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Redesigning Engineering Assessment during the Covid-19 Lockdown – A case study in Computer Networking and Network Security

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Abstract. The objective of this paper is to discuss the issues that emerged during the transition from conventional face to face teaching to online teaching at the Hellenic Air Force Academy, due to the Covid-19 lockdown. A unique situation, different from both face to face lessons and distance learning, emerged: the instructors were isolated in their homes, while the students were all together in the classroom instead of being divided geographically, as happened in most conventional universities. This unprecedented situation made evaluation difficult. The paper focuses on the methods devised by the educator in order to offer personalized assignments, designed to facilitate e-assessment. As a case study, assignments and their assessment for Computer Networking II and Network Security courses are presented. Personalized assignments achieved acceptable grade statistics but were still inferior compared to face to face final exam statistics, probably because our institution was not prepared to cope with this situation. The proposed personalized assignments work best in small classes because they require manual assessment. Actions which could help universities and educators to prepare for future lockdowns (such as improving their teaching material for online teaching, enhancing student support services, etc.) are proposed. The proposed assignments could be useful to other colleagues worldwide.

Keywords. E-assessment, personalized assignments, Computer Networking course, Network Security course, face to face, Bloom's revised taxonomy, Engineering Education.

1. Introduction

1.1 Telecommunications and Electronics Engineering in the Hellenic Air Force Academy

One of the specializations offered by the Hellenic Air Force Academy (HAFA) is Telecommunications and Electronics Engineering (TEE). This program is equivalent to a Bachelor degree in Electrical Engineering. The author of this paper (also referred to as "the instructor" or "the educator") teaches three courses to the senior cadets (4th year): Computer Networking I during the 7th semester; Computer Networking II and Network Security during the 8th semester [1].

During the past 25 years the author has been using several active learning methods in the classroom, based on ICT (Information and Communication Technology) and Web 2.0 tools. A variety of educational activities based on PBL, Connectivism, Learning by Constructivism,

competition-based learning, etc. have been designed and used [1], [2]. The instructor tests various methods each semester and selects those that trigger the students' interest the most.
In addition to face to face teaching, mixed learning methods have been used, in an effort to extend students' learning outside of the classroom. It should be noted here that attending classes is obligatory in HAFA.
Assessment is an inseparable process of education; hence, the aforementioned methods cover assessment as well. Educators having many years of experience, are capable of choosing test questions which examine the targeted objectives on the one hand, and produce the necessary grade distribution on the other. This is taken very seriously in HAFA because it is one of the factors deciding graduation order. Therefore, the grade distribution has to be broad and indisputable.
The plethora of assignments, activities and labs pose an additional load to the educator; therfore, there is an ongoing research on e-assessment, targeting to facilitate the teacher's job [3]-[7]. In order for all these activities to be easily graded, we have concluded that this feature has to be embedded from the right beginning, during the design phase. We discuss this issue in paragraph 3.2.

1.2 About the Computer Networking course
Computer Networking I is offered to Telecommunications and Electronics Engineering cadets during the 7th semester and is a prerequisite for Computer Networking II and Network Security courses offered in the 8th semester.
An innovative approach is followed in teaching Computer Networking courses: on the one hand, theory is taught following a top-down approach, because [8] :

1. The recent revolution in Computer Networking (including the Web) is taking place in the higher layer (called the Application layer).
2. The students are already familiar with many networking applications such as the Web, email, file transfer and sharing, videoconferencing, instance messaging, etc.; this is an extra advantage in an educational process.

On the other hand, a bottom-up approach is followed in the lab; the students learn how to build wired and wireless LAN networks from scratch (i.e., starting from cables and connectors), learn about wired (CSMA/CD) and wireless (CSMA/CA, WiFi) protocols and hardware (network adapters), switches and routers, MAC and IP addresses, how to install and configure a server, etc. This approach has several educational advantages:

1) It is a hands-on method which stimulates and satisfies students.
2) It is directly connected to their Telecommunications and Electronics Engineering background.
3) It offers practical skills to the students useful for their future carrier.

1.3 About the Network Security course
Increasing demand for security experts has motivated many universities to include security classes in Engineering and Computer Science curricula [9]. Following this trend, the Hellenic Air Force Academy has introduced a Network Security course in the 4th year of the undergraduate program of the Telecommunications and Electronics Engineering (TEE) students about 13 years ago [1] .
The syllabus covers Cybersecurity in theory as well as in practice. The course is about protecting networks and systems from digital attacks. The material is covered in lectures, class demonstrations, assignments, videos, lab exercises, demos, etc.

Students also participate in annual national and international cyber defense exercises. The course is using several FOSS tools and two Linux distributions: Ubuntu and Kali. In the lab the students learn how to attack and defend a server, how to hack wired and wireless networks, how to send a digitally signed and encrypted message, and many other practical skills [1].

1.4 Definitions

In order to avoid misunderstandings, definitions of the key terms used in this paper are provided.

