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ΤΜΗΜΑ ΠΑΙΔΑΓΩΓΙΚΟ ΝΗΠΙΑΓΩΓΩΝ

Η Αξιοποίηση Εργαλείων ΤΠΕ σε Ελληνικά και Ρωσικά Πανεπιστήμια

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The Utilization of ICT Tools in Greek and Russian Universities

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Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
ARPG	Action Role-Playing Game
CMS	Content Management System
CL	Collaborative Learning
DiCTE	Developing ICT in Teacher Education
DL	Distance Learning
EUN	European University Networks
FPS	First-Person Shooter
GIS	Geographic Information System
GPS	Global Positioning System
HQ	Headquarters
IaaS	Infrastructure-as-a-Service
IDE	Integrated Development Environment
ICT	Information and Communication Technologies
ILO	International Labour Organization
IoT	Internet of Things
IPS	Intrusion Prevention System
IS	Information System
ISDN	Integrated Services Digital Network
ISCED	International Standard Classification of Education
IT	Information Technologies
LMS	Learning Management System
LLL	Lifelong Learning
MOBA	Multiplayer Online Battle Arena
MS	Microsoft
NM SW	Network Management Software
NT	New Technologies
NW	Network
OS	Operating System
PaaS	Platforms-as-a-Service

PC	Personal Computer
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
RPG	Role-Playing Games
RTS	Real-Time Strategy
SaaS	Software-as-a-Service
SSTU	Yuri Gagarin State Technical University of Saratov
TPS	Third-Person Shooter
UNESCO	United Nations Educational, Scientific and Cultural Organization
UoI	University of Ioannina
VoIP	Voice over Internet Protocol
VR	Virtual Reality

Περίληψη

Εισαγωγή

Η μελέτη της χρήσης εργαλείων ΤΠΕ στην εκπαίδευση είναι σημαντική για πολλούς λόγους. Πρωτίστως, συμβάλλει στη παροχή πληροφοριών για την εκπαιδευτική διαδικασία. Η κατανόηση του τρόπου με τον οποίο οι ΤΠΕ χρησιμοποιούνται σε εκπαιδευτικά περιβάλλοντα με διαφορετικά πολιτιστικά πλαίσια, επιτρέπει τον εντοπισμό βέλτιστων πρακτικών και αποτελεσματικών στρατηγικών. Η ανταλλαγή πρακτικών και εμπειριών για τη χρήση των ΤΠΕ μεταξύ διαφορετικών χωρών και πολιτισμών διευκολύνει την επικοινωνία και προάγει την ενίσχυση των συνεργασιών. Η διαπολιτισμική έρευνα σχετικά με τις ΤΠΕ στην εκπαίδευση βοηθά στη διαμόρφωση μιας παγκόσμιας εκπαιδευτικής προοπτικής, επιτρέποντας τον εντοπισμό κοινών τάσεων αλλά και την μείωση των ανισοτήτων στη χρήση της εκπαιδευτικής τεχνολογίας παγκοσμίως. Αυτό ενισχύει την κατανόηση της εφαρμογής των ίδιων των τεχνολογιών στην εκπαιδευτική διαδικασία, αλλά παράλληλα βοηθά στην ανάπτυξη των πλέον αποτελεσματικών και πολιτισμικά προσαρμοσμένων μεθοδολογιών διδασκαλίας.

Σκοπός της διδακτορικής διατριβής:

Η διδακτορική διατριβή έχει ως στόχο να διερευνήσει την αξιοποίηση των εργαλείων ΤΠΕ στο πλαίσιο της τριτοβάθμιας εκπαίδευσης με έμφαση στη χρήση τους από καθηγητές και φοιτητές από την Ελλάδα και τη Ρωσία.

Η διδακτορική διατριβή οργανώνεται ως εξής:

- Εισαγωγή
- Σκοπός και στόχοι της διδακτορικής διατριβής
- Βιβλιογραφίας
- Υλικά και μέθοδοι
- Συγκριτική επισκόπηση των συμμετεχόντων πανεπιστημίων
- Αποτελέσματα και συζήτηση
- Συμπέρασμα
- Προσεχείς ερευνητικές προτάσεις
- Αναφορά
- Παραρτήματα (8).

Κεφάλαιο 1. Βιβλιογραφία

Το Κεφάλαιο 1 της διδακτορικής διατριβής αποτελεί ανασκόπηση της βιβλιογραφίας. Έχει πραγματοποιηθεί μια ολοκληρωμένη επισκόπηση των θεμελιωδών εννοιών, που είναι εξαιρετικής σημασίας για την κατανόηση και την εξερεύνηση της διδακτορικής διατριβής. Η αποσαφήνιση θεμελιωδών όρων, όπως ο ορισμός των ΤΠΕ, ο ρόλος τους στην εκπαίδευση και τα διάφορα εργαλεία που συνδέονται με αυτήν, θέτει τις βάσεις για μεταγενέστερες συζητήσεις στον εκπαιδευτικό χώρο. Επιπλέον, στο κεφάλαιο αυτό γίνεται μια ευρύτερη κατανόηση του σύγχρονου εκπαιδευτικού τοπίου παρουσιάζοντας μια επισκόπηση των διαφορετικών εκπαιδευτικών συστημάτων, εστιάζοντας ιδιαίτερα στο Ελληνικό και Ρωσικό εκπαιδευτικό πλαίσιο.

Η ταξινόμηση των εργαλείων ΤΠΕ έχει εξεταστεί διεξοδικά, φανερώνοντας διάφορες προσεγγίσεις που προτείνονται από ερευνητές και εκπαιδευτικά ιδρύματα. Αυτή αποτελεί μια βάση για τα επόμενα κεφάλαια, όπου αυτά τα εργαλεία έχουν εφαρμοστεί σε συγκεκριμένα πλαίσια.

Επιπλέον, παρέχονται πληροφορίες σχετικά με κοινές προσεγγίσεις που χρησιμοποιούν τις ΤΠΕ στο σύγχρονο μαθησιακό περιβάλλον. Οι αναφορές σχετικά με τις αλληλεπιδράσεις στο πλαίσιο της μαθησιακής διαδικασίας, την εδραίωση των θεωριών ΤΠΕ και μάθησης και την εμφάνιση διδακτικών πρακτικών, όπως η εξ αποστάσεως μάθηση, η συνεργατική μάθηση και η παιχνιδοποίηση, είναι σημαντικές για την κατανόηση του εξελισσόμενου τοπίου της εκπαίδευσης.

Τέλος, η βιβλιογραφική ανασκόπηση παρουσίασε την έννοια της ψηφιακής μάθησης, τονίζοντας την αυξανόμενη σημασία των δεξιοτήτων αυτών στο πλαίσιο της σύγχρονης εκπαίδευσης.

Κεφάλαιο 2. Υλικά και μέθοδοι

Για αυτή τη διδακτορική διατριβή, εφαρμόστηκε η ποσοτική και ποιοτική μέθοδος σε τέσσερίς διαφορετικές ερευνητικές μελέτες που αναφέρονται σε ξεχωριστά εσωτερικά κεφάλαια. Ο ερευνητικός σχεδιασμός αυτός περιλαμβάνει τέσσερις ξεχωριστές μεθόδους για τις μελέτες που έχουν αναληφθεί.

Λόγω της σημαντικής ανισότητας μεταξύ των πληθυσμών των δύο χωρών, επιλέχτηκε να επικεντρωθεί η έρευνα σε ξεχωριστές διακριτές μελέτες αξιοποίησης των ΤΠΕ σε ελληνικά και ρωσικά πανεπιστήμια. Ειδικότερα:

1. Σύγκριση μεταξύ χωρών: αυτό-αξιολόγηση της χρήσης των ψηφιακών μέσων εκ μέρους των καθηγητών σε ελληνικά και ρωσικά πανεπιστήμια
2. Εξέταση χρήσης ΤΠΕ σε ελληνικό πανεπιστήμιο: μελέτη περίπτωσης του Πανεπιστημίου Ιωαννίνων
3. Σύγκριση μεταξύ χωρών: εξ αποστάσεως εκπαίδευση και αξιοποίηση εργαλείων ΤΠΕ από φοιτητές ελληνικών και ρωσικών πανεπιστημίων
4. Διερεύνηση του αντίκτυπου της ενσωμάτωσης ενός ψηφιακού παιγνιδιού και ειδικότερα του Classcraft στην εμπλοκή των μαθητών στην εκπαιδευτική διαδικασία και στα μαθησιακά αποτελέσματα: μια πειραματική μελέτη που περιλαμβάνει υποψήφιους εκπαιδευτικούς.

Κεφάλαιο 3. Αποτελέσματα

Στο κεφάλαιο των αποτελεσμάτων της διδακτορικής διατριβής, πραγματοποιήθηκε μια ολοκληρωμένη παρουσίαση των αποτελεσμάτων, αναφορικά με το περίπλοκο τοπίο των προκλήσεων που αντιμετωπίζουν σχετικά με τις ψηφιακές ικανότητες μεταξύ καθηγητών και φοιτητών στο πλαίσιο της Ελλάδας και της Ρωσίας. Τα ευρήματα παρουσίασαν μέρος των προκλήσεων και των δυνατοτήτων που σχετίζονται με την ενσωμάτωση των εργαλείων ΤΠΕ σε εκπαιδευτικά περιβάλλοντα.

Η διαπολιτισμική ανάλυση που ακολούθησε, παρουσίασε τις κοινές προκλήσεις που αντιμετωπίζουν οι καθηγητές τόσο στην Ελλάδα όσο και στη Ρωσία, όταν ασχολούνται με εργαλεία ΤΠΕ. Ιδιαίτερα, οι Έλληνες καθηγητές ανέφεραν δυσκολίες στην αξιοποίηση των εκπαιδευτικών παιχνιδιών, σε αντίθεση με τους Ρώσους συναδέλφους τους, οι οποίοι ανέφεραν επάρκεια στη μάθηση με βάση το παιχνίδι.

Διερευνήθηκαν επίσης οι προτιμήσεις των φοιτητών και των δύο χωρών σχετικά με την εξ αποστάσεως εκπαίδευση και την αξιοποίηση των εργαλείων ΤΠΕ. Αν και ορισμένοι φοιτητές εξέφρασαν αρνητική στάση απέναντι στην εξ αποστάσεως εκπαίδευση, αξίζει να σημειωθεί ότι όλοι οι φοιτητές συμμετείχαν ενεργά στην μαθησιακή διαδικασία ως χρήστες υπολογιστών και εργαλείων ΤΠΕ.

Μερικοί φοιτητές είχαν επάρκεια με συγκεκριμένα ΤΠΕ, ενώ άλλοι γνώριζαν εκπαιδευτικά παιχνίδια που είναι περισσότερο δημοφιλή μεταξύ των εκπαιδευτικών.

Η τέταρτη μελέτη βασίστηκε σε μια πειραματική μελέτη με το παιχνίδι Classcraft μεταξύ ομάδων Ελλήνων μαθητών. Τα αποτελέσματα έδειξαν οτι όσο περισσότερο χρησιμοποιούσαν το ψηφιακό παιχνίδι και εξοικιώνονταν οι φοιτητές με αυτό, τόσο αυξάνονταν και η ικανοποίησή τους ως προς τη χρήση του.

Ένα γενικό συμπέρασμα που προέκυψε από την διατριβή αυτή, δείχνει ότι η ενσωμάτωση των ΤΠΕ και των εκπαιδευτικών παιχνιδιών στον ακαδημαϊκό χώρο των ελληνικών και κατ' επέκταση και των ρωσικών πανεπιστημίων, θα συμβάλει σε καινοτόμες παιδαγωγικές προσεγγίσεις και δυνατότητες για εκπαιδευτικές συνεργασίες μεταξύ των χωρών παραβλέποντας τις διαπολιτισμικές διαφορές.

Κεφάλαιο 4. Προσεχείς Ερευνητικές Προτάσεις

Στο κεφάλαιο αυτό προτάθηκαν μελλοντικές ερευνητικές προεκτάσεις όπως:

1. Διαχρονική μελέτη χρήσης εκπαιδευτικών παιχνιδιών για διδασκαλία εφαρμοσμένων μαθηματικών
2. Διαπολιτισμική ανάλυση χρήσης ΤΠΕ πέρα από την Ελλάδα και τη Ρωσία
3. Συγκριτική ανάλυση χρήσης ΤΠΕ σε όλες τις εκπαιδευτικές βαθμίδες.

Αυτές οι μελλοντικές ερευνητικές προτάσεις στοχεύουν να αξιοποιήσουν τα θεμέλια που θέτει η παρούσα διατριβή, προσφέροντας ευκαιρίες για διερεύνηση στο εξελισσόμενο τοπίο της ψηφιακής εκπαίδευσης.

Λέξεις κλειδιά: Τεχνολογίες Πληροφορικής και Επικοινωνίας (ΤΠΕ), εργαλεία ΤΠΕ, τριτοβάθμια εκπαίδευση, καθηγητές, φοιτητές, Ελλάδα, Ρωσία, ψηφιακή ικανότητα, ψηφιακές δεξιότητες, εκπαιδευτικά παιχνίδια, Classcraft

Abstract

This doctoral thesis explores the multifaceted landscape of information and communication technologies (ICT) in university education, offering a comprehensive examination of foundational concepts. The research encompasses the definition of ICT, its role in education, and the intricacies of ICT tools. A thorough review of modern education frameworks, including the comparative analysis of educational systems in Greece and Russia, provides the background for an in-depth analysis. The study scrutinizes prevalent approaches to integrating ICT into the learning process via exploring interactions, learning theories, distance learning, collaborative strategies, and gamification of education.

In the Results section, the thesis carries out a cross-cultural comparison focusing on the digital competences of professors in Greece and Russia, as well as the perception by the students from the two countries of distance learning and use of ICT tools in educational process. The findings reveal challenges faced by professors, as well as students, with a noteworthy distinction in the proficiency of handling gaming tools. Subsequently, a case study involving students reflects different levels of preparedness for different ICTs, highlighting the specific challenges faced by Greek students, particularly in the field of gaming applications.

The next study centers around the evaluation of the Classcraft game among Greek students addressing a notable gap identified in Greece in both professors and students. The experiment showed that Classcraft intensified student engagement and improved learning outcomes. The positive feedback received from the interviews and practical tasks highlights the potential of educational games to enhance the learning experience.

In conclusion, the doctoral thesis puts forward a promising educational proposal. The initiative advocates for the integration of educational games into the curricula of Greek universities, aiming to improve the overall learning experience. This proposal emerges as a strategic response to the identified challenges and stands as a testament to the evolving landscape of digital learning.

Keywords: Information and communication technologies (ICT), ICT tools, higher education, professors, students, Greece, Russia, digital competence, digital skills, educational games, Classcraft

Introduction

At the dawn of the 21st century, we have found ourselves amidst a digital revolution that continues transforming many aspects of our lives, including education. The increasing integration of ICT tools in educational settings has opened up new avenues for teaching and learning, albeit raising concerns regarding the digital competence and the efficacy of the selected tools. Despite growing number of studies in this area, there are no comprehensive studies examining the integration of technology in the context of cross-cultural research, particularly focusing on specific geographic locales, such as Greece and Russia. This study aims to fill the gap via offering a multipronged investigation of the role, challenges, and opportunities provided by the ICT tools employed in educational process.

Cross-cultural study on the utilization of ICT tools in education holds significant importance for several reasons. Primarily, it contributes to the optimization of the educational process. Understanding how ICT is employed in educational settings across diverse cultural contexts allows for the identification of best practices and effective strategies.

Moreover, this study directly influences the development of intercultural communication. Knowledge and experience exchange among representatives of different cultures facilitate broadening horizons and enhancing intercultural relations.

Furthermore, this study contributes to shaping a global perspective. Cross-cultural investigation on ICT in education aids in forming a global outlook, enabling the identification of common trends and disparities in technology usage in education worldwide. This not only enhances comprehension of the technologies themselves but also aids in the development of more efficient and culturally tailored teaching methodologies (Liu et al., 2014).

This doctoral thesis is organized as follows:

- Introduction
- Aim and objectives of the doctoral thesis
- Literature review
- Research approach
- Comparative overview of participating universities

- Results and discussion
- Conclusions
- Forthcoming research proposals
- References
- Appendices (8).

The achievements of the doctoral candidate in developing the research topic are listed below:

Publications in scientific journals:

1. Pange, J., Degteva, A., & Nikiforidou, Z. (2022). ICT tools in Designing Preschool Educational Activities on Historical Events. *Technical Annals*, 1(1), 309–316. https://doi.org/10.12681/ta.32178
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Publications in proceedings of international conferences:

1. Pange, J., Degteva, A. (2024). Cutting-edge Technologies and International Cooperation for Solving Environmental Issues. In A.V. Vasilyev (Eds.), *Proceedings of the Ninth International Environmental Congress (Eleventh International Scientific-Technical Conference) "Ecology and Life Protection of Industrial-Transport Complexes" ELPIT 2021, September 20-24, 2023, Samara-Togliatti, Russia* (Vol. 1). Edition ELPIT, Printed in Publishing House of Samara Scientific Centre. 152–154. ISBN 978-5-93424-895-7
2. Pange, J., Degteva, A., Manglara, V. (2023). When Technology Meets Heritage. In A. Moropoulou, A. Georgopoulos, M. Ioannides, A. Doulamis, K. Lampropoulos, A. Ronchi (Eds.), *Transdisciplinary Multispectral Modeling and Cooperation for the Preservation of Cultural Heritage. TMM_CH 2023. Communications in Computer and Information Science* (Vol. 1889). Springer, Cham. https://doi.org/10.1007/978-3-031-42300-0_20
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5. Degteva, A., Pange, J., Christou, P. (2020). Distance Learning and Internet Use during the COVID-19 Pandemic. The Russian Student Community Opinion. In S.K. Softic, A. Teixeira, A. Szucs (Eds.), *Enhancing the Human Experience of Learning with Technology (Short Paper Book 2020 Research Workshop).* Lisbon: The European Distance and E-Learning Network. 16–21. ISBN 978-615-5511-29-5. https://repositorioaberto.uab.pt/bitstream/10400.2/11177/1/RW11_SPB_v5_skucina_ateixeira_aszucs.pdf#page=16

Abstracts in proceedings of international and national conferences:

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2. Degteva, A., Pange, J., Christou, P. (2020). The Use of ICT Tools for Teaching Environmental Issues in Preschool in Greece and Russia: A Comparative Study. In *Abstract book. Early Childhood Care and Education, The 10th International Conference (ECCE 2020).* Moscow: Mozaika-Sintez. 20–21. ISBN 978-5-4315-1955-0. https://en.ecceconference.com/about/

3. Degteva, A., Pange, J., Christou, P. (2020). Digital Stories for Teaching Environmental Issues: Advantages and Disadvantages. In *The 9th Cyprus International Conference on Educational Research (Online Conference Abstracts book: CYICER-2020)*. Cyprus: Bahçeşehir Cyprus University. 20. http://taeg-center.org/cyicer/

4. Pange, J., Degteva, A., Christou, P. (2020). ICT Use for Teaching Environmental Issues in Greece and Russia. A Literature Review. In K. Plakitsi, E. Stamulis, E. Kolokouri, & A.-Ch. Kornelaki (Eds.), *11th Panhellenic Conference (e-proceedings, SECE 2020).* Ioannina: University of Ioannina. 24–25. ISBN: 978-960-233-249-8. http://sece.gr/9thconference/

Posters presented at international conferences:

1. Degteva, A. (2023). Use of LEGO® Education SPIKE™ Essential Kit for Teachers' Education. *International conference on International PhD Program "ICT in Education: Applications in Natural, Social and Health Sciences", 1–3/09/2023*. Ioannina: Epirus Palace Congress & Spa Hotel (Central Hall 1). https://ictineducation90.wordpress.com/

2. Degteva, A., Manglara, V., Pange, J. (2022). Using Questionnaires in the Tourism Sector. *International Symposium "Applications of ICTs in Entrepreneurship", Laboratory of New Technologies and Distance Learning, Department of Early Childhood Education of the University of Ioannina*. Ioannina, Greece. https://www.uoi.gr/wp-content/uploads/2022/10/ioannina-entrepreneurship-symposium-1920-oct-fin.pdf

3. Manglara, V., Degteva, A., Manglaras, C., Pange, J. (2022). ICT tools for Data Collection, Representation and Analysis. *International Symposium "Applications of ICTs in Entrepreneurship", Laboratory of New Technologies and Distance Learning, Department of Early Childhood Education of the University of Ioannina*. Ioannina, Greece. https://www.uoi.gr/wp-content/uploads/2022/10/ioannina-entrepreneurship-symposium-1920-oct-fin.pdf

4. Pange, J., Degteva, A. (2022). Gamification and Learning: The Classcraft Web Application Tools Experience. *1st Conference of Doctoral Candidates and Postdoctoral Researchers, University of Ioannina*. Ioannina, Greece. https://iaks2022.conf.uoi.gr

5. Evangelou, E., Pange, J., Degteva, A. (2022). Laboratory Electronic courses in MOOCs. *1st International scientific conference "Education in the 21st century: Contemporary challenges and concerns*". University of Ioannina, Ioannina, Greece. https://conf2022.ptde.uoi.gr/en/home-en/

Participation in summer schools:

1. *Online school: Innovation and Smart manufacturing*, European Institute of Innovation and Technology. 27/09/2021–01/10/2021. http://smart2m.eu/
2. *Online International Summer School "Θερινό Πανεπιστήμιο: Σύγχρονες ψηφιακές δεξιότητες εργαλεία, έρευνα και διδακτική" (in Greek)*, Laboratory of New Technologies and Distance Learning (ECEDU) & Department of Speech and Language Therapy, University of Ioannina, Ioannina, Greece, 26–29/08/2021. https://ictsummerschool.ecedu.uoi.gr/
3. *The Interregional with International participance of hydrobiological Bios-school*, House of rest and creativity "Komarovo", St. Petersburg, Russia, 27/07/2021–05/08/2021. https://bios-club.spb.ru/page16

Participation in scientific forums:

1. *XXVII International Bios-forum 2022*, St. Petersburg, Russia, 28/09/2022–03/10/2022. https://bios-club.spb.ru/page48
2. *XXVI International Bios-forum 2021*, St. Petersburg, Russia, 30/09/2021–05/10/2021. https://bios-club.spb.ru/page5
3. *XXV International Bios-forum 2020*, St. Petersburg, Russia, 01/10/2020–05/10/2020. https://bios-club.spb.ru/page5

Aim and Objectives of the Doctoral Thesis

Aim:

This doctoral thesis aims to investigate and explore the utilization of ICT tools in the context of higher education with a focus on ICT use by professors and students from Greece and Russia.

