learning or blended learning were implemented in a rough way even in audiences where such a method is not considered as appropriate, there are some findings stating that face to face learning is preferable and possibly more efficient for the learners (Atwa et al., 2022; Nasution et al., 2021).

Furthermore, as this research doesn't deal with the various elements of the two training models, but is limited to the comparison of the trainees' performance mainly based on the final certification process (through nationwide-independent digital exams), other issues concerning elaboration of qualitative data remain open. These issues could be considered as limitations of our study or subject for further research in the future and include the perceptions of the teacher trainees and the teacher trainers on the application of the training models, the comparison of an entirely distance training model with the blended one including additional face to face activities, the contribution of the particular elements and the characteristics of the models (i.e. the specific design of each model) in the effectiveness of the training program for the utilization of ICT in the teaching practice etc.

Data availability The datasets generated or analysed during the current study are available from the first author of this paper, who is the scientific coordinator of the B-Level ICT teacher training initiative in Greece, on reasonable request.

Declarations

Conflict of interest None.

References

- "In-service Training of Teachers for the utilization and application of ICT in the teaching practice". (n.d.). *Projects of the Operational Programme "Lifelong Learning", NSRF (2007–2013)*. <http://b-epipedo2.cti.gr/>. Accessed June 2022.
- "In-service Training of Teachers in the utilization and application of Digital Technologies in the teaching practice" (B-Level ICT Teacher Training)". (n.d.). *Project of the Operational Program "Human Resources Development, Education and Lifelong Learning", NSRF (2014–2020)*. <https://e-pimor.fosi.cti.gr/>. Accessed June 2022
- Atwa, H., Shehata, M. H., Al-Ansari, A., Kumar, A., Jaradat, A., Ahmed, J., & Deifalla, A. (2022). Online, face-to-face, or blended learning? Faculty and medical students' perceptions during the COVID-19 pandemic: A mixed-method study. *Frontiers in Medicine*, 9, 1–12. <https://doi.org/10.3389/fmed.2022.791352>
- Byrka, M. F. (2017). Blended learning strategy in teacher training programs. *Інформаційні Технології і Засоби Навчання*, 62(6), 216–224.
- Casanova, D., & Moreira, A. (2017). A model for discussing the quality of technology-enhanced learning in blended learning programmes. *International Journal of Mobile and Blended Learning*, 9(4), 1–20. <https://doi.org/10.4018/IJMBL.201710010>
- Christakoudis, C., Androulakis, G. S., & Zagouras, C. (2011). Prepare items for large scale computer based assessment: Case study for teachers' certification on basic computer skills. *Procedia-Social and Behavioral Sciences*, 29, 1189–1198.
- Dagdilelis, V. (2014). The blended learning model for Teacher training as a combinatorial innovation: Design problems (in Greek), 9th Panhellenic Conference with International Participation "Information and Communication Technologies in Education"

- Dhawan, S. (2020). Online learning: A panacea in the time of Covid-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>
- Driscoll, M. (2002). Blended learning: Let's get beyond the hype. *e-Learning*, 1(4), 1–4.
- Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: The new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, 15(1), 1–16. <https://doi.org/10.1186/s41239-017-0087-5>
- Egarchou, D., Fountana, M., Roniotes, C., Hadzilacos, T., Sifakis, N. (2007). What we have learned from the implementation of the MustLearnIT project: The Greek point of view and experience, *In Using ICT for Special Subject Distance Learning in Multigrade Schools: Proceedings of the MustLearnIT Conference*, Syros, Greece. Internet edition [pro1, 15 pages]
- Favale, Th., Soro, F., Trevisan, M., Drago, I., & Mellia, M. (2020). Campus traffic and e-Learning during COVID-19 pandemic. *Computer Networks*, 176, 107290. <https://doi.org/10.1016/j.comnet.2020.107290>
- Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, 7(2), 95–105. <https://doi.org/10.1016/j.iheduc.2004.02.001>
- Graham, C. R., Henrie, C. R., & Gibbons, A. S. (2014). Developing models and theory for blended learning research. *Blended Learning: Research Perspectives*, 2, 13–33.
- Hadzilacos, T., Sifakis, N., Egarchou, D., & Fountana, M. (2009). Making the best of what we have: Life-long distance e-learning revitalizing small remote schools. *International Conference for Open and Distance Education*, 5(2A), 219–227.
- Hrastinski, S. (2019). What do we mean by blended learning? *TechTrends*, 63(5), 564–569. <https://doi.org/10.1007/s11528-019-00375-5>
- Keengwe, J. & Kang, J-J. (2013). A review of empirical research on blended learning in teacher education programs. *Education and Information Technologies* 18,479–493. <https://doi.org/10.1007/s10639-011-9182-8>
- Kemp, N., & Grieve, R. (2014). Face-to-face or face-to-screen? Undergraduates' opinions and test performance in classroom vs. Online learning. *Frontiers in Psychology*, 5(NOV), 1–11. <https://doi.org/10.3389/fpsyg.2014.01278>
- Kentnor, H. (2015). Digital Commons @ DU Sturm College of Law : Faculty scholarship distance education and the evolution of online learning in the United States distance education and the evolution of online learning in the United States. *Curriculum and Teaching Dialogue*, Vol. 17, Nos. 1 & 2, 2015
- Kim, J. H., Baylen, D. M., Leh, A. & Lin, L. (2015). Blended learning in teacher education: Uncovering its transformative potential for teacher preparation programs, *Handbook of research on enhancing teacher education with advanced instructional technologies* (pp. 166–185), IGI Global
- Komis, V., Zagouras, C., Egarchou, D., Skountzis, Goumenakis, G., Simotas, C., Voulgari, I., Misirli, A., Tzavara, A, Fragkaki, M., (2014). The conceptual design of a blended training model for primary school teachers (in Greek), *9th Panhellenic Conference with International Participation "Information and Communication Technologies in Education"*
- Komis, V., Tsourapi, C., Lavidas C., Zagouras C. (2015). Perceptions and Practices concerning the utilization of ICT in the educational process by pre-school teachers participated in B-Level ICT Teacher Training (in Greek), *4th Panhellenic Conference "Integration of ICT in the educational process"*, ETPE, AUTH & UOM, Thessaloniki
- Kupetz, R., & Ziegenmeyer, B. (2005). Blended learning in a teacher training course: Integrated interactive e-learning and contact learning. *ReCALL*, 17(2), 179–196.
- Kusmaryono, I., Jupriyanto, & Kusumaningsih, W. (2021). A systematic literature review on the effectiveness of distance learning: Problems, opportunities, challenges, and predictions. *International Journal of Education*, 14(1), 62–69. <https://doi.org/10.17509/ije.v14i1.29191>
- Lim, D. H. (2002). Perceived differences between classroom and distance education: Seeking instructional strategies for learning application. *International Journal of Educational Technology*, 3(1). <https://eric.ed.gov/?id=EJ664856>. Accessed June 2022
- Means, B., Toyama, Y., Murhy, R., & Baki, M. (2013). *The effectiveness of online and blended learning: A meta-analysis of the empirical literature*. Columbia University.
- Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of evidence-based practices in online learning: A Meta-Analysis and Review of Online Learning Studies. U.S. Department of Education, Center for Technology in Learning. <https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf>. Accessed June 2022