E-learning is the use of Information and Communication Technology (ICT) such as computers, wireless and mobile devices, multimedia technology, the Internet, etc., in learning. E-learning can also be used in conjunction with traditional face to face teaching (blended learning). One of the advantages of e-learning is the automatic generation of individualized, understandable and dynamic learning content in real time [6], [10].

Distance Education is an educational process taking place when teachers and learners are geographically separated from each other. There are no face to face meetings due to distance or other reasons such as adult learners working in different times [11].

Today, Web technologies are used for the presentation and distribution of educational content, as well as for communication among learners and between learners and teachers. In the past (and even today in some places), it was served by conventional means such as conventional mail (mailing textbooks, tapes, CD/DVDs), educational television and radio, and sparce face to face meetings when possible [12]. Distance Education may use synchronous (instructor-led) online meetings via video-conference platforms at scheduled times [13], [14], as well as asynchronous e-learning (study at the learner's place, time and pace) [13], usually supported by Learning Management Systems (LMS) [14]. Online Education is Distance Education offered exclusively online.

1.5 Objective of this paper

This paper first discusses the challenges of the transition from face to face to online learning in general; next it presents this transition at HAFA; then it presents the structure of assignments designed for the lockdown period. The objective of these assignments was threefold: first, to exercise all the necessary skills dictated by the engineering education principles; second, to discourage plagiarism; and third, to facilitate assessment. Finally, a comparison between online assessment statistics and face to face final exam statistics is showcased. The author will be happy if the methods or findings presented herein inspire or help other educators.

This paper is organized as follows: section 2 describes the transition to online education period in HAFA, from the appearance of the Coronavirus in Greece (March 2020) until the end of the semester (June 2020); section 3 discusses e-assessment issues; section 4 is about assessment in Engineering Education, e-assessment issues and proposed solutions; section 5 presents the personalized assignments designed to facilitate assessment. Finally, section 6 concludes the paper.

2. The transition to online education

The Coronavirus pandemic has hindered daily life activities. Online education has substituted the traditional face to face teaching during the lockdown period.

2.1. Towards a new educational mode

Due to Covid-19, face to face classes were cancelled in HAFA on 12 March 2020. During a transitional period of two weeks, while awating instructions from the government, an ad hoc committee under the Commander consisting of the Dean, the network administrator, as well as

some IT staff, explored various alternatives and evaluated various videoconferencing software in order to offer HAFA coursers via synchronous e-learning. The instructors played the role of the students during the tests. Finally, "Zoom" was selected (zoom.us). HAFA classes rarely exceed 25 students. Classes were split in groups of 10 students per classroom, with a computer running Zoom client connected to the Internet, as well as to a projector.
Classes resumed on 30 March 2020, entirely from distance, until the end of May. Students were in campus lockdown, while the instructors were isolated in their homes. From 12 March 2020 until the end of May 2020, all lectures were delivered from distance.
It should be noted here that the same situation during the lockdown period also applied to the academies of the Greek Army and Navy, but not in all other universities of Greece (and many other countries [13]), where the students were isolated in their homes. From this viewpoint, our situation was unique.
In many cases the transition in lecturing was smooth because the material was already in digital format. After some guidance and tests, the necessary familiarization with the platform was achieved. However, traditional face to face activities (such as labs and midterm exams) were postponed; new, online activities had to be designed.
Due to the lockdown, labs and competition-based teaching activities [1] were cancelled. No midterm exam could be given. An experimental effor to give a non-graded, optional digital exam based on Google forms did not attract the students' attention, since only 7 out of 13 students took the test; moreover, the answers were similar. It came out that, such activites would not be the best option for assessing students. The final exams were given face to face after the lockdown period (June 2020).

2.2 Challenges of the transition from face to face to online learning
Running a course designed for face to face education from distance had several difficulties. Online courses designed for distance learning have several requirements because the students are far from their teachers. In distance learning the students are responsible for their own progress to a higher degree and depend more on the educational material [12]. The textbooks written for distance learning have a special structure containing additional sections such as aim and objectives, expected results, self-assessment questions, and often they are accompanied by additional educational material in digital format such as videos, simulations, programs, etc. [15]. The idea is to embed some tasks performed by the teacher in face to face settings in the educational material, animated by the learners themselves. These tasks concern guidance, interaction with the material, (self)assessment and feedback, clarification of difficult concepts and misconceptions, encouragement, etc. [12].
Designing and implementing effective formal e-learning programs is a complex process [11], [16] involving many factors such as [13], [17]:

(1) Objectives;
(2) Content;
(3) Instructional design;
(4) Learning tasks;
(5) Teacher's roles and perceptions;
(6) Learner's knowledge, skills and attitudes;
(7) Infrastructure, and
(8) Assessment.