Objectives:

1. To review literature on ICT in education, defining ICT and its tools.
2. To compare digital competences of teachers in Greece and Russia, highlighting challenges and improvement areas.
3. To review digital competences of University of Ioannina students, examining their readiness and challenges with ICT tools.
4. To compare perceptions of distance learning and ICT use among students in both countries.
5. To evaluate student satisfaction with digital games for learning.
6. To propose an educational program to improve ICT tool usage among teachers and students.

1 Literature Review

1.1 Basic Concepts of the Doctoral Thesis

1.1.1 Definition of Information and Communication Technologies (ICT)

Currently, computers are found everywhere, and understanding what they can offer is essential. They have become a significant part of a daily life and are utilized in various fields. Before reviewing the findings of the doctoral study, some basic aspects of technology need to be understood. Let us commence with the definitions.

Information and communication technologies (ICT) is a broad concept defined by professional communities, organizations, and researchers. Prevailing definitions of the ICT are presented below.

According to the UNESCO Institute for Statistics (2009), *"ICT is defined as a diverse set of technological tools and resources used to transmit, store, create, share or exchange information."* These technological tools and resources include computers, the Internet (including websites, blogs, and e-mails), live broadcasting technologies (including radio, TV, and webcasting), recorded broadcasting technologies (including podcasting, audio and video players, and storage devices), and telephony (including landline or mobile, satellite, visio / video conferencing, etc.).

Wikipedia contributors (n.d.-e) provided the following definition of ICT:

> *"ICT is an extensional term for information technology (IT) that stresses the role of unified communications and the integration of telecommunications (<...>) and computers, as well as necessary enterprise software, middleware, storage and audiovisual, that enable users to access, store, transmit, understand and manipulate information."*

We consider this particular definition as one of the most comprehensive. There are more definitions in different dictionaries.

Cambridge Business English Dictionary defined ICT as *"the use of computers and other electronic equipment and systems to collect, store, use, and send data electronically"* (“ICT,” n.d.-a). Definition from the Cambridge Advanced Learner's Dictionary &

Thesaurus is about ICT as a subject in formal education, *"a school subject in which students learn to use computers and other electronic equipment to store and send information"* ("ICT," n.d.-a). A similar definition was provided by the Oxford Advanced Learner's Dictionary, *"the study of the use of computers, the internet, video, and other technology as a subject at school"* ("ICT," n.d.-b).

According to Ratheeswari (2018), ICT refers to the integration of digital technologies into all aspects of daily life, including education, communication, business, and entertainment.

Additionally, Hinostroza et al. (2022) offered the following information, *"ICT is used to cover any product or service that is designed to store, retrieve, manipulate, transmit, or receive information electronically in a digital form."* The authors classify personal computers, cloud service providers, social media, TV, and radio as ICT. They also noted that the singular 'ICT' is used when it refers to the abstract term or a single technology, while the plural 'ICTs' is used when several technologies need to be designated.

The concept of 'new technologies' is often mistakenly equated with the concept of ICT, and therefore we think it is necessary to explain the difference between them. Below, we provide several definitions of the 'new technologies' (NTs) term.

The clarification of this term can be confusing due to its diverse interpretations and multifaceted dimensions. The *Encyclopedia.com* resource (n.d.), a revered reference utilized by esteemed institutions, such as Harvard University, NASA, and The New York Times, for their research endeavors, elucidated the term 'NT' as:

> *"Any set of productive techniques which offers a significant improvement (whether measured in terms of increased output or savings in costs) over the established technology for a given process in a specific historical context. Defined thus, what is seen as new' is obviously subject to continual redefinition, as successive changes in technology are undertaken"* (Marshall, 2018).

This resource specified that NTs are identified separately for each scientific field.

Alternatively, NTs can be defined as innovations in hardware, software, or methodology that significantly modify existing practices, improve efficiency, and provide novel solutions to longstanding problems. These technologies may arise from advances in any

field of knowledge, and they often lead to changes in the socioeconomic landscape, necessitating regulatory, ethical, and social considerations.

It is important to differentiate between incremental upgrades of existing technologies and truly *novel* technologies. The former represents minor improvements or extensions of the current technological state-of-the-art, while the latter often represents a paradigm shift that challenges conventional wisdom or opens new possibilities for research and application (Wolff, 2021).

According to Boopathi (2023), new technologies include artificial intelligence (AI) and automation, blockchain, 5G networks, quantum computing, edge computing, augmented reality (AR), virtual reality (VR), Internet of Things (IoT), cloud computing, cybersecurity, biometrics, robotics, space technology, digital twin, etc.

The United Nations lists AI, biotechnology, material sciences, and robotics as NTs when it refers to supporting the use of technology to achieve the 2030 Sustainable Development Agenda (United Nations, 2018).

Thus, the concept of NT is included in the concept of ICTs but is not equated with it.

In conclusion, ICT encompasses a broad and evolving spectrum of technologies, applications, and systems that facilitate the creation, storage, processing, retrieval, transmission, and exchange of information through various digital media. ICT includes hardware components, such as computers, servers, and networking devices; software applications and systems, telecommunication infrastructure, internet services, and digital content. ICT encompasses not only traditional computing technologies but also emerging innovations, such as AI, IoT, VR, and other digital advancements that contribute to the interconnected and information-driven nature of contemporary society.

1.1.2 ICT in Education

Numerous authors and organizations offered a variety of definitions for ICT in the context of education. Certain definitions are rather straightforward. Especially, Cordeiro (2022) defines ICT in learning as *"the set of information and communication technologies used in education."* Other definitions explicitly specify the subjects ICTs are aimed at, what these subjects do, and how to interact with them in order to achieve desirable results.

According to Hinostroza et al. (2022), ICT in education encompasses the convergence of ICT and educational practices from various perspectives. This includes the utilization of ICT as a delivery platform by educational program providers to enhance access to learning opportunities, the integration of ICT as instructional tools by educators and learners to improve the effectiveness and quality of teaching and learning processes, and the development of ICT competences or digital skills that are essential for navigating and thriving in our progressively technology-driven world.

An earlier definition (Linways Technologies Pvt Ltd, 2017) states that education employing ICT involves utilizing technology for the delivery of information to support, enhance, and optimize the learning process. Global research indicates that the integration of ICT can result in enhanced student learning outcomes and improved teaching methodologies.

International Institute for Educational Planning (n.d.) emphasizes that the effect of ICT on student learning becomes significant when educators possess digital literacy and capability to seamlessly integrate it into the curriculum. Educational institutions use a range of ICT tools to communicate, create, distribute, store and manage information. Orazi (2023) pointed out that *"ICT can complement, enrich, and transform education for the better."* The author adds that ICT facilitates the utilization of innovative educational resources and the revitalization of instructional approaches, fostering increased collaboration among students while concurrently acquiring technological knowledge.

We also consider it important to include a few words about NT in education. In the field of education, new technologies are of particular importance since with their use, the work of teachers and administrators, as well as the ways students acquire knowledge, changes.

The emerging trends in education technology in 2023 included mobile learning and digital content platforms, AI-powered learning environments, AR and VR, gamification of learning, automated assessments, adaptive learning, and mobile learning (Suk, 2023). Trending new technologies in education vary greatly from author to author.

In conclusion, the concept of ICT in education refers to the comprehensive integration and utilization of digital technologies, tools, and resources to improve teaching, learning, and administrative processes within educational settings. These include the strategic incorporation of hardware, software, networking infrastructure, and digital content to ensure more effective and efficient educational practices.

An integration of ICT in education is an ongoing process that evolves with technological advancements, promoting innovation and improving educational outcomes.

1.1.3 ICT Tools

The term ICT is frequently coupled with the term "tools".

Adegbenro et al. (2015) reported that *"ICT tools are digital infrastructures such as: computers, laptops, desktops, data projector, software programs, printers scanners and interactive teaching box."*

Fusic et al. (2020) defined ICT tools as *"the latest technology or devices and concepts used in information and communication technology among students to students, students to teacher interaction (e.g., flipped classroom, mobile apps, and clickers devices)."*

Posavec (2021) provides the following definition of ICT tools:

> *"Term is referring to various digital tools, e.g., software, applications that can be used for different purpose. Each ICT tool has its own purpose, e.g., tools for editing images, digital drawing and creating illustration, developing mind maps, etc. They are used in education process as assets for enrichment of the teaching process."*

Thus, in an educational context, ICT tools refer to software and applications, electronic devices, and digital infrastructure, as well as teaching methods and concepts.

1.2 Modern Education Overview

1.2.1 Types and Levels of Education

The important role played by ICT tools in education at present is emphasized by researchers (Koutromanos et al., 2023; Mikropoulos, 2023; Pange et al., 2022; Pange, 2016), as well as leading institutions.

UNESCO is the leading global agency responsible for providing good practices and guidelines for ICT use to disseminate knowledge at all levels and in nearly all countries including Greece and Russia (*Digital Learning and Transformation of Education*, 2023). The International Standard Classification of Education (ISCED) was designed by

UNESCO in the last century to serve as *"an instrument suitable for assembling, compiling and presenting comparable indicators and statistics of education, both within countries and internationally"* (ILO Department of Statistics, n.d.). In 2011, the original 1976 version of ISCED and its modified 1997 version were replaced by a new classification (ILO Department of Statistics, n.d.).

Within the domain of education, initial consideration that prominently arises pertains to education within formal systems. According to ISCED (UNESCO Institute for Statistics, 2012), formal education refers to an institutionalized and deliberate form of education that is systematically organized by public entities and recognized private institutions. Collectively, these entities constitute a country's formal education system. Programs within formal education are officially acknowledged by the national educational authorities or their equivalents, including collaborations with other institutions under the oversight of national or subnational educational bodies. Primarily, formal education comprises initial education, although vocational education, special needs education, and certain segments of adult education are frequently considered integral components of the formal education system.

Along with formal education, non-formal education is distinguished (UNESCO Institute for Statistics, 2012). Unlike informal, incidental, or random learning, non-formal education shares similarities with formal education such as the qualities of being institutionalized, intentional and planned by a certain education provider. The distinctive feature of non-formal education is its role as an addition, alternative, and/or complement to formal education within lifelong learning pathways of an individual. It is often offered to ensure a wholesome access to education of people of all ages. Unlike formal education, non-formal education may lack a continuous pathway structure, being brief in duration and/or low in intensity. Typically delivered via short courses, workshops, or seminars, non-formal education habitually results in qualifications that may not be formally recognized by relevant national educational authorities or may lead to no qualifications whatsoever. Non-formal education encompasses programs addressing adult and youth literacy, education for out-of-school children, as well as initiatives focused on life skills, work skills, and social or cultural development.

According to the UNESCO Institute for Statistics (2012), ISCED does not include informal learning in assessing participation in education, but qualifications acquired

through informal learning are recognized in assessing educational attainment. Informal learning is characterized by intentional or deliberate learning forms that lack institutionalization. Consequently, it is less organized and structured than formal or non-formal education. Informal learning comprises activities in family settings, workplaces, local communities and daily life, occurring on a self-directed, family-directed, or socially-directed bases. Similar to formal and non-formal education, informal learning is distinct from incidental or random learning.

Incidental or random learning is defined by ISCED (UNESCO Institute for Statistics, 2012) as various types of learning that lack organization or involve communication not intended for educational purposes. Incidental or random learning may happen as an unintentional outcome of everyday activities, events, or communication that are not intentionally designed as educational or learning activities. Instances could involve learning occurring during a meeting while listening to a radio program, or watching a television broadcast that was not intended as an educational program.

ISCED provided the following classification of education levels (UNESCO Institute for Statistics, 2012) (Table 1).

Table 1. ISCED 2011 levels of education.

Level	Label
01	Early childhood education (Early childhood educational development)
02	Early childhood education (Pre-primary education)
1	Primary education
2	Lower secondary education
3	Upper secondary education
4	Postsecondary non-tertiary education
5	Short-cycle tertiary education
6	Bachelor's or equivalent
7	Master's or equivalent
8	Doctorate or equivalent

The table in Appendix 1 of the doctoral thesis presents a more comprehensive depiction of education levels, along with their descriptions according to ISCED 2011, as presented in Wikipedia (Wikipedia contributors, n.d.-f).

1.2.2 Greek Educational System

According to the constitutional principle in Greece, education must be accessible free of charge to all citizens covering every level of the state educational system. The Ministry of Education and Religious Affairs functions as the primary administrative body for the educational system via supervising all sectors, agencies, and levels within it (*Greece: Overview*, 2023). Additionally, the educational system supports a broad-based curriculum through fostering cultural, social, and civic development rather than encompassing academic subjects alone (Gepis & Gogas, 2005; Gogas & Gepis, 2008).

Compulsory education lasts 11 years covering the ages from 4 to 15 years old. The formal Greek educational system is primarily divided into the next stages (Constantinides, 2021) (Table 2):

Table 2. Levels of the Greek educational system.

Level	Label
Early childhood education and care	Daycare center (gr. Βρεφονηπιακός σταθμός) Kindergarten (gr. Νηπιαγωγείο)
Primary education	Primary school (gr. Δημοτικό σχολείο)
Secondary education	Lower secondary school (gr. Γυμνάσιο) Upper secondary school (gr. Λύκειο)
Higher education	University (gr. Πανεπιστήμιο)

We would like to emphasize that this table shows solely general levels without emphasis on special education. The education structure comprises early education and care for children up to 6 years old; primary education caters to students aged 6 to 12 years; secondary education is for youths 12 to 18 years of age; and higher education is designed for individuals seeking university-level courses (classified into bachelor's, master's, and doctorate programs) (Constantinides, 2021).

The Greek law 4957/2022 opened new horizons in higher education institutions: it is responsible for improving the quality, functionality, and connection of universities with society. The intent behind this legislative initiative was to enhance the functioning of higher education through a comprehensive strategy focused on raising the quality of educational, research and scientific activities in institutions. The law seeks to fortify human resources, align them with the developmental requirements of the state, and furnish supplementary means for executing strategic plans and relevant national strategies. Notable modifications introduced by the law include the incorporation of new technologies into the teaching process (*National Reforms in Higher Education*, 2023).

Lifelong learning (LLL) policy in Greece constitutes a developmental direction. LLL is mainly provided at the following institutions (*Greece: Overview*, 2023):

1. Second chance schools (SDE) (gr. Σχολεία δεύτερης ευκαιρίας)
2. Vocational training institutes (IEK) (gr. Ινστιτούτα επαγγελματικής κατάρτισης)
3. Vocational training schools (ESK) and vocational training apprenticeship schools (EPAS of OAED) (gr. Επαγγελματικές Σχολές Κατάρτισης & Επαγγελματικές Σχολές Μαθητείας)
4. Lifelong learning centers (KDVIM) (gr. Κέντρα Δια Βίου Μάθησης, ΚΕΔΙΒΙΜ)
5. Colleges (gr. Κολλέγια).

The structure of the Greek educational system is shown in Figure 1.

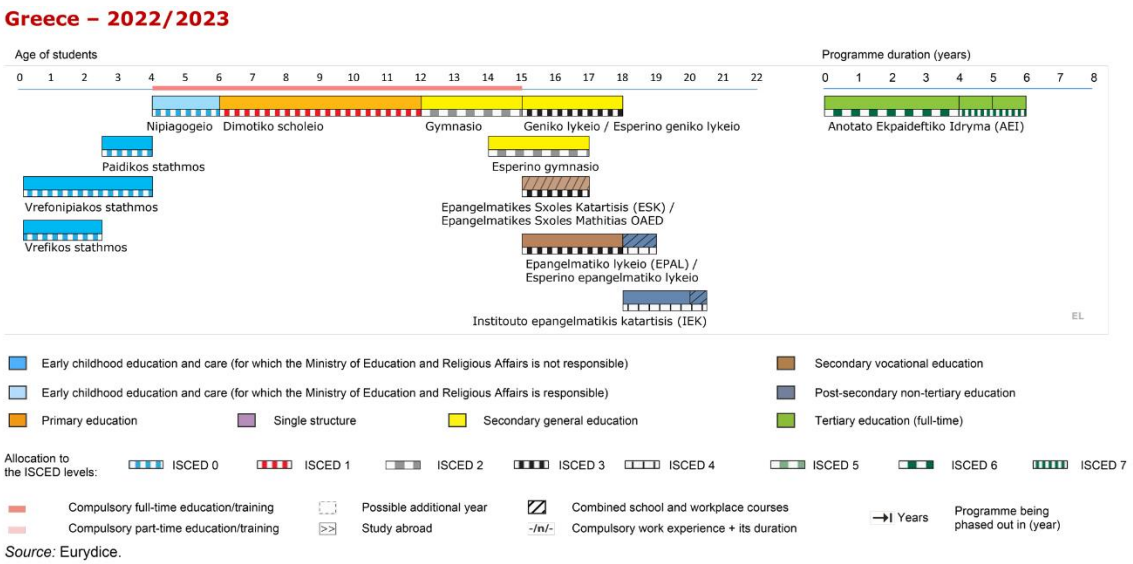

Figure 1. Structure of the Greek educational system as presented in *Greece: Overview* (2023).

1.2.3 Russian Educational System

The Russian national educational system is characterized by a comprehensive and structured approach that spans multiple levels and stages of learning. It is under the control of the Ministries of Education and Science and Higher Education. Citizens of Russia are entitled to free compulsory general education and access to higher education free of charge, based on a competitive selection process (Wikipedia contributors, n.d.-d).

This educational system consists of the following stages (*Education System of the Russian Federation*, n.d.) (Table 3):

Table 3. Levels of the Russian educational system.

Level	Label
General education	I. Kindergarten (rus. Детский сад) II. Primary school (rus. Начальная школа) III. Lower secondary school (rus. Средняя школа) IV. Upper secondary school (rus. Старшая школа)
Vocational education	Colleges and vocational schools (rus. Среднее профессиональное образование)
Higher education	University (rus. Университет / Институт)

According to the Federal Law #273, 'On Education in the Russian Federation', general education with 11 years of formal schooling from primary through upper secondary school is mandatory in Russia. Children under 7 years of age attend kindergartens at the discretion of their parents (since it is an optional stage) (Expatica & Vick, 2023).

Postsecondary education includes several options. Students can be admitted to the university through a specialty program (combining bachelor's and master's degrees), but it is not available to all; or else, students can adhere to the system traditional for Western countries (separate bachelor's and master's degrees). Colleges and vocational schools are popular in Russia, where students can enroll based on incomplete secondary education (Expatica & Vick, 2023).

The structure of the Russian educational system is presented in Figure 2.