- Moore, J. L., Dickson-deane, C., & Galyen, K. (2010). e-Learning, online learning, and distance learning environments: Are they the same?. *Internet and Higher Education*. <https://doi.org/10.1016/j.iheduc.2010.10.001>
- Mouzakis, C., Tsaknakis, H., & Tziortzioti, C. (2012). Theoretical rationale for designing a blended learning teachers' professional development program. In *Blended Learning Environments for Adults: Evaluations and Frameworks*, IGI Global. 274–289. <https://doi.org/10.4018/978-1-4666-0939-6.ch014>
- Nasution, A. K. P., Surbakti, A. H., Zakaria, R., Wahyuningsih, S. K., & Daulay, L. A. (2021). Face to Face Learning vs Blended Learning vs Online Learning (Student Perception of Learning). *Journal of Physics: Conference Series*, 1783(1), 012112. <https://doi.org/10.1088/1742-6596/1783/1/012112>
- Oliver, M., & Trigwell, K. (2005). Can "Blended Learning" be redeemed? *E-Learning and Digital Media*, 2(1), 17–26. <https://doi.org/10.2304/elea.2005.2.1.2>
- Psillos, D. (2014). Development of a blended teacher training model and pilot application in Natural Science Teachers (in Greek), 9th Panhellenic Conference with International Participation "Information and Communication Technologies in Education"
- Qasem, A. A. A., & Nathappa, V. (2016). Teachers' perception towards ICT integration: Professional development through blended learning. *Main Issues of Pedagogy and Psychology*, 11(2), 20–26. <https://doi.org/10.24234/miopap.v11i2.221>
- Šafranč, J. (2013). Using information technology in English language learning procedure: Blended learning. *Procedia — Social and Behavioral Sciences*, 83, 514–521.
- Smith, N. V. (2013). Face-to-face vs. Blended learning: Effects on secondary students perceptions and performance. *Procedia — Social and Behavioral Sciences*, 89, 79–83.
- Sung, Y. H., Kwon, I. G., & Ryu, E. (2008). Blended learning on medication administration for new nurses: Integration of e-learning and face-to-face instruction in the classroom. *Nurse Education Today*, 28(8), 943–952. <https://doi.org/10.1016/j.nedt.2008.05.007>
- Vernadakis, N., Giannousi, M., Derri, V., Michalopoulos, M., & Kioumourtoglou, E. (2012). The impact of blended and traditional instruction in students' performance. *Procedia Technology*, 1(2012), 439–443. <https://doi.org/10.1016/j.protcy.2012.02.098>.
- Watson, J. (2008). Blended learning: The convergence of online and face-to-face education. Promising Practices in Online Learning. *North American Council for Online Learning*. <https://files.eric.ed.gov/fulltext/ED509636.pdf>. Accessed June 2022
- Youngers, T. (2014). Effectiveness of blended learning on student engagement. Graduate Research Papers. 225. <https://scholarworks.uni.edu/grp/225>. Accessed June 2022
- Zagouras, C., (2005). The teacher training for the utilization of ICT in education, (in Greek) "We will all be judged by the future..." («Θα μας κρίνει τελικά όλους το μέλλον...»), Chapter 3, Ellinika Grammata, CTI Press.
- Zhang, W., & Zhu, C. (2017). Review on blended learning: Identifying the key themes and categories. *International Journal of Information and Education Technology*, 7(9). <https://doi.org/10.18178/ijiet.2017.7.9.952>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Charalampos Zagouras^{1,2} · Demetra Egarchou¹ · Panayiotis Skiniotis¹ · Maria Fountana¹

✉ Demetra Egarchou
egarchou@cti.gr
<https://www.cti.gr>

Charalampos Zagouras
zagouras@cti.gr
<https://www.cti.gr>
<https://www.upatras.gr/>

Panayiotis Skiniotis
tskiniot@cti.gr
<https://www.cti.gr>

Maria Fountana
fountana@cti.gr
<https://www.cti.gr>

¹ Department of Training and Certification, Computer Technology Institute & Press – “Diophantus”, Patras, Greece

² Department of Mathematics, University of Patras, Patras, Greece