HAFA, like most conventional educational institutions, was not prepared to cope with a distance e-learning situation because the two modes of operation differ in many ways,

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exceeding the above list. Next, a brief comparison is attempted using as criteria the above factors. This is relevant because a second lockdown forced HAFA to online education again (November 2020).

1) Conventional educational institutions offer formal education to uniform groups of people which are not usually engaged in other activities (such as employment) and avail to attend face to face courses in classrooms, auditoriums and laboratories.

2) The content (educational material); traditional educational institutions use conventional textbooks. On the other hand, the educational material written for distance learning meets several specifications which support self-learning and is usually offered in digital format, fact which gives extra possibilities to the learner (such as search, copy and paste, etc.).

3) Instructional design. Conventional educational institutions work with daily programs structured as academic hours (usually 45 minutes). Traditional educational institutions programs offer stricktly predefined curricula structured on courses while online learning institutions use modules. In online education the material is chunked in (semi autonomous) pieces (being book sections or videos) that can be attended in limited time intervals (typically 25 minutes).

4) Learning tasks is "an interface between the learners and the information offered in the learning environment. They serve to activate and control learning processes in order to facilitate successful learning. They stimulate reactions referring to learning material, thus prompting the learners to engage intensively in the subject matter. Ideally, the learners receive feedback on how well they performed on a learning task and guidance on how to acquire the relevant information" [18].

In traditional educational institutions the educator presents the material to the students and assigns homeworks in order to enforce them to study the material.

5) Teacher's roles and perceptions. Historically, in face to face education, the teacher had assumed the role of the authority who possesses the knowledge and transfers it to the students in the classroom. On the other hand, the educator in distance e-learning assumes the role of the facilitator whose task is to support the students to build their own knowledge [11].

A successful face to face teacher is not necessarily a successful online educator; there are several skills that a successful online educator has to possess. One of the difficulties relies in immediate student feedback; in a face to face environment the experienced teachers have gained the ability to 'hear' or 'poll' the classroom, getting immediate feedback from students, either explicitly or implicitly (e.g., via the body language). In an online environment this is a problem [13]; explicit feedback is usually supported by technological means but teacher as well as student training is needed.

Another issue that we faced during the online teaching was the lack of immediacy; when the teacher is not in the classroom, it is not so easy for the students to ask questions during the lecture. The situation is further impeded when the students use computers in the classroom during computer science courses and labs, such as programming; normally the educator in HAFA courses (where the classes are small) can examine students' code and facilitate debugging, but this is neither easy nor practical in online teaching.

An important issue in distance learning is student support. In conventional universities this usually happens face to face during office hours. In distance learning a variety of media are used, such as email, telephone, text messages, social networks, etc., and the educator is more available throughout the week [12].

6) Students' readiness for online learning. Successful online students have an active approach towards learning, sufficient meta-cognitive competence, adequate self-regulation, and a high level of motivation and capacity for learning from past experiences [19].

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In adult education the students have the responsibility of their actions for achieving their goals. An adult learner is defined as an adult person returning to education some years after graduation; hence, it is not directly related to age [20]. Our students, although adults as 22-years old, are not considered adult learners according to the above defitinition. Hence, they do not have the same incentives for online learning. Many students which were hidden from the camera, could take the opportunity to spend time on their smart phone or their laptop, working on things other than the lecture (like their thesis), or even slacking. [13], [17].

7) Infrastructure. In synchronous online e-learning the students are responsible for their own ICT infrastructure (computer or tablet, Internet connection, etc.). In HAFA each student upon enrollment is given a laptop which is used in the classroom, labs and at home for learning. Additional infrastructure is available in the labs but we could not use it during the lockdown period, since all labs were cancelled. It is interesting to examine how engineering and science labs are conducted in distance learning frameworks. A common approach is to use low cost kits. This approach is applicable to some majors like electronics, microprocessors, microcontrollers, chemistry, etc. Other approaches include virtual labs, simulations, virtualization (working with virtual machine images), etc. [21]. In the Fall 2020 semester, looking ahead, Arduino boards were obtained on time and the students were trained to conduct the experiments and record the process and send the video clip to the educator for assessment, according to a simple technique described in [21].

8) There are big differences in the process of assessment. Traditionally, this is done through homeworks and midterm exams. At the Hellenic Open University (HOU), where there is one teacher per 32 students maximum, five written assignments per class are given. The final exam is given face to face. In e-learning courses including Massive Open Online Courses (MOOCs), assessment is usually done electronically (e-assessment) via Multiple Choice Questions (MCQ). Another popular option is peer assessment. These issues will be revisited in section 3. Now in our case, conventional assignments and midterm exams with all students in class and the teacher away would not work. So the educator had to explore other alternatives.

2.3 Education in the lockdown period

It should be noted that the author is familiar with distance learning through his experience with the Hellenic Open University (HOU), both as teacher and student. In the HOU paradigm, students have the chance to meet the educator and peers during five face to face meetings per course [12], and often, they take this chance to connect to each other in order to join efforts.