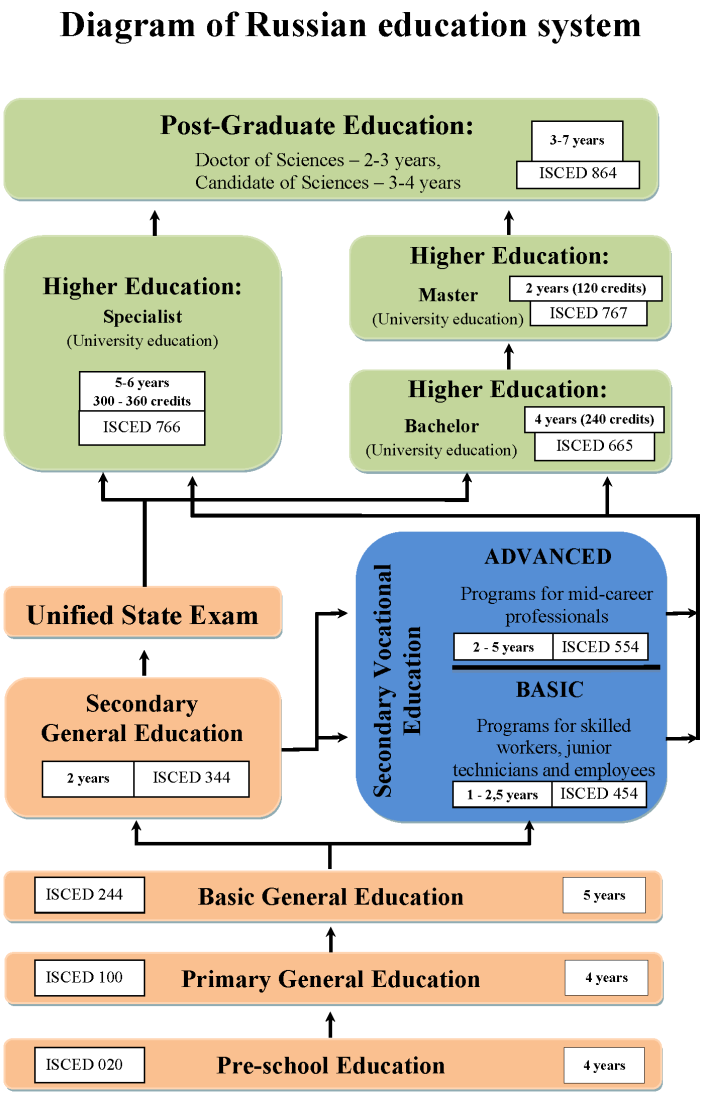

Figure 2. Structure of the Russian educational system as presented in *Education System of the Russian Federation* (n.d.).

The curricula across educational institutions, including schools and universities, in the Greek and Russian educational systems vary based on the selected subject, particularly in the field of science.

1.2.4 General Classification of the Branches of Science

For the need of our research, we distinguish the following branches of science, also known as *scientific fields* or *disciplines*. They are typically categorized into three main groups (Wikipedia contributors, n.d.-a):

- Formal sciences involve investigating formal systems, including logic and mathematics. This field relies on a priori methodology rather than empirical approach.
- Natural sciences focus on studying natural phenomena encompassing cosmological, geological, physical, chemical and biological aspects of the universe. This category can be further subdivided into physical science and life science (biology).
- Social sciences revolve around the study of human behavior in its social and cultural contexts.

The relationships between the branches of science are presented in Table 4.

Table 4. Relationships between the branches of science as presented in Wikipedia (Wikipedia contributors, n.d.-a).

Science			
	Formal science	Empirical sciences	
		Natural science	Social science
Foundation	Logic, Mathematics, Statistics	Physics, Chemistry, Biology, Earth science, Astronomy	Economics, Political science, Sociology, Psychology, Anthropology
Application	Computer science	Engineering, Agricultural science, Medicine, Pharmacy	Business administration, Jurisprudence, Pedagogy

1.3 Classifications of ICT Tools

Researchers and educational institutions have proposed diverse approaches to categorizing ICT tools (Basole, 2008; El-Hadidi et al., 2009; Luo and Lei, 2012; Gazem and Rahman, 2014). This doctoral thesis examines primarily main classifications. It is important to point out that no universally endorsed classification is unanimously accepted by scientists, organizations, or prescribed in regulatory documents.

El-Hadidi et al. (2009) provided the following classification of ICT tool component categories and some typical examples for each one (Table 5).

Table 5. Categories of ICT tools with some typical examples as presented in El-Hadidi et al. (2009).

Categories	Examples
Hardware	Application Servers, Firewalls, IPS, Antivirus, Web Content Filtering, PCs, Printers, Scanners, Plotters
Software	Windows OS, LINUX OS, MS Office, Autocad, GIS, NM SW, LMS, CMS, E-Archive, E-Publishing, Video Conferencing, Virtual Labs, Discipline-specific packages
Networks	Link to University HQ, Link to EUN, Link to Internet, Link to PSTN, Link to ISDN, VoIP, NW inside Labs, NW inside Central Library, NW inside Department Building, NW inside Admin Building, NW bet. Buildings, Wireless Access Points
Contents	Digital Libraries, E-Books, Question Banks
Humanware	NW Admin/Engineer, SW Admin/Engineer, Graphics Specialist, Instructional Designer, Servers Admin, Web Admin, E-Learning Admin, Lib Information Specialist, System Admin, PC & Peripherals Specialist
Methodologies & Policies	Technology Code of Conduct, Internet Etiquette, E-Library policy, Circulation Policy, Help Desk Policy
Applications	Student IS, Employee IS, Financial IS, Purchase IS, Inventory IS, Web Site/Portal, Hospital IS, Housing IS, Open University IS

This is not a complete list, and there may be other examples of ICT tools that could fit into each category. Accordingly, we presented the author's set of ICT tools.

According to the definition of ICT tools (Adegbenro et al., 2015) that includes devices, educational institutes suggest the classification of ICT tools based on used device (*Information Processing Cycle: General Concepts of Computing*, n.d.) (Table 6).

Table 6. Classification of ICT tools based on devices, their appearance and purpose.

Device	Appearance and Purpose
Servers	Computers for managing network resources and providing services
Desktop PCs / Laptops	Personal computing devices with a keyboard, mouse, and monitor
Mobile Devices	Portable electronic gadgets such as smartphones
Tablets	Lightweight touchscreen devices that are typically larger than smartphones
Interactive Whiteboards or Smart Boards	Digital display boards that allow interactive communication
E-readers	Devices designed for reading digital books and documents
Projectors	Devices that project images or presentations onto a screen or a surface
Audio/Video Devices	Equipment for playing and recording sound (audio) or images (video)

Basole (2008) and Gazem & Rahman (2014) focused on the functionality of categorized ICT tools, developing the most common classification found both in the literature and on open websites (*ICT*, 2022). The classification of ICT tools by functionality refers to grouping them based on their specific purpose or performed function. We reviewed the available published sources and tabulated the most common types of ICT tools based on their functionality with examples (Table 7).

Table 7. Classification of ICT tools by functionality with some typical examples.

Groups of tools	Examples
Communication	E-mail, Social networks, Forums, Instant messaging, Video conferencing, etc.
Collaboration	Online document editing, Virtual whiteboards, Collaborative platforms, Wikis, etc.
Content creation and editing	Graphic design software, Video editing tools, Presentation tools, etc.
Cloud computing	Private and public clouds, Infrastructure-as-a-Service (IaaS), Platforms-as-a-Service (PaaS), Software-as-a-Service (SaaS), etc.
Games	Simulations, Role-playing, Online games, etc.
Productivity	Word processors, Spreadsheets, Note-taking applications, etc.
Search	Search engines, Databases, etc.
Assessment	Learning analytics, Quizzes, E-portfolios, etc.
LMS	Moodle, Canvas, Blackboard, etc.

Despite classifying ICT tools into specific groups, it is essential to recognize the inherent flexibility of many tools, allowing them to go beyond single categorization. This is attributed to the extensive spectrum of functionalities and capabilities that ICT tools often encompass. The dynamic nature of technology results in tools with broad-ranging capabilities enabling them to address various needs within the digital landscape. Therefore, while the above classification provides a helpful framework, the multifaceted nature of ICT tools implies that they may belong to multiple groups, which reflects the adaptability and complexity inherent in contemporary ICT.

In their classification, Luo and Lei (2012) focused on the types of ICT tools traditionally used in education, and due to the specifics of this study, we consider necessary to present this classification as well (Table 8).

Table 8. Types of ICT tools used for education with some typical examples as presented in Luo and Lei (2012).

Type of ICT tools	Definition	Examples
Educational Networking	Online learning platforms that connect learners to sites such as Facebook or MySpace	Ning, Classroom 2.0, Elgg
Web-Based Learning	A set of online applications or services that expand learner abilities to interact and collaborate with each other in the process of seeking, receiving, organizing, and generating educational content	Wiki, blog, podcasting, social bookmarking, virtual worlds
Mobile Learning	Mobile devices or technologies used for educational purposes that support different aspects of instruction or make new educational activities available	Smartphone, PDA, GPS (for augmented reality games), interactive response pad
Classroom Equipment	Stand-alone devices that are used in traditional classrooms to facilitate the interaction between teachers and students in different classroom activities	Interactive whiteboard, touch-screen computer, Kiosk

ICT tools differ substantially due to the different purposes they serve and the varied needs they address within the realm of ICT. Each tool is designed with specific functionalities and features tailored to meet distinct requirements. For instance, communication tools prioritize real-time interaction, while productivity tools focus on organizing tasks and timelines. The diversity stems from the evolving nature of technology and the continuous advancements in software and hardware. Additionally, the uniqueness of each tool arises from the specific contexts and industries they cater to, emphasizing specialized capabilities. Such differentiation ensures that ICT tools can be customized to suit specific tasks, industries, and collaborative environments via providing users with a range of options to select the tool that suits best to their objectives and preferences. An important factor is a user ability to operate ICT tools depending on his/her digital literacy and competences.

1.4 Digital Competence

Over the past decade, there has been a growing interest with the notion of digital competence. Viewed from a European standpoint, digital competence has been employed across various domains to delineate the skills essential in a digitized knowledge society (Pettersson, 2017).

Within the Digital Competence Framework (DigComp), an initiative developed by the European Commission to define and standardize digital competence, the concept includes confident and responsible use of digital technologies. Such use extends across domains (e.g., learning, professional contexts, and active societal engagement). Digital competence, as per DigComp, is characterized by the integration of knowledge, skills, and attitudes into a cohesive framework (*DigComp Framework*, 2018).

The DigComp identifies the key components of digital competence in five fields (*DigComp Framework*, 2018):

1. Information and data literacy
2. Communication and collaboration
3. Digital content development
4. Safety
5. Problem solving.

There are 21 competences pertinent to these areas. They are outlined in Figure 3.

Built on the DigComp framework, the 'Digital Competence Wheel' is an interactive online tool (https://digital-competence.eu/) developed by the Center for Digital Dannelse (Center for Digital Dannelse, n.d.). This tool, ensuring mapping digital competences, reflects the specialization of the center in digital education and competences. Comprising four fundamental components (information, communication, production and security), the wheel encapsulates key aspects of digital competence (Center for Digital Dannelse, 2021).

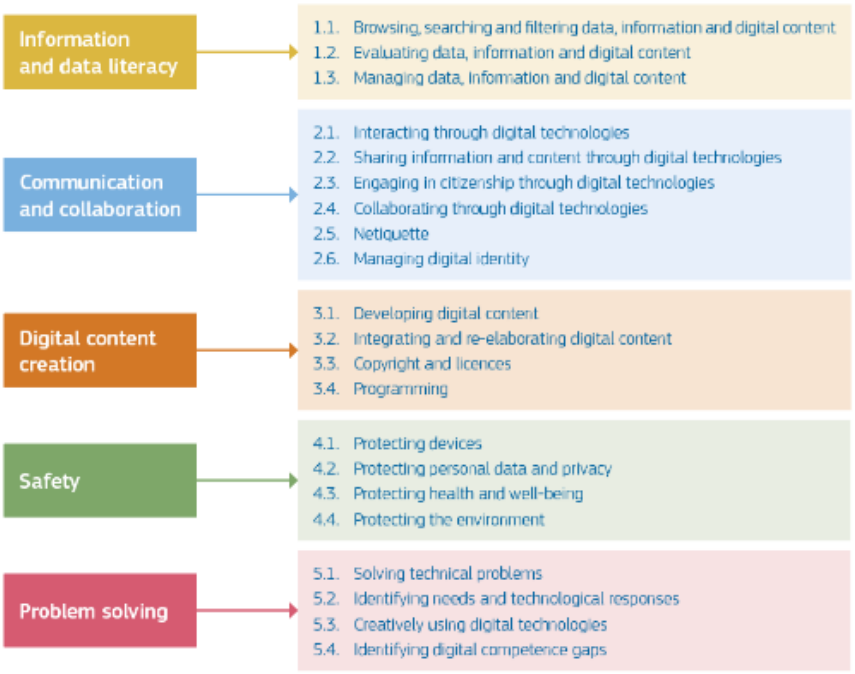

Figure 3. The DigComp conceptual reference model as presented in *DigComp Framework* (2018).

A demo group that participated in identifying digital competences using the 'Digital Competence Wheel' in 2021 exhibited the following results (the higher the score, the stronger the competence) in four key areas:

- Information: 69% (ability to identify, locate, retrieve, store, organize and analyze digital information, and evaluate its relevance and purpose).
- Communication: 72% (ability to communicate, collaborate, or interact with, as well as participate in, virtual teams and networks, along with using appropriate media, attitude and behavior).
- Production: 65% (ability to create, configure and edit digital content, solve digital problems, and explore new ways to take advantage of technology).
- Safety: 71% (ability to use digital technology safety and sustainably regarding data, identity and work-based damage, and to consider legal consequences, rights and duties).

The digital competences within each area encompassed Storage, Search, Critical Evaluation, and Self-Service within the Information area; Active Participation, Collaboration, Social Awareness, and Media Choice within the Communication area; Production and Sharing, Digital Exploration, Automation, and Configuration within the

Production area; and Law, Identity Management, Data Protection, and Health within the Safety area. The digital competence of Automation exhibited the lowest performance (60%), whereas respondents achieved a higher score of 76% in the competence of Social Awareness (Figure 4).

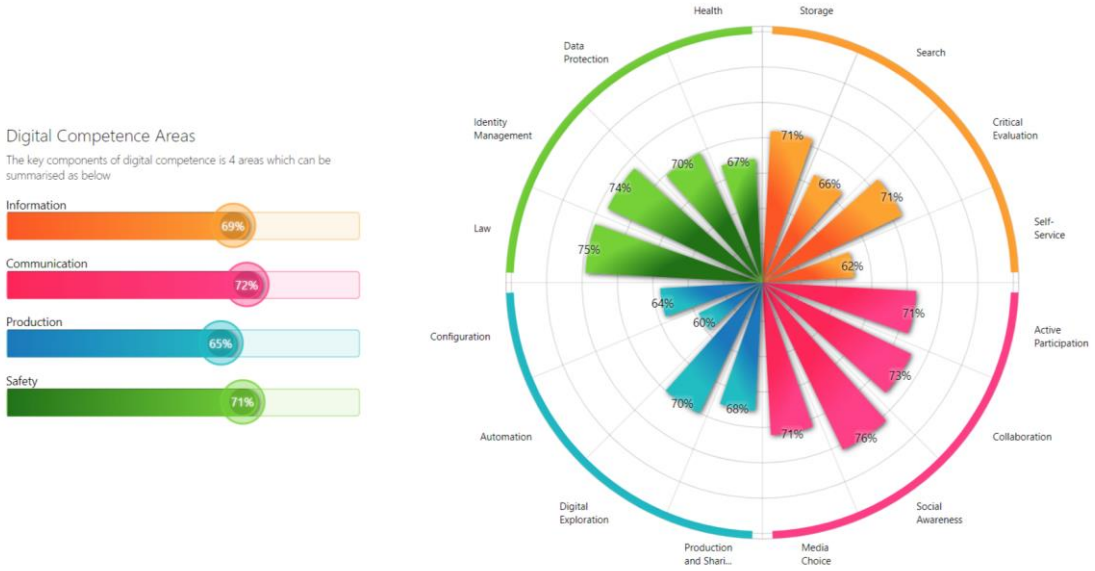

Figure 4. Results of the demo group that participated in defining digital competences using the 'Digital Competence Wheel' as presented in Center for Digital Dannelse (2021).

Another example of digital competence assessment involves the 'Developing ICT in Teacher Education' (DiCTE) project experience. This collaborative Erasmus+ initiative includes partnerships with universities in Limerick, Malta, Oslo, and Valencia, and the leadership provided by Oslo Metropolitan University. As part of this project, a questionnaire has been developed to investigate and assess the digital competence of student teachers upon entering their teacher education program. The survey also aimed at understanding how this competence evolved during their preservice education. Beyond this, the broader project endeavored to identify the diverse dimensions of digital competence among student teachers, compare competency levels across participating institutions, and share effective approaches employed in enhancing student teachers' digital competence. The questionnaire has proven its effectiveness (Giæver et al., 2020).

1.5 ICT-Supported Learning

1.5.1 ICT and Learning Theories

The relationship between ICT and learning theories is dynamic and influential in shaping contemporary educational practices. Several learning theories highlight the impact of ICT on the learning process.

In accordance with the learning theories advocated by behaviorists, learning is a mechanistic procedure involving the association of stimuli with responses resulting in the development of new behaviors. Furthermore, some psychologists argue that operant conditioning plays a role in reinforcing such behaviors ("Learning Theories: Implications for ICT," n.d.). ICT can incorporate elements of behaviorists' principles through gamification, simulations, and adaptive learning platforms. These technologies provide immediate feedback and reinforcement, supporting behaviorists' concepts of operant conditioning.

Cognitivists believe that learning is an internal mental process that involves acquiring and organizing information in the brain. They focus on how people process, store and retrieve information ("Learning Theories: Implications for ICT," n.d.). ICT can be designed to optimize cognitive load according to the cognitive load theory. Well-designed digital resources can manage the balance between intrinsic, extraneous, and germane cognitive loads enhancing learning efficiency.

The constructivism theory suggests that learners actively construct their own understanding and knowledge of the world based on their experiences and interactions with it (Prawat, 1999). ICT suit well to constructivist' theories emphasizing active engagement, collaboration, and construction of knowledge. Digital tools provide opportunities for hands-on, interactive learning experiences, enabling students to construct their understanding.

The connectivism theory emphasizes the importance of connections and networks in learning. It suggests that learners should be encouraged to create and use their networks and connections to access information and knowledge (Picciano, 2017; Siemens, 2005). In the digital age, connectivism has gained prominence asserting that learning is a networked process. ICT facilitates connectivity enabling learners to access information,

collaborate with peers globally, and engage in diverse online communities to improve their knowledge base.

The relationship between ICT and various learning theories can be summarized in a tabular form as follows (Table 9).

Table 9. Relationships of ICT with various learning theories.

Learning theory	Short description	ICT and learning
Behaviorism	Learning occurs through the association of stimuli and responses	Use of interactive multimedia and simulations to provide immediate feedback and reinforcement
Cognitivism	Learning is an internal mental process that involves acquiring and organizing information	Use of instructional technology to present complex information in visual and interactive formats
Constructivism	Learners actively construct their understanding of the world based on experiences and interactions	Use of collaborative online tools to facilitate social constructivist learning, such as online discussion forums and wikis
Connectivism	Emphasizes the importance of connections and networks in learning	Use of online networks and social media to access and share information, and to participate in online learning communities

1.5.2 ICT Tools Facilitating Interaction: Online and Offline Capabilities

Interactions in the field of education refer to the various ways in which individuals and groups interact during the learning process (Sakellariou, et al., 2024). There are three primary forms of interaction in education (Pange, 2021):

- Teacher-to-student
- Student-to-student
- Student-to-content.

These interactions can take place in both traditional classroom settings and online learning environments (Pange, 2021; Spatioti et al., 2022).

In the offline classroom, teacher-to-student interactions involve an exchange of information and ideas through certain methods, such as lectures, one-on-one meetings, and group discussions. In turn, in the online classroom, this interaction occurs through e-mail, video conferencing, online discussion forums, LMS, and social networks or instant messaging services (Rachmah, 2020; Kim, 2021).

For student-to-student interactions in offline classrooms, collaboration among peers takes place through group projects, study groups, peer assessments, and class discussions. In the online environment, students engage with each other through social networks, instant messaging, forums, and online collaborative tools (Wang, 2010; Amrullah et al., 2022).

When it comes to student-to-content interactions in offline settings, students are engaged with learning resources (e.g., textbooks, reading assignments, lab experiments and hands-on activities). However, in the online classroom, students interact with content through e-books, online journals and articles, simulations, and audiovisual materials (Kolokouri & Plakitsi, 2023; Topoliati et al., 2023; Pange, 2021; Bempeni et al., 2018).

Blended classroom formats are increasingly common facilitating an on-site integration of technology into the classroom (Sharma et al., 2022).

Currently, teachers employ numerous concepts, methods, and approaches in teaching, including those used for teaching with ICTs. Let us look at some of them.

1.5.3 Distance Learning

The Cambridge Advanced Learner's Dictionary & Thesaurus provides the following definition of Distance Learning (DL), *"... a way of studying in which you do not attend a school, college, or university, but study from where you live, usually being taught and given work to do over the internet"* (“Distance Learning,” n.d.-a).

The Cambridge Business English Dictionary clarifies that DL is *"a way of studying, especially for a degree, where you study mostly at home, receiving and sending off work by mail or over the internet"* (“Distance Learning,” n.d.-a).

It should be noted that both definitions include elements of ICT, such as the Internet and e-mail.

The Merriam-Webster ("Distance Learning," n.d.-b) and the Oxford Advanced Learner's dictionaries ("Distance Learning," n.d.-c) offer similar definitions, which also encompass the use of the Internet and e-mail as tools for DL beyond the on-site classroom.

Therefore, when referring to DL, we address the remote availability of educational resources through ICT tools enabling students to receive education from anywhere. The implementation of DL involves the use of multiple ICT tools for content creation and delivery.

DL offers the advantage of flexibility and accessibility, allowing students to access course materials at their convenience, regardless of time and location. This flexibility accommodates students with diverse schedules and responsibilities (Demetriou & Nikiforidou, 2019). However, distance learning demands self-discipline and efficient time management to navigate the challenges of isolation and distractions inherent in this learning technique (Pange et al., 2020).

There are two types of DL, synchronous and asynchronous, each with its pros and cons (Stanford Graduate School of Education, 2021) (Figure 5).

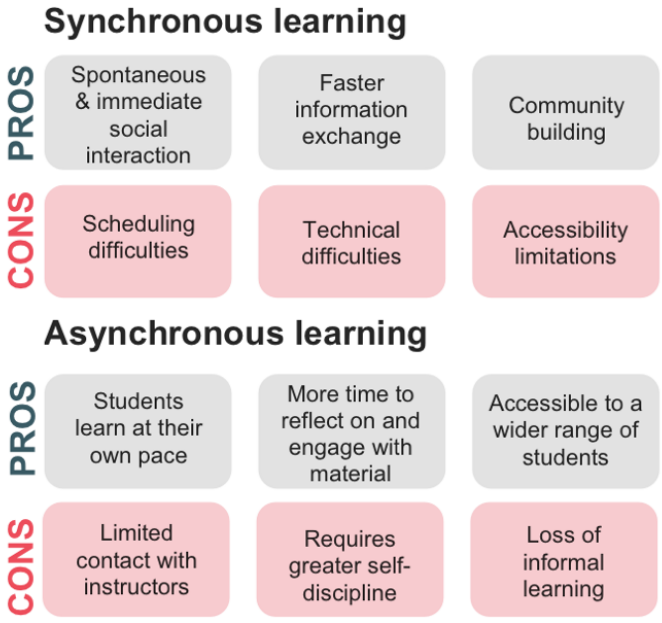

Figure 5. Pros and cons of synchronous and asynchronous learning as presented in Stanford Graduate School of Education (2021).

Synchronous learning involves instructors and students meeting simultaneously in a virtual environment and involved in real-time interaction. In contrast, asynchronous learning allows students accessing materials and interact with each other at their own pace for extended time. There is also a hybrid form, in which synchronous learning and asynchronous learning are combined in one way or another.

Various scientific publications gave different interpretations of distance learning, e-learning, online learning, and digital learning. These terms are sometimes used interchangeably, and the specific definitions and features vary based on the specific context and educational institutions (Moore et al., 2011). Nevertheless, ICT and its tools consistently serve as a common thread connecting these diverse approaches.

1.5.4 Collaborative Learning

According to Laal and Laal (2012), collaborative learning (CL) *"is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product"*.

CL emphasizes interaction, shared understanding, and mutual benefit among participants. Rather than relying solely on traditional teacher-centered methods, collaborative learning encourages active involvement and cooperation among peers (Laal & Ghodsi, 2012).

In contemporary education, CL has become increasingly significant due to its compliance with contemporary pedagogical principles and the evolving nature of work environments (Qureshi et al., 2021). The main features of CL include group activities (Luchini et al., 2002), diverse perspectives (such diversity fosters a rich environment where participants learn both from the instructor and from each other) (Lee & Yang, 2020), technology integration (Zhu & Ergüleç, 2023), active participation (such active engagement enhances critical thinking, communication skills, and the ability to work in diverse teams), and real-world relevance (Zhou et al., 2023).

With the advent of technology, CL has taken on new dimensions. ICT tools facilitated communication and teamwork, overcoming geographical barriers (Spatioti et al., 2023).

Among the ICT tools used in CL, we would like to mention the following (Laal and Laal, 2012; Laal and Ghodsi, 2012; Lee and Yang, 2020; Qureshi et al., 2021):

- Digital collaborative tools
- Cloud systems
- Social networks
- E-mail
- Video communication tools
- LMS
- Educational games
- Quizzes platforms, and others.

Thus, CL is an educational approach emphasizing active and participatory engagement among learners, and fostering a collective and interactive environment where individuals work together to achieve common learning goals. This approach goes beyond traditional individual learning by promoting social interaction, communication, and mutual support. It encompasses various instructional methods, including group discussions, peer teaching, collaborative projects, and problem-solving activities. Collaborative learning is designed to improve critical thinking, communication skills, teamwork, and to benefit better understanding of the subject matter. It acknowledges the social nature of learning, where learners contribute to, and benefit from, the shared knowledge and experiences of the group, creating a dynamic and cooperative learning community (Kollias et al., 2005).

1.5.5 Gamification

According to the Cambridge Dictionary, gamification is *"the practice of making activities more like games in order to make them more interesting or enjoyable"* (“Gamification,” n.d.-a). Oxford Learner's Dictionary provides the definition of gamification with an emphasis on the elements of game playing, *"... the use of elements of game-playing in another activity, usually in order to make that activity more interesting"* (“Gamification,” n.d.-b).

Therefore, gamification in education involves incorporation of elements of game design and mechanics into the learning process to make it more engaging, interactive, and enjoyable (Zavogianni et al., 2018; Nikiforidou & Jones, 2023). By leveraging the motivational aspects inherent in games, educators aim at enhancing student participation, motivation, and overall learning outcomes (Pange et al., 2023; Sakellariou et al., 2024).

While the categorization of video game genres was once straightforward, the contemporary landscape is marked by a notable complexity. The diversity of genres and subgenres have expanded considerably, driven by game developers who have increasingly blended different types of games in innovative ways. This continuous evolution characterizes the dynamic nature of the video gaming scene.

Presently, ten prominent video game categories stand out, each exemplified by notable titles (Pavlovic, 2023):

1. Sandbox games (e.g., *Minecraft, The Sims*)
2. Real-time strategy (RTS) games (e.g., *Warcraft, Age of Empires*)
3. Shooters (FPS and TPS) (e.g., *Gears of War* (TPS), *DOOM* (FPS))
4. Multiplayer online battle arena (MOBA) games (e.g., *League of Legends; Smite*)
5. Role-playing games (RPG, ARPG, and more) (e.g., *Skyrim; The Witcher 3* (ARPG))
6. Simulation and sports games (e.g., *Forza Motorsport, Madden NFL*)
7. Puzzlers and party games: e.g., *Jackbox Party Pack* (party game), *The Talos Principle* (puzzler)
8. Action-adventure games (e.g., *Assassin's Creed, Star Wars Jedi: Fallen Order*)
9. Survival and horror games (e.g., *The Long Dark, Don't Starve*)
10. Platformers (e.g., *Cuphead, Ori & The Blind Forest*).

The ongoing proliferation of new games and diverse styles underscores the continuing expansion of the list of video game genres. Despite the perceived complexity, this diversity serves as a testament to the robust health of the gaming marketplace.

As for educational games, they are represented by the following types (Yu, 2019; Pange et al., 2018; Akilli, 2007):

- Serious games
- Simulations
- Gamified learning platforms
- Escape games and puzzles
- Role-playing games (RPGs).

Educational games come in various forms, each serving a unique purpose in the educational journey. Serious games, for instance, are meticulously designed to deliver

specific educational content or skills, providing a simulated learning environment. Simulations, on the other hand, transport learners into interactive scenarios, fostering practical experiences in fields ranging from science to business. There is also a rising trend in gamified learning platforms, where game elements are seamlessly integrated into educational contexts to enhance motivation and engagement (Handayani et al., 2020).

One cannot ignore the popularity of escape games and puzzles, which not only challenge students but also stimulate critical thinking and collaborative problem-solving. RPGs add certain depth to education by allowing students to play different roles in fictional or historical settings, promoting empathy and a holistic understanding of different perspectives (Thodi et al., 2018; Torner, 2018).

Gamification transforms traditional educational approaches by introducing the following game-like elements (Thiel, 2016):

- Points, badges, and leaderboards offer students concrete incentives for accomplishing assignments, reaching milestones, or showcasing skills. Leaderboards instill a competitive spirit, motivating students to aspire in order to improve their performance (Gibson et al., 2013).
- Narrative and storytelling contribute to a richer learning experience by infusing educational content with engaging storylines. Students immersed as active participants in the narrative find the educational journey more compelling and memorable (Rossiter & Garcia, 2010).
- Quests and missions, when employed in learning activities, introduce an element of adventure. Students advance through challenges and tasks, experiencing a sense of accomplishment as they successfully navigate obstacles and reach educational milestones (Pange et al., 2023).
- Simulation and role-playing offer a hands-on, experiential learning setting where students can apply theoretical knowledge to real-world scenarios. This approach enhances comprehension and practical skills (Wiggins, 2016).
- Immediate feedback is a common feature in games, enabling students to learn from errors and make real-time corrections. This prompt feedback loop accelerates the learning process, making it more efficient (Kickmeier-Rust et al., 2014).

Researchers emphasize the advantages of incorporating gamification in education, including augmented engagement of students, intrinsic motivation, skill development, adaptability, and sense of achievement (Kapp, 2012; Pange et al., 2018).

Technology plays a pivotal role in implementing gamification in education. Purpose-built educational games and applications offer a foundation for gamified learning experiences, AR and VR contribute to deeper immersion, enabling students to engage in educational content in a more sensory-rich environment. Finally, LMS platforms have the capacity to integrate gamification features, empowering educators to monitor progress, assign rewards, and manage gamified elements effectively (Kapp, 2012; Kapp, 2013; Pange et al., 2023).

Embracing a gamification strategy allows educators establishing an environment that fosters curiosity and enthusiasm for knowledge acquisition in students rather than solely supporting learning. With ongoing technological advancements, the potential for creative and effective game-based educational experience is expected to grow. At present, some games, such as Classcraft, are extensively praised by researchers, teachers, and students for their notable advantages as highlighted in relevant studies (Sanchez et al., 2016; Krishnan et al., 2021).

Classcraft (https://www.classcraft.com/) is a gamification platform available online free of charge, allowing educators to transform their classes into interactive role-playing games (Classcraft, n.d.-b). Students can acquire knowledge in immersive game-based environments using this platform. First introduced in 2014, Classcraft strived to establish an award-winning and user-friendly atmosphere for gamified learning experiences. Currently, Classcraft is employed in over 50,000 classrooms across 75 countries, supporting 11 languages, and serving as an additional pedagogical tool (Zhang et al., 2021).

It is important to note that Classcraft diverges from conventional gaming structures. The platform does not involve students in the enactment of character adventures or exploration of a virtual game world. Instead, Classcraft functions as a gamification toolbox designed for daily use, influencing the dynamics of interactions between educators and students, among students themselves, and shaping the overall perception of the class (Zhang et al., 2021). The primary objective of Classcraft is to impart greater meaning to the educational

experience, while concurrently introducing an element of enjoyment to all participants (Classcraft, n.d.-b).

The advantages of utilizing gaming principles in education are evident in Classcraft, a platform that, while not inherently a game, draws upon key principles from the gaming field. These principles, including autonomy (the ability to make choices), competency (overcoming challenges), and relationships (adding perceived value to the experience), are integrated into the Classcraft model but are tailored to the classroom setting (Krishnan et al., 2021).

This adaptation of gaming principles to non-game environments, such as the classroom, is commonly referred to as gamification. Classcraft employs technology to facilitate classroom management, leveraging the aesthetic and fundamental appeal of games to captivate and involve students (Pange et al., 2023).

In the Classcraft setup, students may or may not assume characters, with the classroom serving as the game world where every action may influence the Classcraft experience. For instance, positive behavior in class can be rewarded with Experience Points, crucial for student progression within the game (Classcraft, n.d.-a).

This gameplay is firmly grounded in real-life experiences, fostering teamwork, instilling positive behavioral habits, and offering students a tangible measure of their progress throughout the academic year (Papadakis & Kalogiannakis, 2018).

Analogous to video games, students unlock new powers and privileges in the class when they accumulate sufficient Experience Points to level up (Classcraft, n.d.-a).

Classcraft operates as an overlay on the conventional classroom structure, ensuring that students continue with their regular lessons while enhancing their connections with peers, teachers, and the content under study.

To understand the essence of Classcraft, we provide general terms for this game, taken from the official game resource (Classcraft, n.d.-a). These terms collectively form the vocabulary used in the educational platform providing a comprehensive understanding of the gamified elements and their functions (Appendix 2).

Classcraft can be implemented with minimal requirements, comprising just a single computer and a projector for running the game discreetly in the background during class

sessions. Additionally, the platform offers mobile compatibility, allowing educators to assign points or utilize tools effortlessly while conducting lessons. Students possessing individual devices have the option to log in and employ their powers during class interactions (Sanchez et al., 2016).

1.6 Chapter Conclusions

In conclusion, it should be noted that Chapter 1 has provided a comprehensive overview of the foundational concepts crucial for the understanding and exploration of the doctoral thesis. The elucidation of fundamental terms, such as the definition of ICT, its role in education, and the various tools associated with it, establishes the groundwork for subsequent discussions. Additionally, the chapter explored a broader understanding of the modern educational landscape presenting an overview of different educational systems, particularly focusing on the Greek and Russian contexts.

The classification of ICT tools has been thoroughly examined illuminating various approaches proposed by researchers and educational institutions. This exploration presents a basis for the subsequent chapters where these tools will be analyzed and applied in specific contexts.

Furthermore, the chapter provides insights into common approaches employing ICT in the contemporary learning environment. Discussions on interactions within the learning process, the consolidation of ICT and learning theories, and the advent of teaching practices, such as distance learning, collaborative learning, and gamification, are crucial for understanding the evolving landscape of education.

Lastly, the chapter touched on the pivotal concept of digital competence, emphasizing the growing importance of this skill set in the context of contemporary education. As we proceed with the thesis, the foundational knowledge established in this literature review would serve as a platform for in-depth analyses and applications in subsequent chapters.

2 Research Approach

2.1 Research Design

Russia and Greece differ significantly in terms of geographical location and population size. Russia, being the largest country in the world, spans over Eastern Europe and Northern Asia, with a diverse range of climatic conditions and landscapes. It is home to a multinational population exceeding 145 million people (Wikipedia contributors, n.d.-c). On the contrary, Greece is a much smaller country located in Southern Europe, known for its rich history, ancient culture, and rather warm Mediterranean climate. The population of Greece is significantly smaller, amounting to around 10 million inhabitants (Wikipedia contributors, n.d. -b).

For this doctoral study, we applied conventional complex dissertation macrostructure (Anderson et al., 2021) to comprehensively explore the topic of the doctoral thesis. Such macrostructure refers to a dissertation comprising two or more separate research studies reported in distinct interior chapters. The research design encompasses three distinct methods for the undertaken studies.

Due to a significant disparity between the populations of the two countries, we have chosen to focus on research on the use of ICT in Greek and Russian universities using qualitative and quantitative methods:

1. Reviewing the digital competences of teachers in Greek (A) and Russian (B) universities and examining the competences of students (C) at a Greek university using the triangulation method.
2. Conducting a cross-country comparison of distance learning and the utilization of ICT tools by students in Greek and Russian universities.
3. Exploring the impact of digital games integration on student engagement and learning outcomes through an experimental study involving prospective teachers.

Triangulation in research involves using multiple methods, data sources, theories, or investigators to enhance the credibility and validity of the findings. It aims to cross-verify results and provide a comprehensive understanding by capturing different perspectives. Common types include methodological, data, theory, and investigator triangulation.

The comparison method presumes analyzing and contrasting different groups or conditions. It provides insights into relationships and variations in naturally occurring situations.

The experimental method presumes manipulating variables to observe their effects, thereby allowing researchers to reveal cause-and-effect relationships. This method is widely used to test hypotheses and assess interventions in controlled settings, providing the ability to draw cause-and-effect conclusions.

Let us examine each of the studies more closely.

2.2 Reviewing Digital Competences of Teachers in Greek and Russian Universities

The first study aimed at revealing digital competences of teachers in two countries, Greece and Russia via employing a mixed-methods survey. This instrument consisted of both closed and open-ended questions to collect quantitative and qualitative data.

Participants:

Two groups of teachers from the University of Ioannina (UoI), Greece (20), and the Yuri Gagarin State Technical University of Saratov (SSTU), Russia (20), voluntarily agreed to participate. The mean age of UoI professors was 51.47±7.6 years old, and the mean age of SSTU professors was 41.93±10.9 years old. Among UoI professors participating in the study, there were 11 men and 9 women vs. 15 women and 3 men at SSTU.

Data collection procedure:

An anonymous questionnaire, created in Google Forms, was distributed to a randomly selected group of teachers at SSTU in October 2021. Twenty of them gave their consent to the analysis and publication of responses in the public domain. The questionnaire was compiled in Russian language and included 14 questions. The collected data were analyzed using qualitative and quantitative methods. The questions were posed to gather information about the self-evaluation of the digital competence levels of SSTU professors.

An identical questionnaire was translated into English and distributed to a randomly selected group of UoI professors in November 2021. Twenty of them gave their consent

to the analysis and publication of responses. Both the questionnaires in English and Russian are included in the Appendices 3 and 4.

Data analysis:

For this study, the analysis of responses from the professors was performed preliminarily using the automated tool of Google Forms. This process utilized the platform's functionality to structure and process the responses.

Descriptive statistics constitutes a methodological approach to compare responses from professors in Greece vs. Russia. Descriptive statistics includes quantitative measures to summarize and describe essential features of a dataset. In this study, we calculated various descriptive statistics (the mean, standard deviation, median, and mode) within the two samples of responses provided by teachers from Greece and Russia. These statistical measures allowed conducting a comprehensive analysis of central tendencies, variability, and distribution characteristics in the questionnaire responses, facilitating a nuanced understanding of the comparative aspects between the two groups.

2.3 Reviewing Digital Competences of Students at the Greek University

This study was conducted at the UoI, Greece. The digital competences of the university students were self-assessed by them within a comprehensive questionnaire with closed and open-ended questions.

Participants:

A group of students from the UoI, Greece (141). This group included undergraduate (73), graduate (55), and doctoral students (8). The mean age of students was 24.74±8.4 y.o. Among them, 107 were female and 31 were male.

Data collection procedure:

The anonymous questionnaire, created in Google Forms, was distributed to a randomly selected group of 150 students at UoI in February 2022. Consent for the analysis and subsequent publication of responses in the public domain was obtained from 141 participants. The questionnaire in English comprised 15 questions designed to elicit both qualitative and quantitative data. The questionnaire is annexed in Appendix 5.

Data analysis:

The analysis of responses provided by participants was conducted using the automated tool of Google Forms.

2.4 Cross-Country Comparison of Distance Learning and ICT Tool Utilization by Students in Greek and Russian Universities

This study aimed at showing the perception by students from the two countries, Greece and Russia, of the distance learning and the use of ICT tools. We used a questionnaire consisting of both closed and open questions to collect quantitative and qualitative data.

Participants:

Two groups of undergraduate, graduate and doctoral students from universities of Greece (146) and educational institutions of Russia (149). The mean age of Greek students was 20.97 ± 5.5 y.o., and the mean age of Russian students was 20.24 ± 8.7 y.o. Greek students were represented mainly by female gender (84% vs. 15% of male students), whereas Russian students had nearly equal sex ratio (50% female vs. 48% male).

Data collection procedure:

One hundred and forty-six undergraduate, graduate and doctoral students studying at Greek universities, who gave us consent for the analysis and publication of the results, participated in this study during the fall semester of the 2021-2022 academic year (November-December). Similar number of students from Russian universities (149) completed the questionnaire and gave their consent to the analysis and publication of their responses during the same academic year.

An anonymous questionnaire was compiled both in English and Russian (Appendices 6 and 7) and included 14 questions each. The collected data were analyzed using qualitative and quantitative methods. The questions were posed to collect information on the perception by students from two countries, Greece and Russia, of the distance learning and the use of ICT tools.

Data analysis:

For this study, the analysis of responses from the students was conducted using preliminarily the automated tool of Google Forms. This process utilized the platform's functionality to structure and process the responses.

Descriptive statistics was used as a methodological approach to compare responses from students in two countries.

2.5 Exploring the Impact of Digital Game Integration on Student Engagement and Learning Outcomes: An Experimental Study with Prospective Teachers

This study investigated the effects of integrating the digital game (Classcraft) into the educational process, focusing on student engagement and learning outcomes.