The author is also familiar with online learning because he systematically attends MOOCs, in an effor to stay competitive and expand his personal Zone of Proximal Development (ZPD); In MOOCs it is even more difficult for the students to connect to each other; hence, there is no need to personalize assignments.

The situation in HAFA during the Covid-19 lockdown was unique, in that the students were all together in the classroom during the lectures, but the instructors were isolated in their homes. This setup differs from regular face to face classes in that the instructors teach from distance (synchronous e-learning); it also differs from regular online e-learning in that the students were at the same place instead of being geographically separated. Compared to conventional face to face classes, this setup has the disadvantage of losing immediacy in teacher-student interaction; compared to regular distance e-learning, this setup has some advantages for the educational process such as mutual support among students, but also some disadvantages, cheating being the most prevalent.

Given the above, some lab exercises were substituted by simulation, using Packet Tracer software [22]. Other lab exercises were substituted by activities run in computers, including symmetric and public key cryptography, message integrity, digital signatures, secure email

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(PGP), key distribution, SSL, https, etc. All these were demonstrated online; in addition, https transactions were demonstrated using Wireshark with which the students were familiar since the Computer Networking I course, and firewalls. However, some issues such as wireless LAN security and IDS, were not demonstrated due to lack of time, as well as, because these require special setup (wireless ad hoc networks for wireless LAN security).

The most difficult issue however proved to be that of the assessment. In HAFA this is usually done through homeworks and exams. The latter require the presence of the instructor, for supervision reasons. However, this was impossible during the lockdown, where the students were all together in campus whereas the instructor was restricted at home. When the instructor received the responses to assignment no.1 of Computer Networking II which was about Link State routing [8], [23], [24], he realized that they were almost identical! The solution selected was the use of personalized assessment; each student had to perform a specific task with different setup.

The design of assignments and activities which facilitate assessment is a critical issue; we call this "design for assessment". Our objective is to describe and propose personalized assignments exercising all the necessary engineering skills [25], covering all the levels of Bloom's revised taxonomy, shown in Figure 1 [26], [27], which will also be easy to assess with the use of free or open-source software, or custom scripts. The assignments should also discourage plagiarism.

3. E-assessment issues

3.1 Bloom's taxonomy and Engineering education

Figure 1 presents the so-called revised Bloom's taxonomy. As we can see, creating is the top skill. Creating is also included in the 21st century skills: Learning and innovation skills: critical thinking and problem solving, communications and collaboration, creativity and innovation [28].

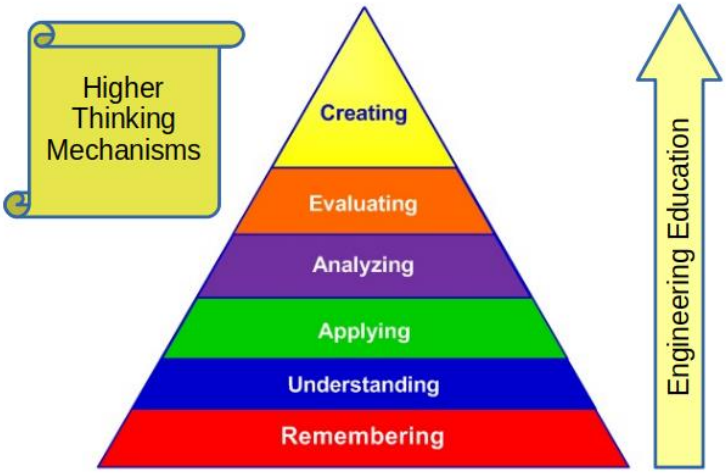

Figure 1 Bloom's revised taxonomy and Engineering Education

Multiple choice questions (MCQs) are extensively used in e-assessment. The author's experience as a MOOC student is that MCQs is the dominant e-assessment method, even in engineering. Out of approximately 60 MOOCs, there were only few brilliant exceptions such as a Python course using an auto-grader based on Python interpreter, and a Matlab course using 'graded external tool'. In the best case, MCQs present several options such as code, calling the student to select the correct ones (evaluation). But this does not assess code creation which is an essential skill today, not only for engineers and scientists (Figure 1). It is a common finding

and our firm position that MCQ is not the best way to assess engineering courses. Another issue with MCQs is the factor of luck.
Engineering education should train the students throughout the whole Bloom's taxonomy, especially the higher thinking mechanisms.
Since assignments and assessment are learning activities, we ought to develop and assess all of the students' skills. This is impossible with MCQs, because in the best case, MCQs can assess up to the Evaluation level. The questions of this type have the form: "which of the following items perform this task correctly?", where the items might be pieces of code or circuits or systems in Engineering. It is impossible to learn a programming language without writing code; hence, "Creating" is an indispensable skill in Engineering Education and has to be assessed. But how can this be done without posing a tremendous task on the evaluator?
Another common e-assessment method used heavily in programming MOOCs is peer assessment; it is common in popular courses gathering several thousands of students. Peer assessment works best when it is anonymous and the students do not know each other (which is not our case). Peer assessment of students' projects tested experimentally in the past failed. Several problems are associated with peer-assessment, including subjectivity, instability and inability to control the results, especially when there are many students [29]. Therefore, peer assessment was avoided in our case. In order to facilitate the process, we turned to smart problem design.