Participants:

This study included undergraduate students from the Department of Early Childhood Education at the UoI attending the "Educational Programs Using ICT" course during the spring semester of the 2022-2023 academic year. A total of 60 volunteering students were randomly assigned to either the experimental group (n=30) utilizing Classcraft, or the control group (n=30) following the standard course curriculum. The mean age of the students was 24.31 ± 6.3 years.

Study design:

The experimental group received a comprehensive introduction to Classcraft during the first week of the semester, including guidance on its seamless integration into the course.

Both groups were monitored for engagement metrics, such as participation in discussions, completion of assignments, and attendance. Classcraft-specific metrics, including in-game participation, achievements, and collaboration, were observed in the experimental group.

Learning outcomes in both groups were assessed through regular quizzes, examinations and a final project. Both groups underwent pre- and post-course interviews to elucidate their expectations and perceptions.

Qualitative feedback regarding the impact of Classcraft on engagement and learning was collected. Descriptive statistics was used to compare academic performance and engagement metrics between the experimental and control groups.

Students representing the experimental group took part in substudies devoted to the evaluation of Classcraft.

Classcraft evaluation was within the Kirkpatrick 4-level model:

In the initial step, participants responded to a set of 12 questions (Appendix 8), categorized into four levels following the Kirkpatrick 4-level model (Reaction, Learning, Behavior, Results) (*What is the Kirkpatrick Model?*, 2022). Responses were recorded on a 10-point scale. This assessment was administered at three distinct time points in the beginning, middle, and end of the academic semester.

Thematic study:

Following the quantitative analysis, a qualitative approach was employed through a thematic study. In this phase, individual interviews were conducted with the voluntarily participating students from the experimental group. The interviews were structured to cover various aspects of their experiences with the Classcraft game. Subsequently, responses were grouped based on the themes identified during the interviews.

Quality assessment for digital quests:

This substudy involved 8 students who independently developed their own quests within the Classcraft game. Additionally, a research group consisting of five individuals (the professor, who is responsible for the course, and four doctoral students) was formed to evaluate these quests.

The eight students were given the task of creating unique quests within the Classcraft game, focusing on elements such as storyline, challenges, and educational content. While we provided a broad theme (Statistics), the students autonomously selected the target age group for their lessons, decided on the ICT tools to employ, and determined the aspects of the topic to cover.

The research group evaluated the eight quests based on a comprehensive set of criteria formulated by Tse et al. (2021):

1. Creativity: Assessing the originality and imaginative aspects of the quests.

2. User-friendly: Evaluating the ease of navigation and overall user experience within the quests.
3. Educational content: Analyzing the depth and relevance of educational material incorporated into the quests.
4. Multimedia used: Assessing the effectiveness and appropriateness of multimedia elements and ICT tools integrated into the quests.
5. Story structure: Evaluating the coherence and structure of the narrative within each quest.
6. Presentation: Examining the clarity and effectiveness of how the quests were presented to students.
7. Quality of the story: Assessing the overall quality and impact of the narrative elements within the quests.

The research group individually assessed each of the eight quests according to the specified criteria, assigning a score on the 10-point scale for each criterion. Scores were based on subjective judgments of the research group members, considering the overall merit of each particular quest regarding the specific criterion.

Mean scores and standard deviations were calculated for each criterion across the eight quests. The aggregated scores provided insights into the overall performance of the quests in terms of creativity, user-friendliness, educational content, use of multimedia, story structure, presentation, and the story quality.

Data analysis:

Quantitative data from the set of questions were analyzed using statistical software. Thematic analysis of interview responses involved identifying recurring themes and patterns within the qualitative data.

2.6 Proposal for Integration of Educational Games into Greek Universities

This part focused on the development and formulation of an educational proposal aimed at enhancing the educational experience through the integration of educational games in the curriculum at Greek universities. The methodology employed a systematic and collaborative approach to address the identified needs in the field of digital competences.

Drawing insights from existing educational frameworks, the proposal aimed at creating a comprehensive program that would align with contemporary educational standards and pedagogical approaches.

A proposed program structure was developed that identified specific objectives, rationale, and implementation plan.

This proposal serves as an outline for fostering international collaboration to enhance the capabilities of professors and students in modern educational approaches and digital skills.

2.7 Ethical Considerations

Prior to the onset of each study, ethical approval was obtained from the relevant institutional review boards. Participants were informed about the purpose of the study, and informed consent was obtained from each of them. Confidentiality and anonymity of participants were rigorously observed throughout the research process.

2.8 Limitations

In this doctoral thesis, the doctoral candidate encountered several challenges that must be listed. Data for this study was collected from selected areas in two countries, with participation of teachers and students from specific universities due to several reasons which will be mentioned later in this report. The study was conducted from 2020 to 2024, during the COVID-19 pandemic and the associated restrictions were applied, so the selection of participants had some limitations, and the convenience sampling was applied in this thesis. The sample included professors and students of different ages enrolled in different fields of teaching/studying, which we believe positively influenced the research results.

Some research activities planned within Russian universities became unfeasible due to the current political situation in Russia. The inability to obtain consent forms from participants from Russian university teachers and students led us to focus this research on Greek university students and staff.

Additionally, a number of university professors did not give their consent to be tested for their ICT competences, so we asked from all professors to give us their self-assessment of their digital competences. Thus, 'Digital Competence Wheel' from the Center for Digital Dannelse and 'Developing ICT in Teacher Education' (DiCTE) project were used by participants of this study.

Moreover, the educational game Classcraft (https://www.classcraft.com/) will officially close on June 30, 2024. The new version, HMH Classcraft, will be available only to schools and districts, not to individual users.

Despite these limitations, the research contributed valuable insights to the integration of ICT tools in complex settings.

3 Participating Universities: Comparative Overview

3.1 Universities in Greece

Greece has 24 universities (National and Kapodistrian University of Athens, National Technical University of Athens, Athens School of Fine Arts, Agricultural University of Athens, Athens University of Economics and Business, Aristotle University of Thessaloniki, Panteion University of Social & Political Sciences, University of Piraeus, University of Macedonia, University of Patras, University of Ioannina, Democritus University of Thrace, University of Crete, Technical University of Crete, University of Thessaly, University of The Aegean, Ionian University, Harokopio University of Athens, University of Peloponnese, Hellenic Open University, University of Western Macedonia, International Hellenic University, University of West Attica, Hellenic Mediterranean University) and 2 educational institutes (School of Pedagogical & Technological Education – ASPETE, and Mediterranean Agronomic Institute of Chania). These are represented by both public and private organizations. The universities award degrees in various fields of formal, natural, and social sciences (Study in Greece, 2023).

While the primary language of instruction is Greek, there is a presence of English-language programs, particularly at the doctoral level. Greek universities play an active role in research and innovation engaging in collaborations with international institutions across a wide range of scientific environments (Katharaki & Katharakis, 2010).

The University of Ioannina (UoI) is considered among the highest-ranked educational institutions in Greece (University of Ioannina, n.d.-c).

3.1.1 University of Ioannina

UoI is a highly regarded higher education institution located in Ioannina, the capital of the Epirus Province in northwestern Greece. As of 2023, the university hosts over 33,000 students pursuing undergraduate, graduate, and doctoral studies across 23 departments within 11 schools (*University of Ioannina*, n.d.-b). Renowned for its excellence in natural, social, and formal sciences, the university boasts collaborations with world-famous scientists.

The university campus is well-equipped with modern facilities, encompassing classrooms, laboratories, libraries, and research centers. This environment supports a conducive atmosphere for learning, research, and extracurricular activities. Additional recreational and sports facilities contribute to fostering a balanced lifestyle among students (University of Ioannina, n.d.-a).

Consistently featured in national and global university rankings, the UoI holds a prominent position as the foremost academic and research center in the country (University of Ioannina, n.d.-c). Actively engaged in international cooperation initiatives, the university strengthens partnerships with global universities and research institutes, enriching the academic experience with cultural diversity and a broader global perspective (*University of Ioannina*, n.d.-b).

Demonstrating a deep commitment to community engagement, the UoI collaborates with local communities to provide expertise and resources for addressing social issues. Through these outreach programs, the university plays a vital role in the development and progress of the region (*University of Ioannina*, n.d.-b).

3.2 Universities in Russia

Russia is home to a variety of higher education institutions, comprising both universities and specialized institutes. There are over 1,000 universities and educational institutes in the country (Wikipedia contributors, n.d.-d). These institutions vary in their public and private nature, contributing to the richness of the Russian higher education system.

Russian universities offer a wide array of academic disciplines, covering formal, natural, and social sciences, reflecting the country's commitment to providing comprehensive education.

Although the main language of instruction at Russian universities is Russian, English-language programs are also available.

Russian universities are actively engaged in research and innovation, participating in collaborations with international institutions in diverse scientific domains. This collaborative approach enhances the global standing of Russian academic institutions and fosters advancements in various fields of study (Smolentseva, 2015).

3.2.1 Yuri Gagarin State Technical University of Saratov

Yuri Gagarin State Technical University of Saratov (SSTU) is among leading technical institutions in Russia, located in Saratov within the Saratov Region of the Volga Federal District. The university holds historical significance as it is associated with Yuri Gagarin, the first human to journey into space, who pursued his education at this institution during his student years (*About SSTU*, n.d.).

Presently, SSTU comprises 62 departments across 8 schools and 2 campuses, including a college, catering to the educational needs of approximately 19 thousand undergraduate, graduate, and doctoral students (2022) (*SSTU: Facts and Figures (1 November 2022)*, n.d.).

SSTU is widely recognized for its commitment to academic excellence and innovation. Offering a diverse array of programs in different fields, such as engineering, natural sciences, computer science, economics, and humanities (*About SSTU*, n.d.), the university's comprehensive curriculum is strategically designed to equip students with the necessary knowledge and skills to achieve success in their chosen professions.

The university is actively engaged in collaborative initiatives with industry partners and research institutions, fostering a culture of innovation and entrepreneurship among its students and researchers (*About SSTU*, n.d.). SSTU encourages international collaboration and welcomes students and researchers from various countries (*International Projects*, n.d.).

Situated on a well-equipped campus featuring state-of-the-art facilities, including modern classrooms, laboratories, research centers, and libraries, SSTU provides students with access to resources and technology that enhance their learning experience. The campus also offers recreational spaces, sports facilities, and various student organizations, emphasizing a holistic approach to education and personal development (*Campus Life*, n.d.).

The university's contributions significantly impact the progress of both society and technology.

4 Results and Discussion

4.1 Reviewing Digital Competences of Teachers in Greek and Russian Universities

SSTU professors (n=20) gave their consent to analyze and publish their anonymous responses to the questionnaire administered during the fall semester of the academic year 2021-2022 (October 2021). The same questions were asked to 20 professors at the UoI one month later. We compared the responses of professors between the two universities.

For the purpose of this study, we asked professors from different departments to clarify their proficiency in using ICT tools (by category) and their attitudes toward the teacher-technology interaction. Professors were also asked a series of demographic questions.

In the case of the UoI, professors from the Departments of Early Childhood and Primary Education, Economics, Psychology, and Physics participated in this study. Some professors chose to hide their affiliation with a particular university department.

The fields of expertise of Greek professors in this study were: Pedagogy, Psychology, Informatics, Sociology, Economics, Philology and, more specifically: Mathematics Education, Environmental and Sustainability Education, Early Years Science Education, Museum Education in Early Years, Intercultural Education, History of Education, ICT in Education: Emphasis on Virtual Reality, New Technologies Applied to the Research Methodologies, Linguistics and Greek Language, Electrical Engineering, Econometrics, and Consumer Theory.

SSTU professors from the Departments of Ecology, Economics, Psychology, and Physics took part in our study. In the case of SSTU, some professors chose not to indicate their affiliation with a particular department of the university as well.

The fields of expertise of the Russian professors in this study were: Ecology, Biology, Pedagogy, Technology, Economics and, more specifically: Earth Sciences, Environmental Monitoring, Biochemistry, Environmental Protection and Rational Nature Management.

ICT tools are conventionally used in the above fields.

At the Greek university, approximately half of the male (55%) and female (45%) participants took part in this study, while at the Russian university, the number of female

participants (83%) substantially exceeded the number of male participants (17%) (Figures 6*a* and 6*b*).

Figures 6*a* and 6*b*. Gender distribution among professors at UoI and SSTU.

The mean age of professors from UoI was 51.47 ± 7.6 y.o.; mode: 51. The range of the provided data set was 30, representing the difference between the maximum value of 62 and the minimum value of 32. The mean age of professors from SSTU was 41.93 ± 10.9 y.o.; mode: 32. The range of this set was 38, representing the difference between the maximum value of 63 and the minimum value of 25.

The competences of professors for the use of ICT were estimated by the number of years that professors worked at universities and used ICT for teaching. The mean teaching experience of UoI professors was 17.425 ± 9.7 years; mode: 10 (the range was 32). SSTU professors in our sample had much shorter teaching experience: on average, 12.9 ± 8.9 years; mode: 10 (the range was 34).

Professors from both countries were asked to self-assess their digital competence as teachers on a 6-point scale ranging from Newcomer (A1) to Pioneer (C2). This system was adopted from the Digital Competence Wheel, an interactive online tool that maps digital competences (Center for Digital Dannelse, n.d.).

Slightly over a half of Greek professors (53%) evaluated themselves as technology integrators (B1); 32% of Greek professors considered themselves experts in the field of ICT (B2); 2 professors (10%) rated their skills at the pioneers (C2) level, and none of Greek professors called themselves newcomers or explorers (A1-A2) (Figure 7*a*). Among Russian professors, half of them (50%) evaluated themselves as experts in the field of ICT (B2), while another half, in varying proportions, ranked themselves across the other five levels (Figure 7*b*).

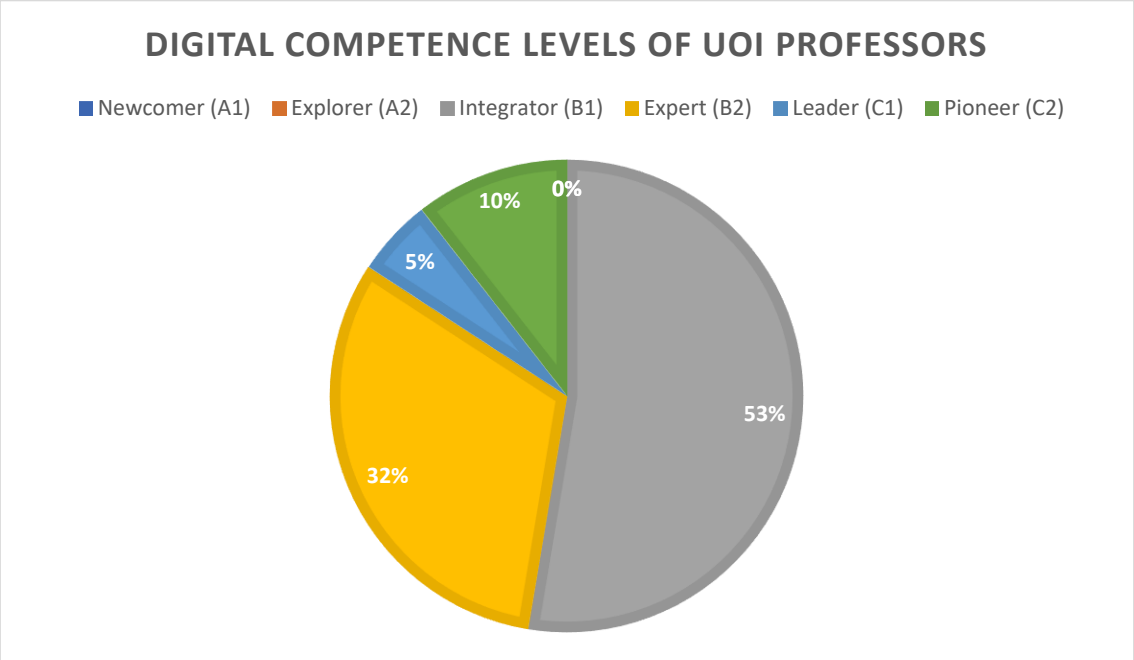

Figure 7*a*. Digital competence levels of UoI professors.

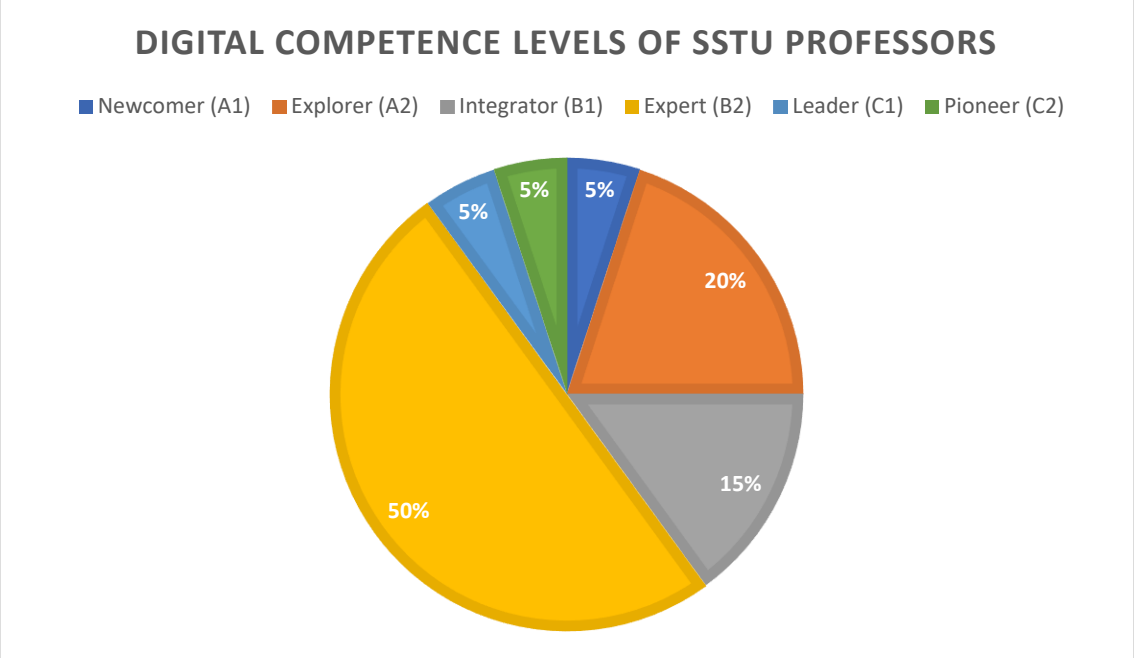

Figure 7*b*. Digital competence levels of SSTU professors.

We then gave professors several sets of five statements each to determine their attitudes toward ICT use for educational purposes by teachers and students, along with their current digital skills. The statements complied with those listed in the questionnaire developed

for the Erasmus+ project DiCTE (Giæver et al., 2020). Some additional statements were added for the needs of this study.

The first set of statements was as follows:

i. I constantly use technology to communicate with my students and colleagues (e.g., email, social media, etc.)
ii. I actively develop my digital skills
iii. I regularly participate in online webinars for my job
iv. I am constantly looking for new educational approaches using ICT
v. I encourage students to use ICT tools for educational purposes.

The responses of professors were categorized on a Likert scale (1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree).

Regarding statement (i), the opinions of Greek professors were clear; they stated that constantly used technology to communicate with other professors and students (25% agreed, and 75% strongly agreed). Most of them (60% agreed, and 35% strongly agreed) confirmed the ongoing improvement of their digital skills (ii). Greek professors regularly participated in online webinars for their work (40% agreed, and 25% strongly agreed) (iii). The majority of professors (65%) agreed or strongly agreed that they were constantly seeking new educational approaches using ICT (iv). Finally, nearly all Greek professors in our sample (90%) encouraged their students to use ICT for educational purposes (v) (Figure 8*a*).

In the Russian sample, only 5% of professors disagreed with the constant use of ICT tools for communication, while 95% of them regularly used ICT to communicate with students and colleagues (i). Most professors (85%) were keen to develop their digital skills (ii) and the same number of them regularly participate in online webinars for their job (iii). Half of Russian professors (50%) were seeking new educational approaches using ICT (iv). Almost everyone (90%) agreed or strongly agreed with the use of ICT tools for educational purposes by their students (v) (Figure 8*b*).

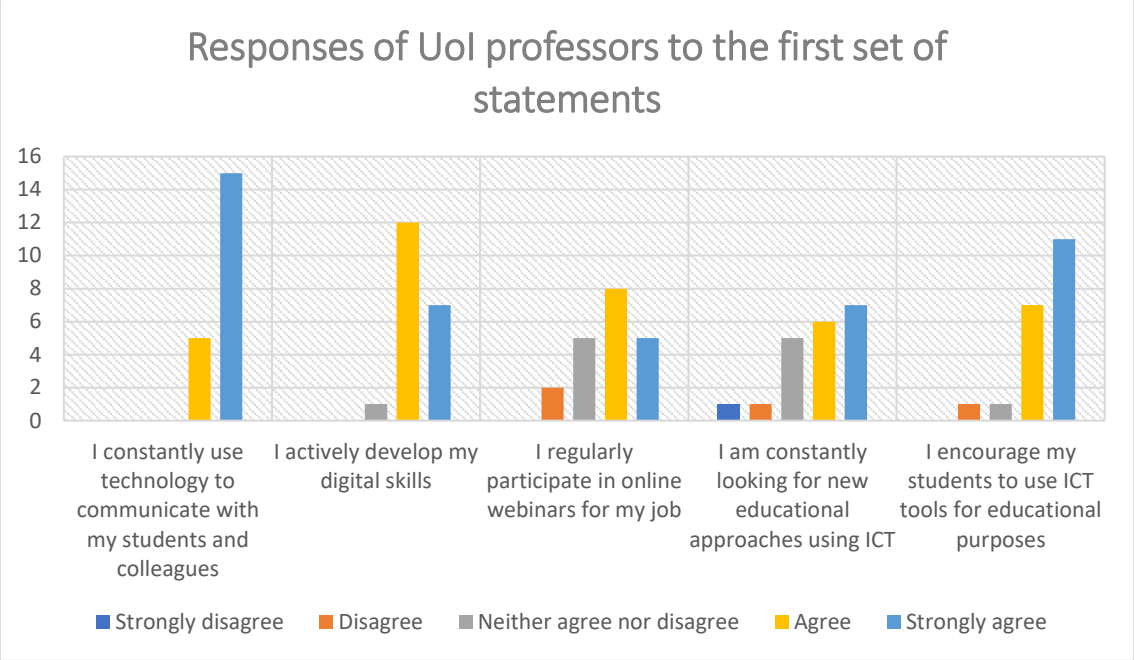

Figure 8*a*. Responses of UoI professors to the first set of statements (i-v).

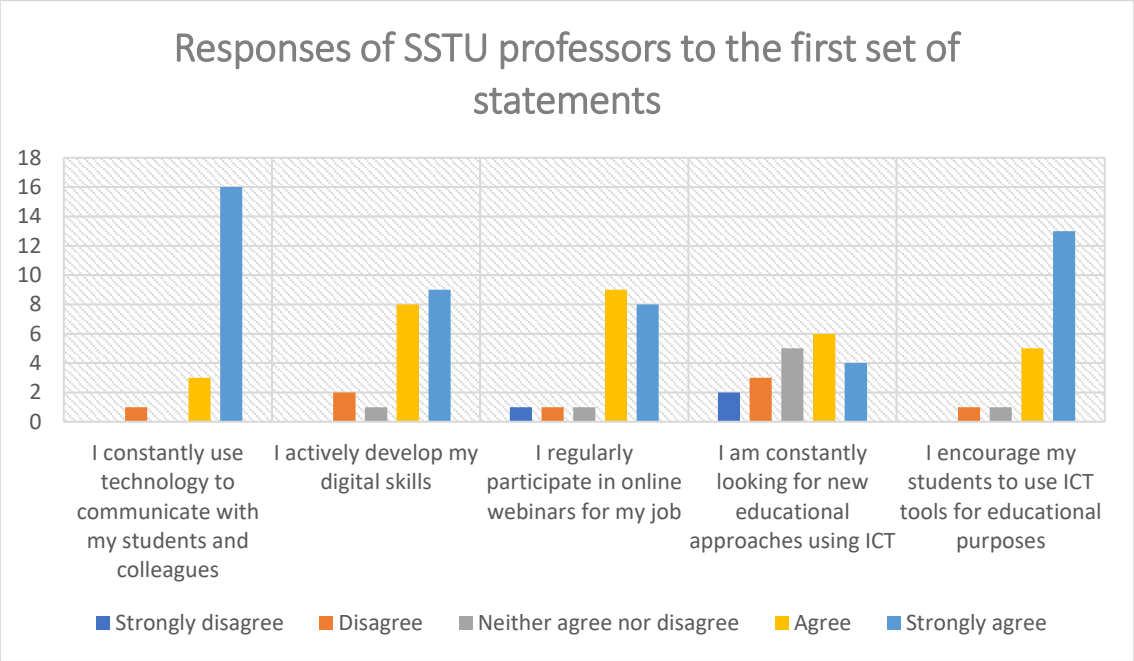

Figure 8*b*. Responses of SSTU professors to the first set of statements (i-v).

In the next three (2^{nd} – 4^{th}) sets, professors had to rate on a 5-point scale (1-very poor, 2-poor, 3-neither good nor poor, 4-good, 5-very good) their competence of using various groups of ICT tools. We started with the next set:

vi. Word processor (e.g., MS Word)

vii. Spreadsheet (e.g., Excel)
viii. Presentation tools (e.g., PowerPoint)
ix. Image processing (e.g., Paint)
x. Video editing (e.g., Movie Maker).

All Greek professors noted their excellent knowledge of word processors (the mean score for this statement was 4.9±0.3) (vi) and presentation tools (4.8±0.4) (viii); in the case of spreadsheet (vii), most professors also noted their good training in working with them (4.45±0.7). In contrast, in the case of image processing (ix) and video editing (x), our sample already included professors who were not proficient in the appropriate tools. The mean scores for these statements were 3.65±1.0 and 3.05±1.2, respectively (Table 10).

Russian professors outperformed Greek professors in the image processing category of ICT tools (ix), where they scored a mean of 3.75±0.9. For other statements, Russian professors had lower scores compared with their Greek colleagues and were: 4.45±0.7 for word processor (vi), 3.95±0.5 for spreadsheet (vii), 4.25±0.7 for presentation tools (viii), and 2.75±1.2 for video editing tools (x) (Table 10).

Table 10. Comparative descriptive statistics: mean, standard deviation, median, and mode for the second set of statements (vi-x).

ICT Tool	Uni	Mean	SD	Median	Mode
Word processor	**UoI**	4.9	0.3	5	5
	SSTU	4.45	0.7	5	5
Spreadsheet	**UoI**	4.45	0.7	5	5
	SSTU	3.95	0.5	4	4
Presentation tools	**UoI**	4.8	0.4	5	5
	SSTU	4.25	0.7	4	4
Image processing	**UoI**	3.65	1.0	4	3
	SSTU	3.75	0.9	4	4
Video editing	**UoI**	3.05	1.2	3	2
	SSTU	2.75	1.2	3	2

We used descriptive statistics (mean, median, and mode) for the purposes of summarizing, organizing, and presenting key characteristics of our datasets. Descriptive

statistics provide insights into central tendency, variability, distribution, and relationships between variables.

In the third set, Greek and Russian professors had to rate their competence of using the following:

xi. Digital collaborative tools (e.g., MS Teams)
xii. Cloud systems (e.g., Google Drive)
xiii. Social networks (e.g., Facebook)
xiv. E-mail (e.g., Gmail)
xv. Video communication tools (e.g., Skype).

Among Greek professors, as expected, the first positions were taken by e-mail (4.95±0.2) (xiv) and video communication tools (4.7±0.5) (xv): professors rated their competences of the kind as good and very good, respectively. Digital collaborative tools (xi) were also easy for almost all professors from our sample (4.3±0.6). But for the cloud systems (4.1±1.1) (xii) and social networks (3.6±1.5) (xiii), our sample included professors who rated their knowledge as poor (Table 11).

Russian professors outperformed their Greek colleagues on social networks (xiii), scoring 4.35±0.6. For the remaining statements, as in the case of the previous set, Russian professors were inferior to their Greek colleagues and their mean scores were lower. According to our results, digital collaborative tools (xi) pose the most challenges for them (Table 11).

Table 11. Comparative descriptive statistics: mean, standard deviation, median, and mode for the third set of statements (xi-xv).

ICT Tool	Uni	Mean	SD	Median	Mode
Digital collaborative tools	**UoI**	4.3	0.6	4	4
	SSTU	3.4	1.1	3	3
Cloud systems	**UoI**	4.1	1.1	4	5
	SSTU	3.75	1.1	4	4
Social networks	**UoI**	3.6	1.5	4	5
	SSTU	4.35	0.6	4	4

E-mail	**UoI**	4.95	0.2	5	5
	SSTU	4.42	0.6	5	5
Video communication tools	**UoI**	4.7	0.5	5	5
	SSTU	4.2	0.7	4	4

In the fourth set, professors had to rate their competence of using the following:

xvi. Learning management systems (e.g., Moodle)
xvii. Tools for creating content (video, audio)
xviii. Tools for interactive whiteboards (e.g., SmartBoard)
xix. Educational games (e.g., Classcraft)
xx. Quizzes platforms (e.g., Kahoot!).

The responses to this set of statements were, perhaps, the most varied of all. For each of the listed tool categories, some Greek professors reported that they were very good at it, as well as very poor at it. LMS (xvi) was the easiest for Greek professors: the mean score among the responses to this statement was 3.95±1.3. For educational games (xix), the mean score was much lower and amounted to 2.2±0.4 (Table 12).

The mean scores on educational games (4.7±0.4) (xix) and quizzes platforms (3.25±1.3) (xx) were much higher for Russian professors vs. Greek ones. As we can see, these types of ICT did not cause difficulty for the majority of professors in our sample. For other types of ICT (xvi-xviii), the mean scores were lower compared with statements from the 2nd and 3rd sets (Table 12).

Table 12. Comparative descriptive statistics: mean, standard deviation, median, and mode for the fourth set of statements (xvi-xx).

ICT Tool	Uni	Mean	SD	Median	Mode
LMS	**UoI**	3.95	1.3	4.5	5
	SSTU	3.0	1.2	3	3
Tools for creating content	**UoI**	3.1	1.2	3	3
	SSTU	2.85	1.2	3	3
	UoI	2.85	1.2	3	3

Tools for interactive whiteboards	**SSTU**	2.75	1.2	3	3
Educational games	**UoI**	2.2	0.4	2	2
	SSTU	4.7	0.4	5	5
Quizzes platforms	**UoI**	2.75	1.3	2.5	2
	SSTU	3.25	1.3	3.5	4

After conducting a thorough descriptive statistics analysis on the datasets (UoI and SSTU), several key insights can be derived. We cannot confidently dismiss the possibility that these differences are attributable to chance rather than a systematic pattern. Judging by the distributions, in both samples there were professors who rated their competence highly (4-5) and professors who rated their knowledge of some types of ICT at 1-2. Notably, Russian professors preferred using educational games and quizzes in educational practice, while Greek professors avoided those.

This study examined ethical issues in how often professors in both samples applied:

xxi. Copyright rules online
xxii. Privacy rules online
xxiii. Evaluation rules of the reliability of digital material.

The responses of professors were categorized on a 5-point scale where: 1-almost never, 2-seldom (less than once per month), 3-sometimes (1-3 times a month), 4-often (1-3 times a week), 5-always (more than 3 times a week).

We received a variety of responses to this set of statements from Greek professors, including variations from almost never (10% for each statement) to always (20% (xxi), 25% (xxii) and 15% (xxiii)). Half of Greek professors (50%) applied privacy rules online and evaluation rules of the reliability of digital material less than once per month (Figure 9*a*).

Among professors from Russia, we also saw a variety of options from almost never (5% for each statement) to always (25% (xxi, xxii) and 35% (xxiii)). However, the option often (1-3 times a week) was more common among them (Figure 9*b*).

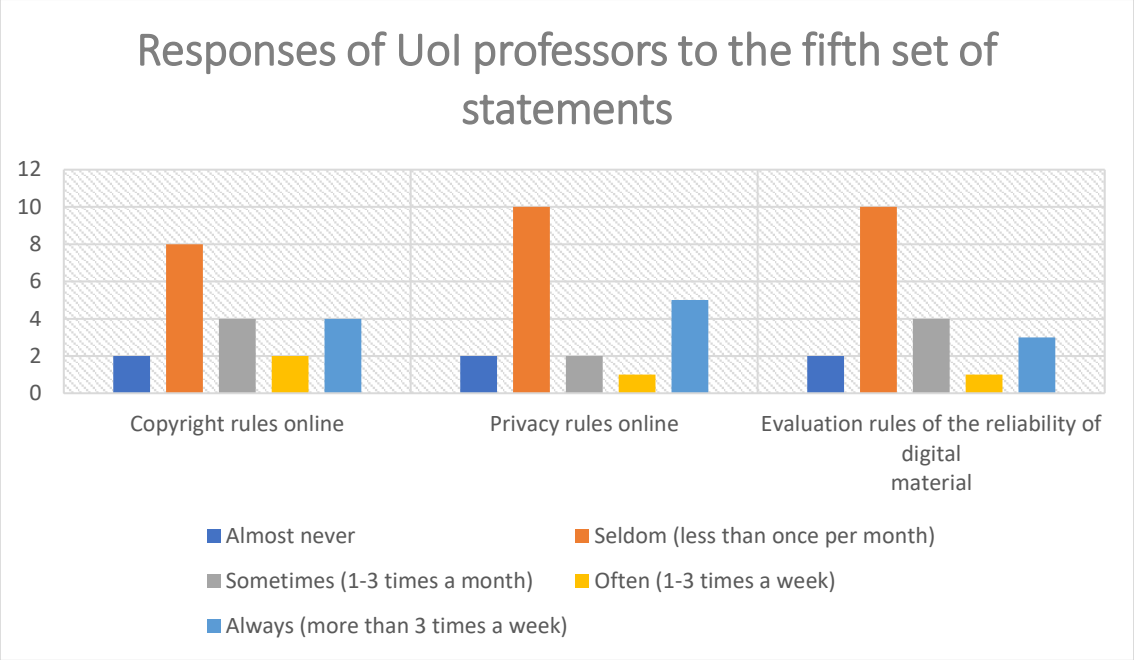

Figure 9*a*. Responses of UoI professors to the fifth set of statements (xxi-xxiii).

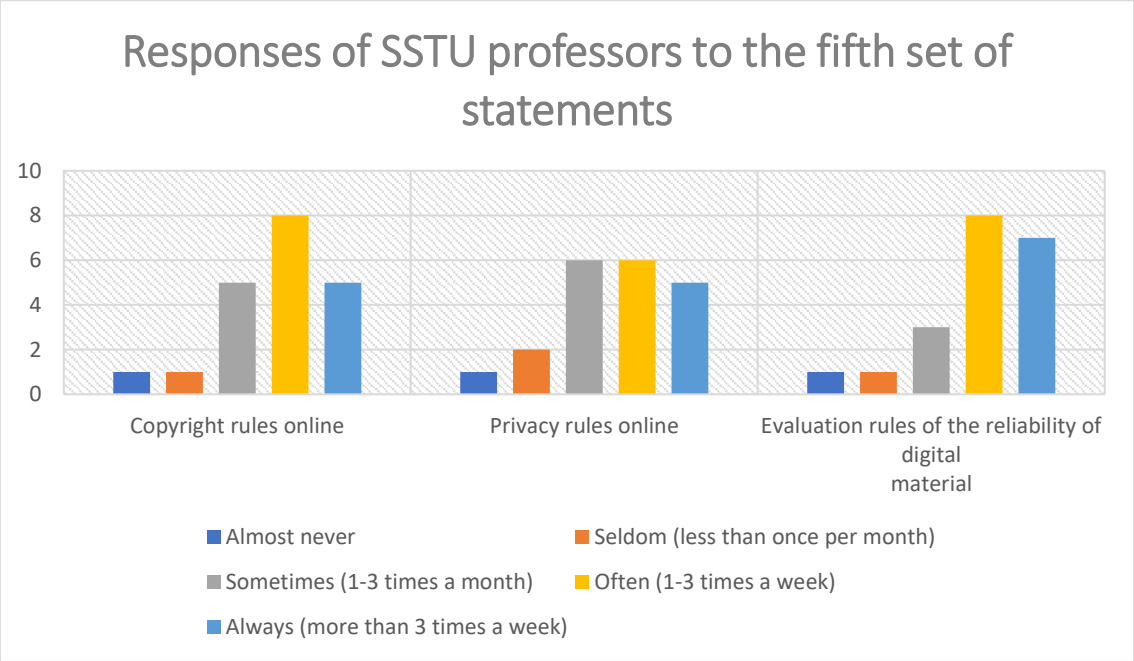

Figure 9*b*. Responses of SSTU professors to the fifth set of statements (xxi-xxiii).

The sixth and last set of statements included the following:

xxiv. A teacher should have a positive attitude towards ICT

xxv. A teacher should use ICTs in teaching practice

xxvi. A teacher must be proficient in ICT in order to diversify teaching methods.

The responses of professors were categorized on a 5-point scale, where: 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree.

In this set, both the majority of Greek professors and the majority of Russian professors agreed or strongly agreed with all three statements (Figures 10*a* and 10*b*).

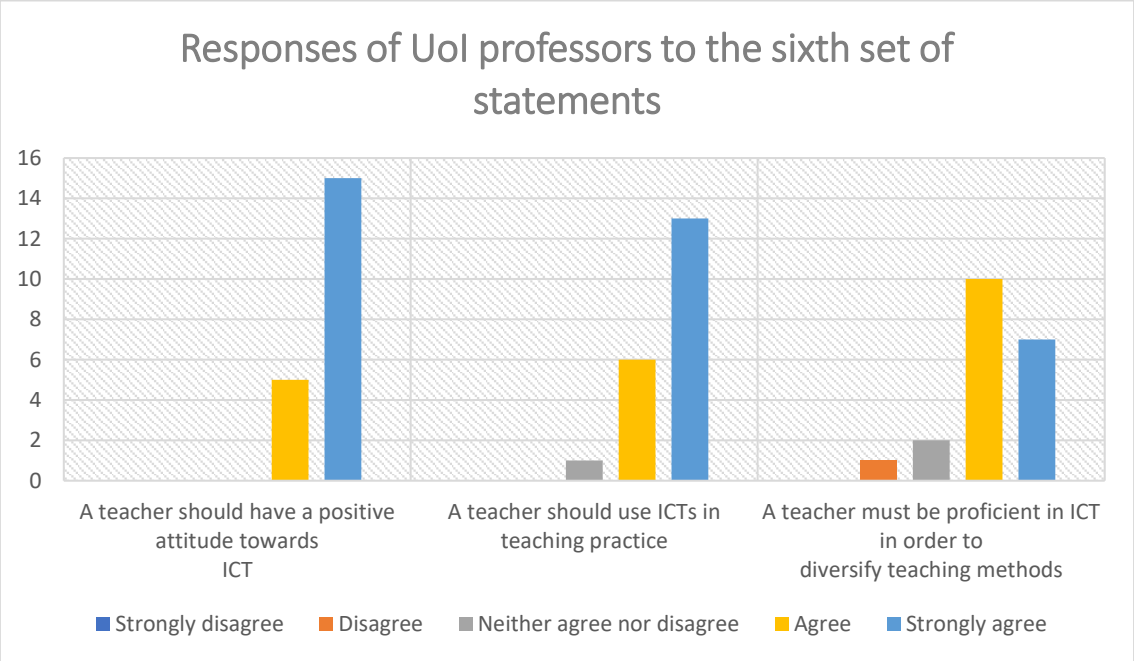

Figure 10*a*. Responses of UoI professors to the sixth set of statements (xxiv-xxvi).

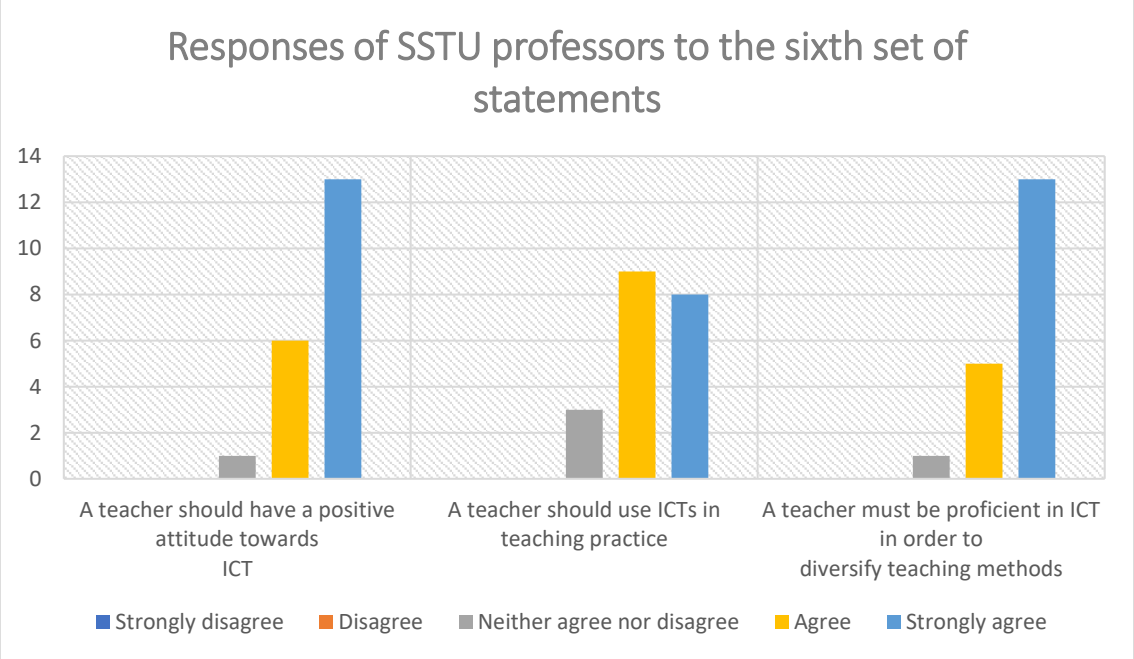

Figure 10*b*. Responses of SSTU professors to the sixth set of statements (xxiv-xxvi).