3.2 Design for E-assessment
The design of assignments and activities which facilitate e-assessment (we call this "design for E-assessment") is a critical issue.
During the past 14 years there is an ongoing research and experimentation on e-assessment methods [4]-[7].
In [3] the use of engineering software such as compilers, CAD tools and packages for numerical computations like Matlab in the assessment process has been proposed. Some implementations can be found in [4]-[7]. The work presented herein is towards this direction.

3.3 Personalized assignments
The objective of this effort is to describe and propose personalized assignments covering all the skills of Bloom's taxonomy, which will also be easy to assess. The terms 'personalization' and 'personalized' in this paper mean that each student has to solve a different problem. It should not be confused with the personalization of several educational settings as described in [14], except the personalization of (part of the) content. In our work, personalization is based on parametarization, i.e., the ability to create many different problems from one common core, by changing some parameters. This discourages students to engage in plagiarism by copying each other's work [7].
In this paper, some such problems for Computer Networking and Network Security courses are presented. These problems were designed to be easily graded by a human. Free and open-source software, as well as, custom scripts have been used in the process of problem production and/or problem assessment.

4. Personalized assignments designed for easy assessment
As already stated, we had to cope with an unprecedented situation where the instructors were isolated in their homes, while the students were all together in the classroom. The objective was to allow the students to cooperate exchanging views but discourage plagiarism.
In order to cope with this problem, personalized assignments for Computer Networking and Network Security courses were designed. The design as well as methods facilitating or

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automating assessment will be presented in this section. Note that these activites were tailored to the specific class of 13 students, number which enabled the instructor to spend time on each student's project. For large class sizes other solutions should be selected, such as LMS exam modules and e-assessment platforms [7],[30], [31]. The softwares used in the current situation were Packet Tracer, OpenSSL, Seahorse, PGP, GPG and Mailvelope.

The following Network Security lab exercises were given as assignments:

- Lab 1: Public key cryptography: create a personal PGP key pair.
- Lab 2: Send a Secure email encrypted and signed with your private PGP key.
- Lab 3: Edit specific Firewall rules on your personal computer Networking assignement (built in Packet tracer).

Computer networks assignment no.2

Students had to design and configure a small network with two subnets and three servers in Packet tracer. Several design parameters such as the number and type of hosts, the type of routers, subnet IP addresses, website parameters, etc. changed, based on students' ID number. This resulted in a completely different network topology for each student (Fig.2). Care was taken to keep the complexity at the same level (more or less).

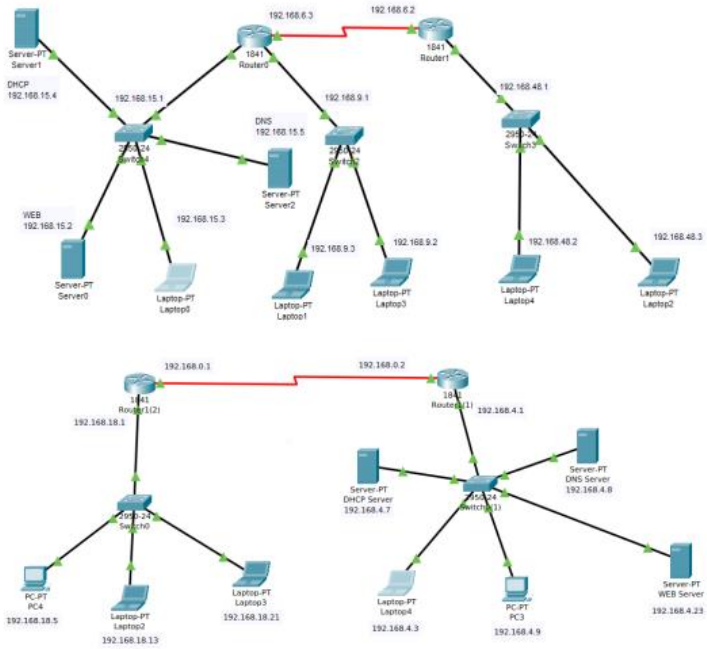

Figure 2 Two different implementations of the same parametarizable problem

Assessment of Computer Networks Assignment no.2

Students had to send a report demonstrating their personalized requirements, as well as the relative packet tracer code implementing their network.

The instructor could check the requirements, the implementation, the topology, correct configuration of the Web server pages, correct operation of the DNS and DHCP servers (ping and access to the Web server from various hosts) via Packet tracer.