Finally, we asked the professors an open-ended question to list five favorite ICT tools (either platforms or programs) for a classroom use (both online and on site). Almost all the Greek professors (17 individuals) shared their favorite tools with us and we have listed them below in Table 13.

Table 13. UoI professors' favorite ICT tools to use in the classroom.

ICT tool name	ICT tool type	Number of references by UoI professors
Microsoft software		
MS PowerPoint	Presentation program	14
MS Word	Word processor	11
MS Teams	Collaborative software	10
MS Excel	Spreadsheet	4
MS 365	Collaboration and cloud-based service	1
Google workspace		
Gmail	Webmail	4
Google Scholar	Bibliographic database	1
Google Forms	Collaborative software, web survey	1
Google Meet	Communication software	1
Google Drive	File hosting service	1
Video communication tools		
Zoom	Videoconferencing, VoIP and instant messaging	3
Skype for business / Skype		3
Slido (Cisco Webex)		2
Statistical and numerical analysis		
Stata	Statistical and numerical analysis	1
SPSS		1
Social networks		
YouTube	Video hosting service	2

Facebook (Meta Platforms)	Social networking service	1
LMS		
E-course (https://ecourse.uoi.gr/)	Course management system	6
Moodle		4
SaaS		
LaTeX	Typesetting	4
Mentimeter	Presentation software	3
Padlet	Knowledge management	2
MindMaster	Collaborative and brainstorming tool	1
Database		
Scopus	Abstract and citation database	1
Digital material editors		
Windows Movie Maker	Video editing software	1

Russian professors (n=11) also listed their five favorite ICT tools for use in a classroom. Their selection is also tabulated (Table 14) and presented below:

Table 14. SSTU professors' favorite ICT tools to use in the classroom.

ICT tool name	ICT tool type	Number of references by SSTU professors
Microsoft software		
MS Word	Word processor	9
MS PowerPoint	Presentation program	8
MS Excel	Spreadsheet	2
Google workspace		
Gmail	Webmail	2
Google Drive	File hosting service	1
Video communication tools		

Telegram	Videoconferencing, VoIP, and instant messaging	2
Zoom		1
Skype for business / Skype		1
WhatsApp		1
Social networks		
VK	Social networking service	2
SaaS		
Padlet	Knowledge management	2
Keynote	Presentation software	1
Educational games		
Quizizz	Online game-based learning platform	1
Digital material editors		
InShot	Video editing software	1

Greek professors listed more ICT tools that they use in a classroom, but even with fewer responses from Russian professors, we see overlap in most ICT tools. Tools from such giants as Microsoft and Google are conventionally used in the field of education due to their high availability and reliability. Also, scientists from UoI and SSTU included social networks, communication tools, and editors of digital materials in their work. Overall, we see a wide range of ICT tools in both countries used for a variety of purposes.

Our findings show that professors in both countries had lack of knowledge about one or another ICT tool, but in general, their level of competence can be described as high enough to use ICT tools in teaching. It is important that teachers strive to improve their level of competence and learn new technologies, as well as encourage students who use technology for educational purposes. Moreover, almost all professors in both countries agreed that teachers should have a positive view of ICT and use it in teaching practice to diversify teaching methods.

4.2 Reviewing Digital Competences of Students at the Greek University

As for the third study of this doctoral thesis, 150 undergraduate, graduate and doctoral students from different UoI departments took part in it, and 141 of them agreed to have their responses processed and published.

The purpose of this study was to gain insight into students' mastery of ICT tools, as well as their attitudes towards them and the need for interaction in the course of online and on-site classes. Students were also asked several demographic questions. Since the sample of students at UoI differed much from the sample of professors (presented in the first study), we did not think it was appropriate to compare these results, albeit nearly identical questions were asked in both cases.

Our sample included representatives of all three levels of higher education: undergraduate (bachelor's) students (54%), graduate (master's) students (40%) and doctoral students (6%) (Figure 11).

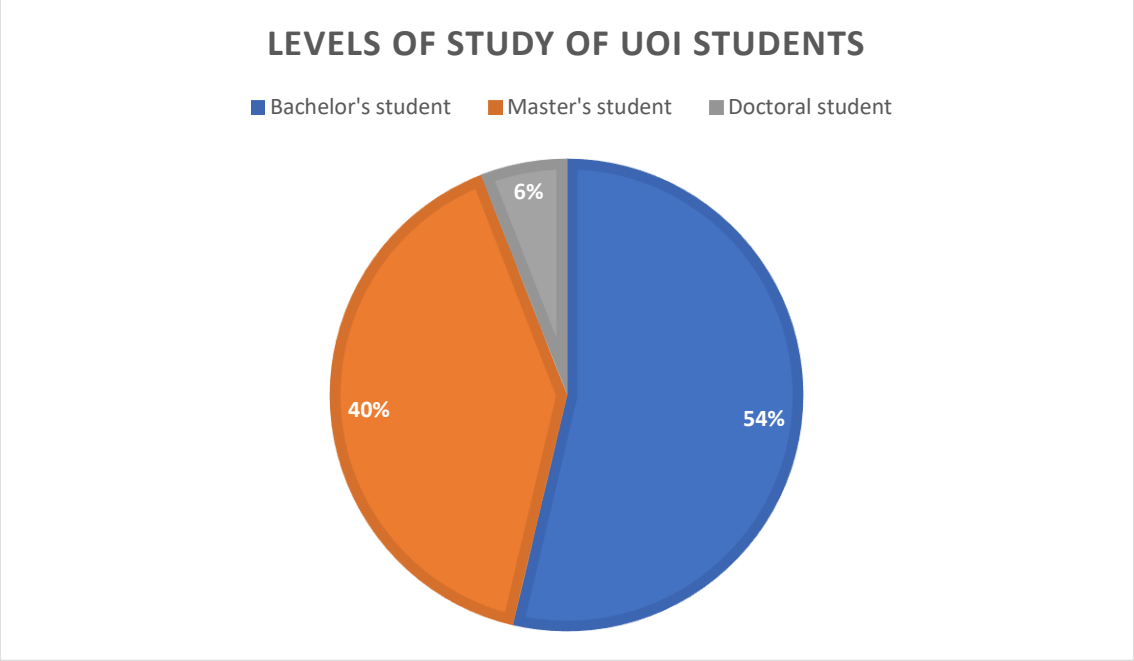

Figure 11. Levels of study of UoI students.

These students specified the following fields of their study: preschool education (30 responses), education (10), medicine (8), fine arts (7), computer science and engineering (7), history and archeology (6), economics (6), physics (5), primary education (5),

mathematics (4), pedagogy (4), philology (4), arts in education science (4), philosophy (3), materials science (3), chemistry (3), biology (2), ICTs use in education (2), anthropological studies (1), social and emotional learning (1), and music (1). Doctoral students indicated more specific fields of expertise, while bachelors and masters reported a general name of their field of study.

The majority of students were female (76%), while 22% of them were male (Figure 12).

The mean age of students was 24.74±8.4 years; mode: 19 with the range of 39 years.

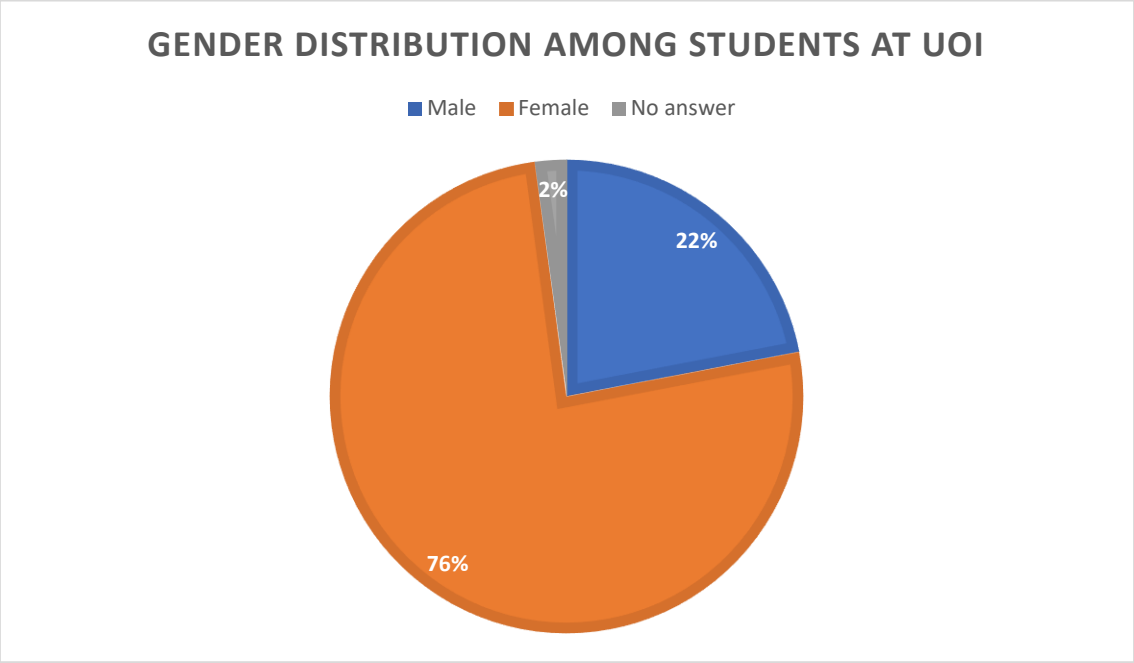

Figure 12. Gender distribution among students at UoI.

We asked students to self-evaluate their level of digital competence on a 6-point scale from Newcomer (A1) to Pioneer (C2), and they considered themselves as explorers (A2) (36%), integrators (B1) (22%), newcomers (A1) (21%), and experts (B2) (14%). Only a few students highly self-evaluated their digital skills: 4% of students considered themselves leaders (C1), and 3% of students considered themselves pioneers (C2) (Figure 13).

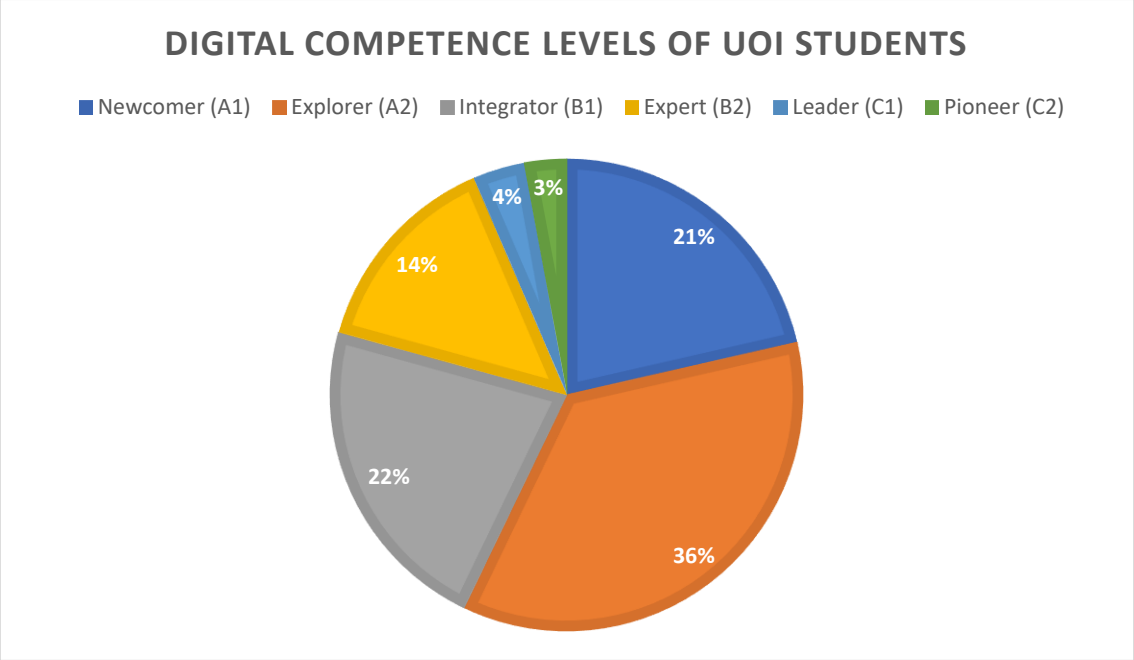

Figure 13. Digital competence levels of UoI students.

The first set of statements for students included the following five:

i. I constantly use technology to communicate with my classmates and university staff (e.g., email, social media, etc.)
ii. I actively develop my digital skills
iii. I regularly participate in distance classes and/or online conferences/webinars
iv. I am constantly looking for new educational ways using ICT
v. I am enthusiastic about classes that encourage the use of ICT by students and/or teachers.

The responses of students were categorized on a Likert scale (1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree).

Most students agreed (45%) and strongly agreed (42%) with the first statement (i). The use of ICT for communication was an integral part of their learning process. The majority (73%) were also committed to developing digital skills (ii). Approximately equal numbers of students regularly participated in online meetings for their studies (38%), or did not participate in them (41%) (iii). Responses to statement (iv) were also divided between the following options: approximately half of students (46%) were looking for new educational ways of using ICT one way or another, while the rest were either unsure (30%) or in doubt (24%). Half of the students (51%) strongly agreed / agreed with the

last statement (v) regarding their enthusiasm for using ICT tools in a classroom (Figure 14).

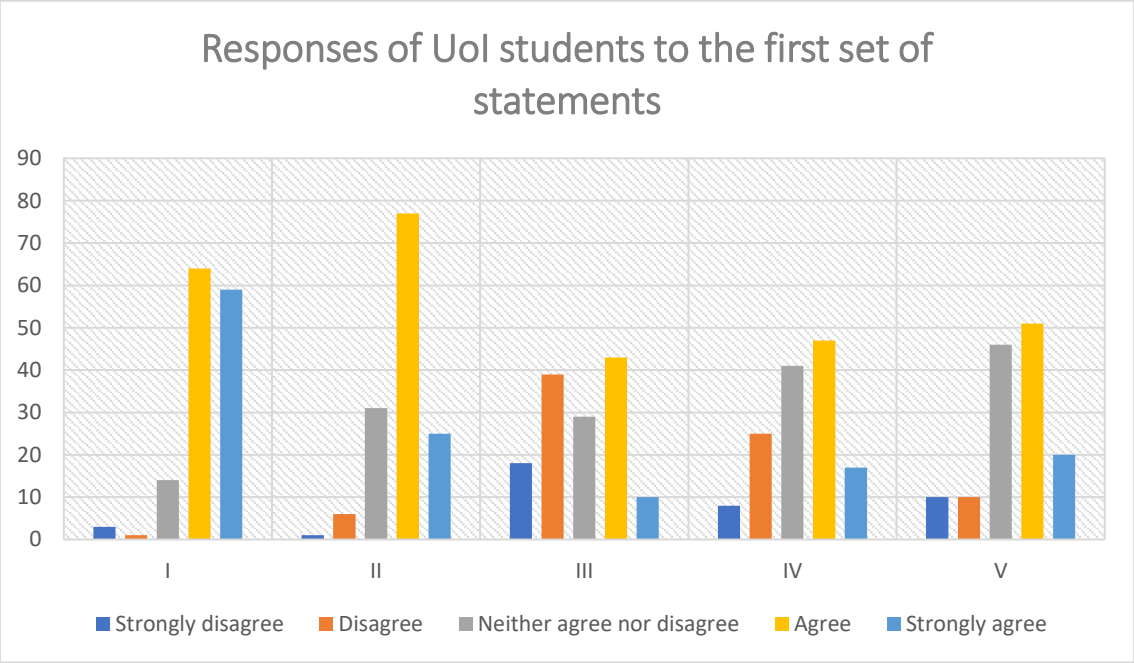

Figure 14. Responses of UoI students to the first set of statements (i-v).

In the second set, students had to rate their competence of using the following tools on a 5-point scale (1-very poor, 2-poor, 3-neither good nor poor, 4-good, 5-very good):

vi. Word processor (e.g., MS Word)
vii. Spreadsheet (e.g., Excel)
viii. Presentation tools (e.g., PowerPoint
ix. Image processing (e.g., Paint)
x. Video editing (e.g., Movie Maker).

The leading tools in which students had no doubts about their competence were word processors (with the mean score of 4.15±0.9) (vi) and presentation tools (4.2±0.8) (viii). Most students were more or less proficient with spreadsheets (3.5±1.1) (vii). For image processing (3.44±1.2) (ix) and video editing (2.9±1.3) (x) tools, students' responses varied the most, and the prevailing response in these cases was neither good nor poor (Table 15).

Table 15. Descriptive statistics: mean, standard deviation, median, and mode for the second set of statements (vi-x).

ICT Tool	Mean	SD	Median	Mode
Word processor	4.15	0.9	4	5
Spreadsheet	3.5	1.1	4	4
Presentation tools	4.2	0.8	4	4
Image processing	3.44	1.2	3	3
Video editing	2.9	1.3	3	3

In the third set, students had to rate their competence of using the following tools:

xi. Digital collaborative tools (e.g., MS Teams)

xii. Cloud systems (e.g., Google Drive)

xiii. Social networks (e.g., Facebook)

xiv. E-mail (e.g., Gmail)

xv. Video communication tools (e.g., Skype).

It is obvious that the use of social networks (4.19±0.9) (xiii) and e-mail (4.58±0.6) (xiv) did not cause difficulties for students: they noted a high level of their competence regarding these communication tools. For the remaining three statements (xi-xii, xv), the numbers of students who rated their competence as poor or very poor were higher, but in any case, the number of experienced students working with these tools prevailed (Table 16).

Table 16. Descriptive statistics: mean, standard deviation, median, and mode for the third set of statements (xi-xv).

ICT Tool	Mean	SD	Median	Mode
Digital collaborative tools	3.66	1.0	4	4
Cloud systems	3.73	1.1	4	4
Social networks	4.19	0.9	4	5
E-mail	4.58	0.6	5	5
Video communication tools	3.86	1.1	4	4

In the fourth set, students had to rate their competence of using the following tools:

xvi. Learning management systems (e.g., Moodle)
xvii. Tools for creating content (video, audio)
xviii. Tools for interactive whiteboards (e.g., SmartBoard)
xix. Educational games (e.g., Classcraft)
xx. Quizzes platforms (e.g., Kahoot!).

We received a wide variety of responses to this set. It is obvious that for the above-listed tools, just as many students were competent. The mean score for this set ranged from 2.64 to 3.14 points. Learning management systems (xvi), tools for interactive whiteboards (xviii) and educational games (xix) caused the greatest problems to students, as can be seen in Table 17.

Table 17. Descriptive statistics: mean, standard deviation, median, and mode for the fourth set of statements (xvi-xx).

ICT Tool	Mean	SD	Median	Mode
LMS	2.8	1.2	3	4
Tools for creating content	3.14	1.1	3	3
Tools for interactive whiteboards	2.69	1.2	3	3
Educational games	2.64	1.1	2.5	2
Quizzes platforms	3.09	1.2	3	4

Greek students openly acknowledged a significant gap in their understanding of educational games. This particular tool secured the lowest mean score (2.64 ± 1.1) vs. all other tools.

Among other things, we were interested in how frequently students applied the following issues:

xxi. Copyright rules online
xxii. Privacy rules online
xxiii. Evaluation rules of the reliability of digital material.

The responses of students were categorized on a 5-point scale where: 1-almost never, 2-seldom (less than once per month), 3-sometimes (1-3 times a month), 4-often (1-3 times a week), 5-always (more than 3 times a week).

The prevailing response for all three statements among students was sometimes (29%, 27%, and 37%, correspondingly), which we feel is a good result (Figure 15).