Network Security Assignment no.1

1. Students had to create an RSA key pair with 'openssl genrsa'; show snapshots.
2. Students had to create a pair of RSA keys with 'openssl x509'; show snapshots.

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3. Students had to send their work as an attachment, encrypted with the instructor's public key.

Assessment of Network Security Assignment no.1

The assessment is facilitated by:

a) Asking the students to prove the generation of their RSA keys by providing screenshots of their terminals as well as of the generated (public) keys;

b) Sending their report encrypted by a symmetric session key, as well as the session key encrypted by the instructor's public key; the instructor would decrypt the latter using his private key.

Network security Assignment no.2

1. Students had to upload their keys to a key-server; download and insert the instructor's public key.
2. Students had to use the above in order to send an email to the instructor using PGP.

Assessment of Network Security Assignment no.2

The assessment is automated by a script searching for the students' keys in the key server, importing them to the instructor's key-case; the instructor could open and read the signed and encrypted emails using a special browser add-on (web-based emails).

Network Security Assignment no.3

Network security assignment no.3 was based on Computer Networks II assignment no. 2; students had to add security rules to their networks in order to deny access from a subnet to the Web server (Fig.3):

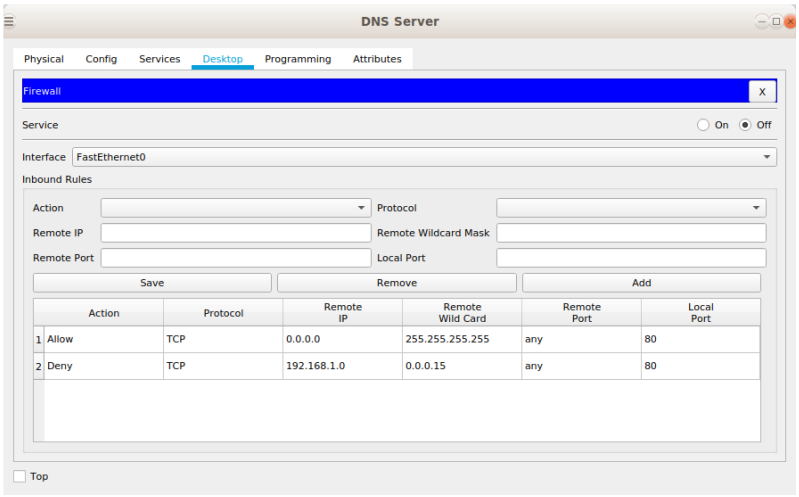

Figure 3 Implementation of Firewall rules on Packet Tracer

Assessment of Network Security Assignment no.3

All the instructor had to do was to open the Packet tracer file submitted and try to access the Web server from various subnets in order to test the effectiveness of the firewall rules.

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Network Security Assignment no. 4
The instructor emailed a digitally signed and PGP encrypted personalized photograph, which the students had to open using their private PGP key and the instructor's public PGP key.

Assessment of Assignment no. 4
Finally, the students had to demonstrate the decrypted photograph, which was a photo of the class with their name printed, as a souvenir from their studies in HAFA.

5. Results

5.1. Oral grades (from distance)

The results concern thirteen senior cadets of HAFA, aged 22 years; three females and ten males. They were collected from April to June 2020 (Spring semester).
Preliminary results are encouraging: each student worked on their own assignments; assessment was easy. Statistical results of Computer Networking II oral grades had a satisfactory distribution. However, in Network Security, since almost all students completed the exercises, the results have poor quality, probably because they were not very complicated. The statistics of the oral grades were inferior compared to past academic years. Fig. 4 and Table 1 present the statistics of the oral grades of Computer Networking II.

Computer Networking II oral grades statistics

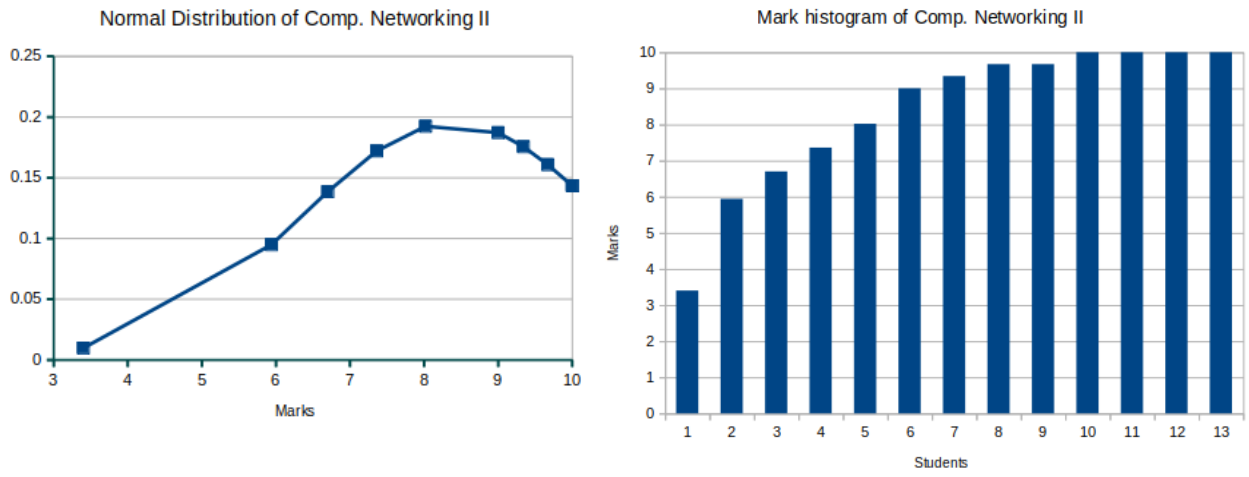

Figure 4 Statistics of the oral grades of Computer Networking II

Table 1. Computer Networking II oral grades Statistics.

Criterion	Value
MAX	100
AVG	83
MIN	34

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Max-Min	66
STDEVP	22.62

Fig. 5 and Table 2 present the statistics of the oral grades of Network Security.

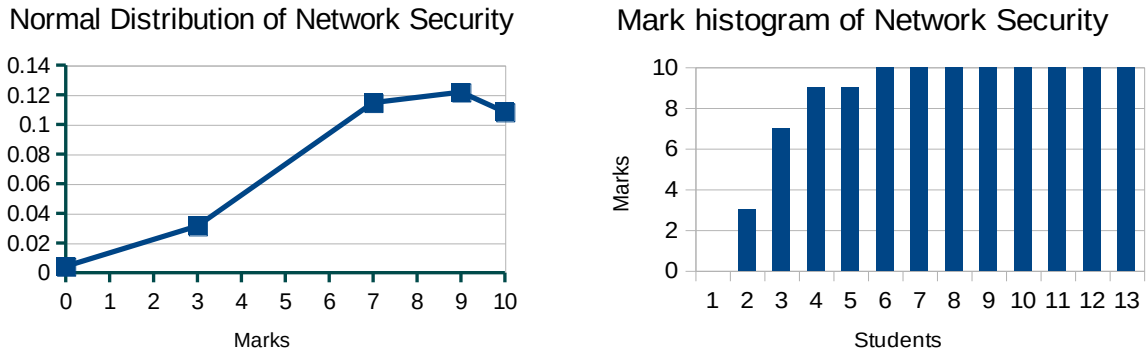

Figure 5 Normal distribution and histogram of the oral grades of Network Security

Table 2. Network Security oral grades Statistics.

Criterion	Value
MAX	100.00
AVG	75.56
MIN	0.00
Max-Min	100.00
STDEVP	34.35

5.2. Final exams (face to face)

Final exams were given normally (i.e., face to face, in the auditorium). The difficulty of the exams was the same as in previous academic years. The statistics of the final exams were comparable to past academic years. Fig. 6 presents the Normal distribution and histogram of Computer Networking II final exam.

Computer Networking II final exam statistics

Fig. 6 presents the Normal distribution and histogram of Network Security final exam.

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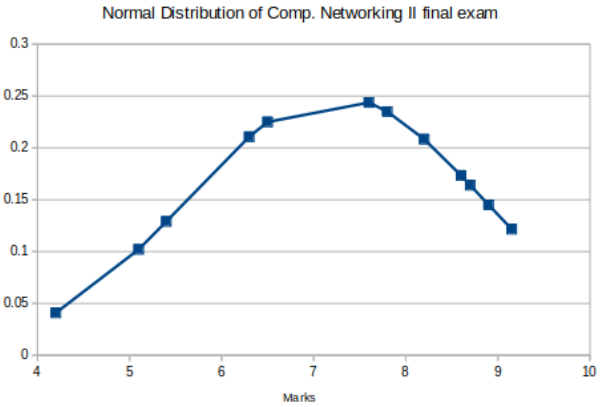


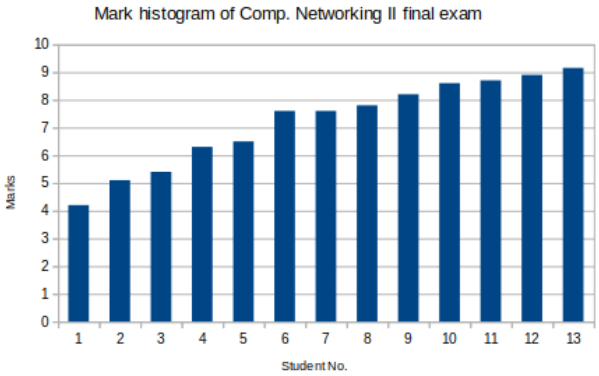
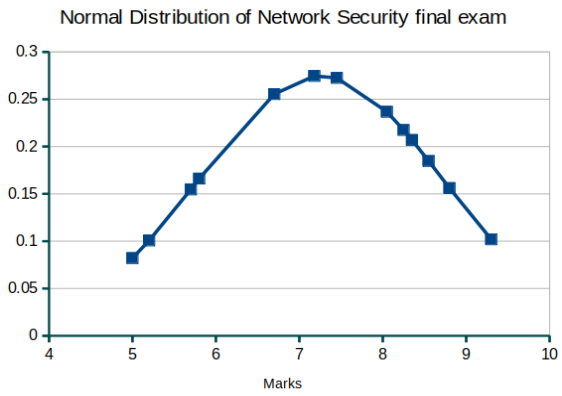


Figure 6 Normal distribution and histogram of Computer Networking II final exam

Network Security final exam statistics

Fig. 7 and Table 3 present the statistics of the oral grades of Network Security.



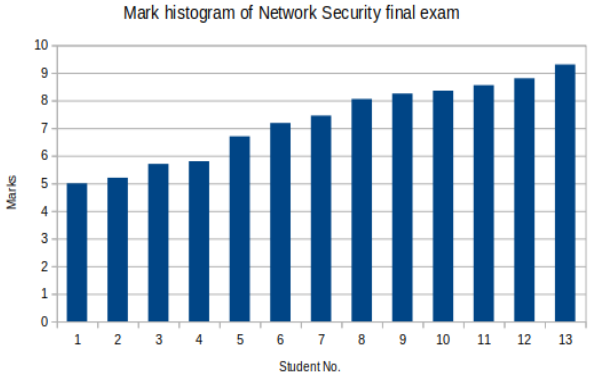


Figure 7 Normal distribution and histogram of Network Security final exam

Table 3. Final exams statistics.

Criterion	Value
MAX	88
AVG	69.81
MIN	50.00
Max-Min	38.00
STDEVP	13.52

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A comparison of the results reveals that the lockdown assessment results are inferior to the final face to face exams, where grade distribution is broad, nearly Gaussian and indisputable.
We attribute this result to the fact that HAFA is a conventional university and as such, it was not prepared by design to offer online courses. The statistics of the final exams show that despite the difficulties, finally our students managed to conquer the educational material and graduate successfully.

6. Discussion, Conclusion and further work

6.1. Synopsis

This paper discusses the challenges of the transition from face to face to online teaching faced by the Hellenic Air Force Academy (particularly by the author) when face to face courses had to be offered online during the lockdown period of the spring semester (March-May 2020).
A brief comparison of conventional education to online education using the following criteria was presented: (1) objectives; (2) content; (3) instructional design; (4) learning tasks; (5) teacher's roles and perceptions; (6) learner's knowledge, skills and attitudes; (7) infrastructure, and (8) assessment.
The situation in HAFA was different from that of Open Universities because the HAFA students were situated in the classrooms and in general, restricted in the HAFA campus. This fact had some advantages such as mutual support, but posed some difficulties to the educator as far as assessment is concerned, that had to be solved. Next, some personalized assignments for Computer Networking II and Network Security courses, designed and offered during the Covid-19 lockdown period, as well as their assessment have been presented.

6.2. Research limitations

These assignments work best in small engineering classes because they require semi-manual assessment. For large classes other solutions have been proposed, including the use of engineering software [3], as well as the use of LMS modules or special Online Exam software [30], [31].

6.3. Further work

The next steps in the short term are: the redesign of Computer Networking Assessment no.1 as a parametric problem and the development of code, providing the solutions to facilitate assessment [32],[33],[34]; the redesign of Network Security Assessments; the use of students' ordinal number, ID, as well as random numbers, as additional parameters in personalized assignment design and e-assessment [7]. Ideally, assignments should cover all higher thinking mechanisms of Bloom's revised taxonomy (Fig. 1).
The next steps in the long term are to get prepared for future circumstances: design assignments, activites and lab exercises, develop or adapt educational material to support online learning, and use complementary ways to support students from distance.

6.4. Propositions

Covid-19 might lead to further lockdowns; hence, we must get prepared. Authorities and educators of conventional universities should study the modus operandi of distance education universities and try to adopt some features which will potentially facilitate their tasks, as well as, enable the students to continue their studies smoothly during future lockdowns.
A face to face successful teacher needs training in order to become a successful online teacher. Many MOOC providers offer relevant online courses.

University authorities could launch fast training programs, counseling meetings, seminars, etc., in order to prepare their educators and students for online learning. Instructors could also attend such courses on their own initiative.
University authorities could install software to support synchronous and asynchronous online learning, including videoconferencing tools and LMS.

Teachers could create new learning material or adapt existing for online delivery, by adding aim and objectives, expected results, self-assessment questions, etc.
Educators should use flexible new media in order to communicate with students (including email, telephone, social networks, etc.) and have great availability to support students. They should also provide written or oral feedback via telephone, social networks, videoconferencing, etc.

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