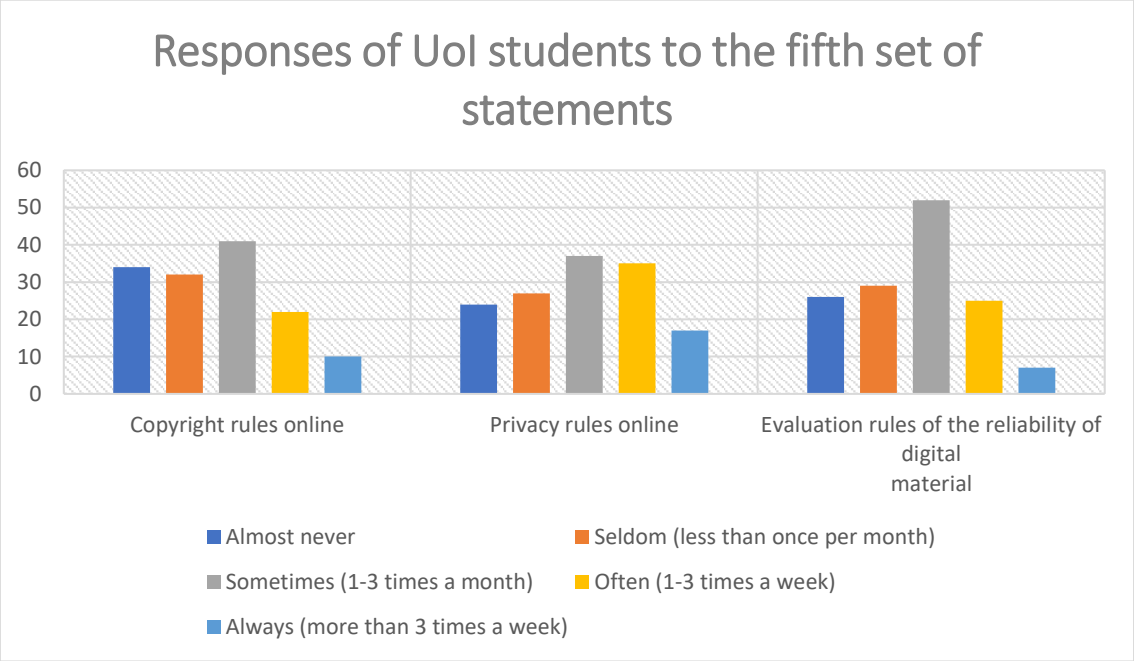

Figure 15. Responses of UoI students to the fifth set of statements (xxi-xxiii).

The last set (6th) included the following statements:

xxiv. A teacher should have a positive attitude towards ICT

xxv. A teacher should use ICTs in teaching practice

xxvi. A teacher must be proficient in ICT in order to diversify teaching methods.

We were interested to find out how students feel about the role of a teacher in the inclusion of ICT in the educational process. In this set, most students agreed or strongly agreed with all three statements (Figure 16).

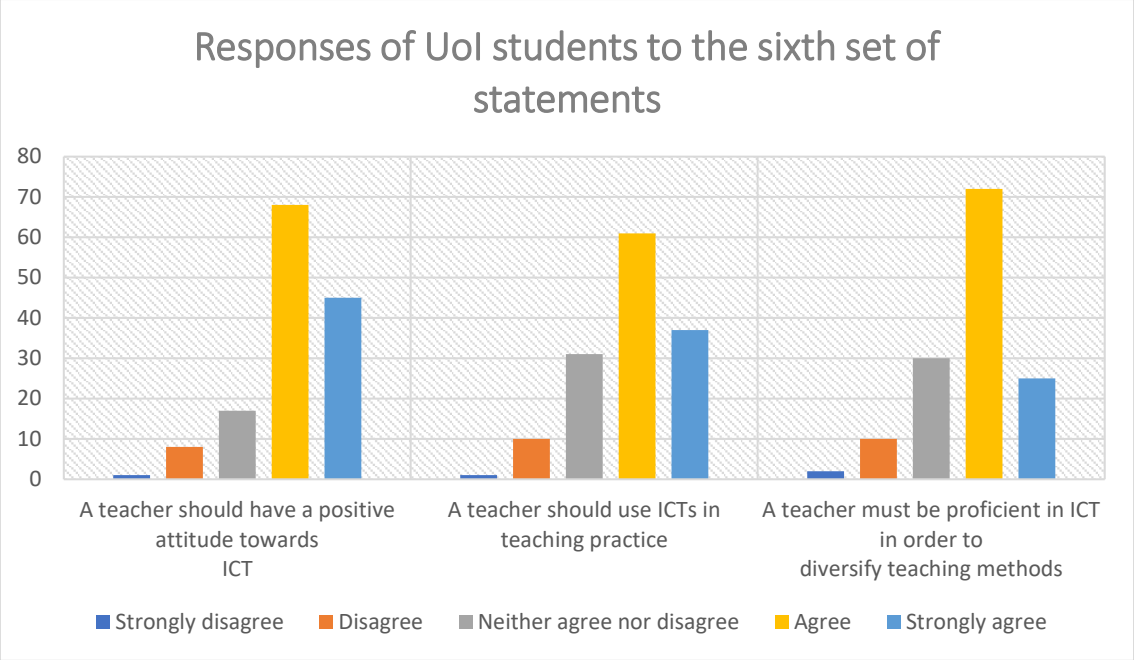

Figure 16. Responses of UoI students to the sixth set of statements (xxiv-xxvi).

Finally, we asked students an open-ended question asking them to list their five favorite ICT tools (either platforms or programs) for use during their studies. Many students (106 individuals) shared their favorite tools with us and we have listed them below in Table 18.

Table 18. UoI students' favorite ICT tools used for studying.

ICT tool name	ICT tool type	Number of references by UoI students
Microsoft software		
MS PowerPoint	Presentation program	83
MS Word	Word processor	78
MS Teams	Collaborative software	38
MS Excel	Spreadsheet	34
MS Access	Relational database management system	2
Google workspace		
Gmail	Webmail	30
Google Drive	File hosting service	14

Google Search	Web search engine	5
Google Chrome	Web browser, mobile browser	4
Google Docs	Collaborative software, word processor	2
Google Classroom	Educational software	1
Video communication tools		
Skype	Videoconferencing, VoIP and instant messaging	15
Zoom		8
Viber (Rakuten)		3
Cisco Webex		2
Discord		2
Social networks		
Instagram (Meta Platforms)	Photo and video sharing social networking service	15
Facebook (Meta Platforms)	Social networking service	9
TikTok	Video sharing	3
Pinterest	Social media service	1
Educational games		
Kahoot!	Online game-based learning platforms	7
Classcraft		2
Quizizz		1
Digital material editors		
Paint / 3D Paint	Raster graphics editors	6
Adobe Photoshop		3
PhotoScape		1
Windows Movie Maker	Video editing software	5
Adobe Premiere Pro		2
Vegas Pro		1
Wondershare Filmora		1
LMS		

Moodle	Course management system	4
E-course (https://ecourse.uoi.gr/)		4
Search engine		
PubMed	Search engine	3
Statistical and numerical analysis		
Wolfram Mathematica	Statistical and numerical analysis	3
OriginLab		2
SPSS		2
PSPP		1
Digital material creators		
Book Creator	Visual content creating	2
Canva	Graphic design software	2
Procreate	Digital illustration app	2
Storyboard That	Comic creator	1
Wix	Website builder	1
Discovery Studio	Software for modeling	1
Nomad Sculpt	Sculpting and painting mobile application	1
PyMOL	Molecular modelling	1
IDE		
Code::Blocks	Integrated development environment (IDE)	1
Visual Studio		1
SaaS		
Padlet	Knowledge management	3
Miro	Collaborative software	1
LaTeX	Typesetting	1
AI systems		
ChatGPT	Chatbot, large language model, generative pre-trained transformer	2

As can be seen from Table 23, students listed applications with broad functionality as well as highly specialized ones. We think it is important that some students indicated professional programs, which implied their high interest in a chosen discipline and their search for opportunities to improve academic success. In this regard, none of the students had any difficulties finding suitable tools for our research, because the names of applications and programs were familiar to them. We therefore can conclude that university students in our study were active users of ICT tools and the Internet.

Since the Google Form provided the opportunity to leave comments and feedback for the researchers, some students did not miss the opportunity to express their opinions on the topic of the questionnaire. For instance, one of them was pleasantly surprised to discover how many tools students use every day for educational purposes. This student liked the idea of the educational process including modern approaches to studying. On the contrary, another student was strongly against the introduction of ICT tools into the educational process and did not share the opinion about the efficacy of e-learning.

We feel that students' satisfaction in participating in a particular teaching approach depends on their evaluation of the set of ICT tools chosen by a teacher. Another issue arises with the evaluation of ICT tools, especially in dynamics. We devoted the following study to this topic, focusing on educational games that Greek students did not pay enough attention to.

4.3 Cross-Country Comparison of Distance Learning and ICT Tool Utilization by Students in Greek and Russian Universities

One hundred and forty-six (146) undergraduate, graduate and doctoral students studying at Greek universities who gave us consent for the analysis and publication of the results participated in this study during the fall semester of 2021-2022 academic year (November-December). During the same period of time, similar number of students from Russian universities (149) responded to the questionnaire and gave their consent for the analysis and publication of their responses.

Most Greek students were female (84%), and their minority were male (15%), while half of Russian students were female (50%) and another half were male (48%) (Figures 17*a* and 17*b*).

The mean age of Greek students was 20.97 ± 5.5 y.o.; mode: 20. The age of the majority of Greek students ranged from 19 to 21 years (69%); 28% of students were 22-24 years old; and 3% of participants were over 25 y.o. at the time of the study. The mean age of Russian students was 20.24 ± 8.7 y.o.; mode: 20; 27% of participants were between 16 and 18 y.o. at the time of the study, while 44% of students were between 19 and 21; another 21% were between 22 and 24, and 8% were over 25 years old.

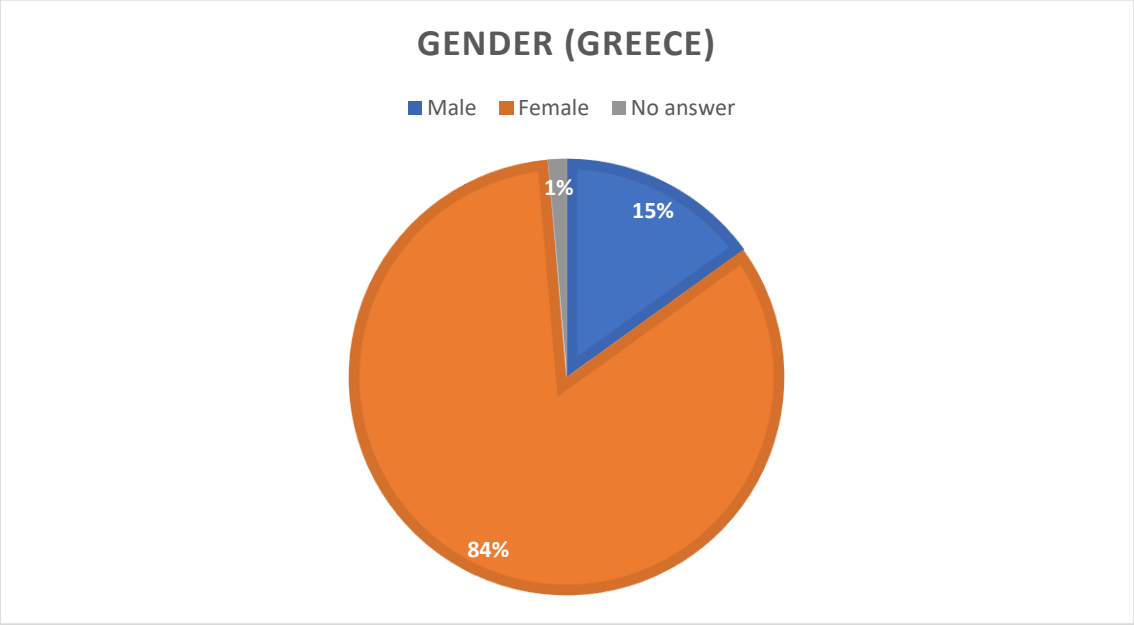

Figure 17*a*. Gender distribution among Greek students.

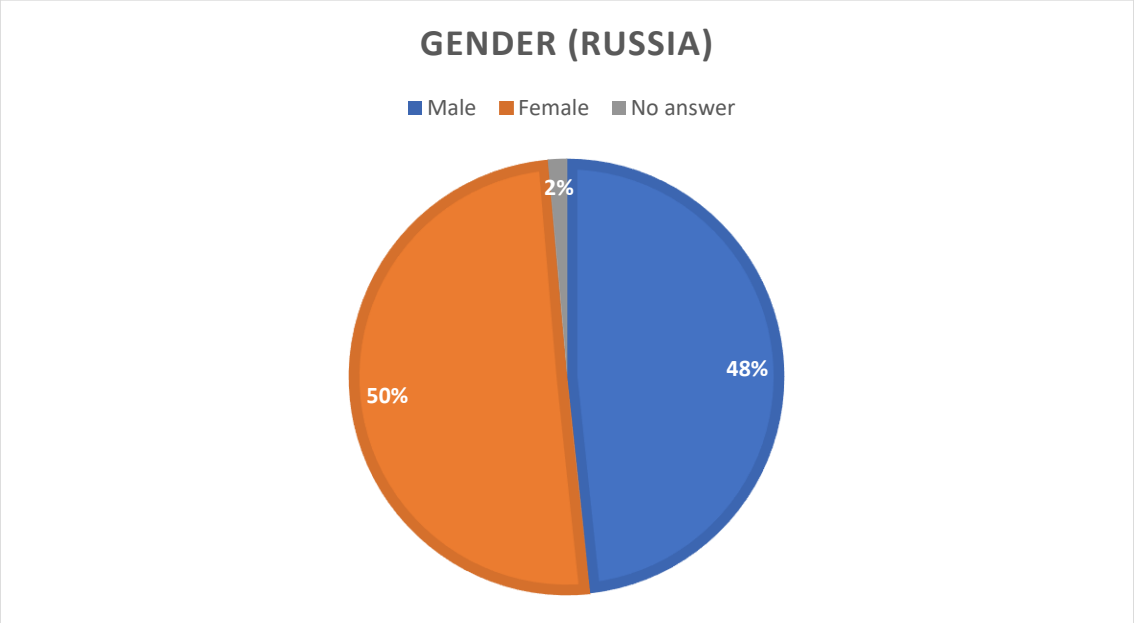

Figure 17*b*. Gender distribution among Russian students.

Greek students named three cities in Greece where they studied (Table 19).

Table 19. Study locations of Greek students.

City	Frequency	%
Ioannina	103	70.5
Athens	11	7.5
Thessaloniki	8	5.5
Total	122	83.5

Also, some of the Greek students named their universities in Greece (Table 20).

Table 20. Universities represented by Greek students.

University	Frequency	%
University of Ioannina	102	69.8
University of West Attica	11	7.5
International Hellenic University	5	3.4
Aristotle University of Thessaloniki	3	2.05
Total	121	82.8

Russian students named six cities in Russia where they studied, among which there were both large cities, including the administrative region capital, and smaller towns (Table 21).

Table 21. Study locations of Russian students.

City	Frequency	%
Saratov	125	83.9
Chelyabinsk	14	9.4
Moscow	5	3.4
Saint-Petersburg	3	2.1
Volgograd	1	0.6
Balakovo	1	0.6
Total	149	100

Russian students named 10 universities and a college where they studied (Table 22).

Table 22. Educational institutions represented by Russian students.

Educational institute	Frequency	%
Yuri Gagarin State Technical University of Saratov	56	37.5
Saratov State University	30	20
South Ural State University	12	8
Professional Training College of Yuri Gagarin State Technical University of Saratov	10	6.7
Russian State Agrarian University – Moscow Timiryazev Agricultural Academy	2	1.3
Russian Presidential Academy of National Economy and Public Administration	2	1.3
Lomonosov Moscow State University	1	0.6
Moscow State Pedagogical University	1	0.6
Plekhanov Russian University of Economics	1	0.6
Saint-Petersburg State Institute of Technology	1	0.6
ITMO University	1	0.6
Total	117	77.8

The majority of Greek students who took part in our research were studying social sciences (90%); however, formal (4%), natural (3%), and applied (3%) sciences were also present in our sample (Figure 18*a*). Among Russian students, 47% studied formal

sciences, while 30% studied social sciences, and another 12% and 11% studied natural and applied sciences, respectively (Figure 18*b*).

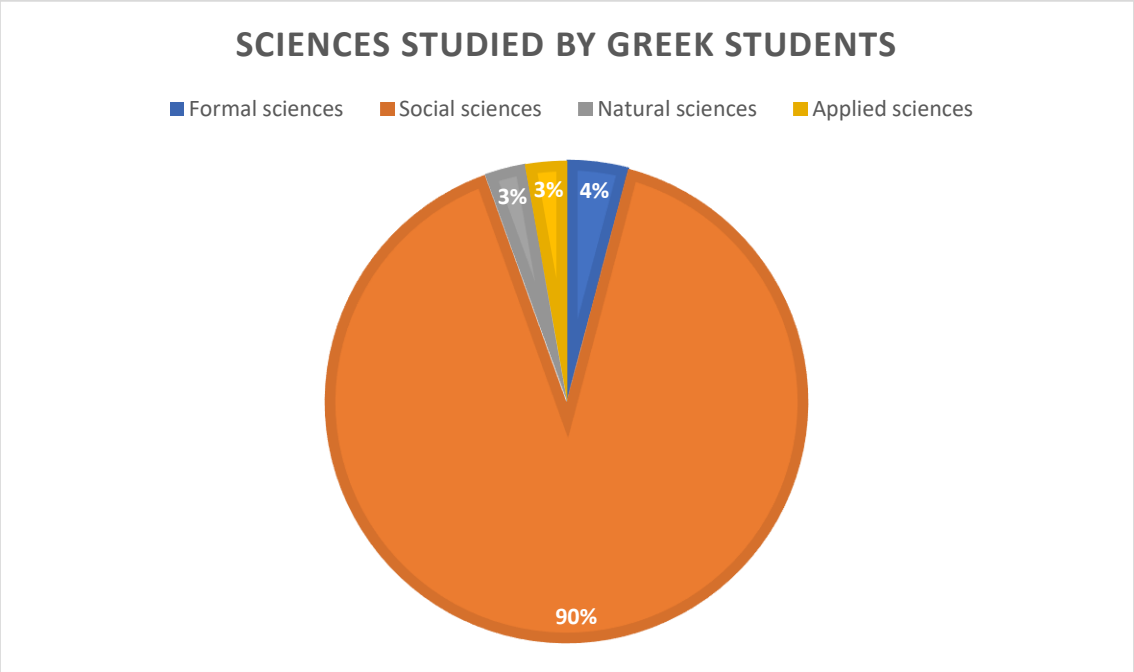

Figure 18*a*. Sciences studied by Greek students.

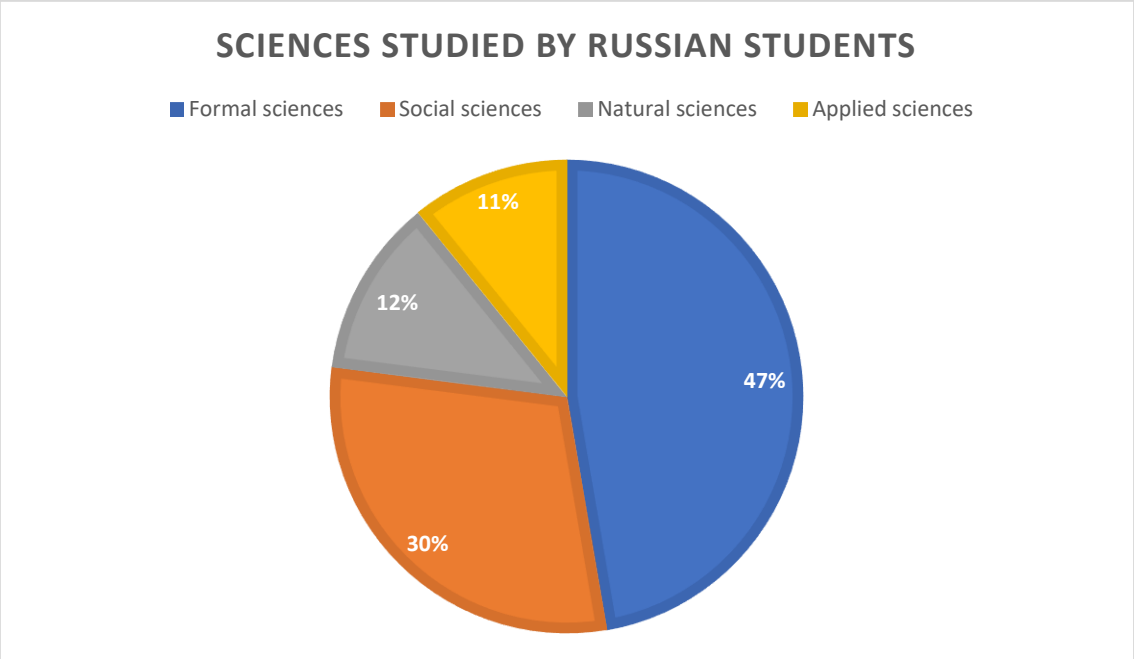

Figure 18*b*. Sciences studied by Russian students.

The majority of Greek students responded the question about the availability of DL at their universities. At the same time, students were asked to clarify how long the DL format

has been offered at their universities. Most students (71%) familiarized themselves with DL since 2020 due to the COVID-19 pandemic (Figure 19*a*).

A similar pattern was observed for students from Russia, 67% of whom also confirmed the onset of DL from 2020 (Figure 19*b*).

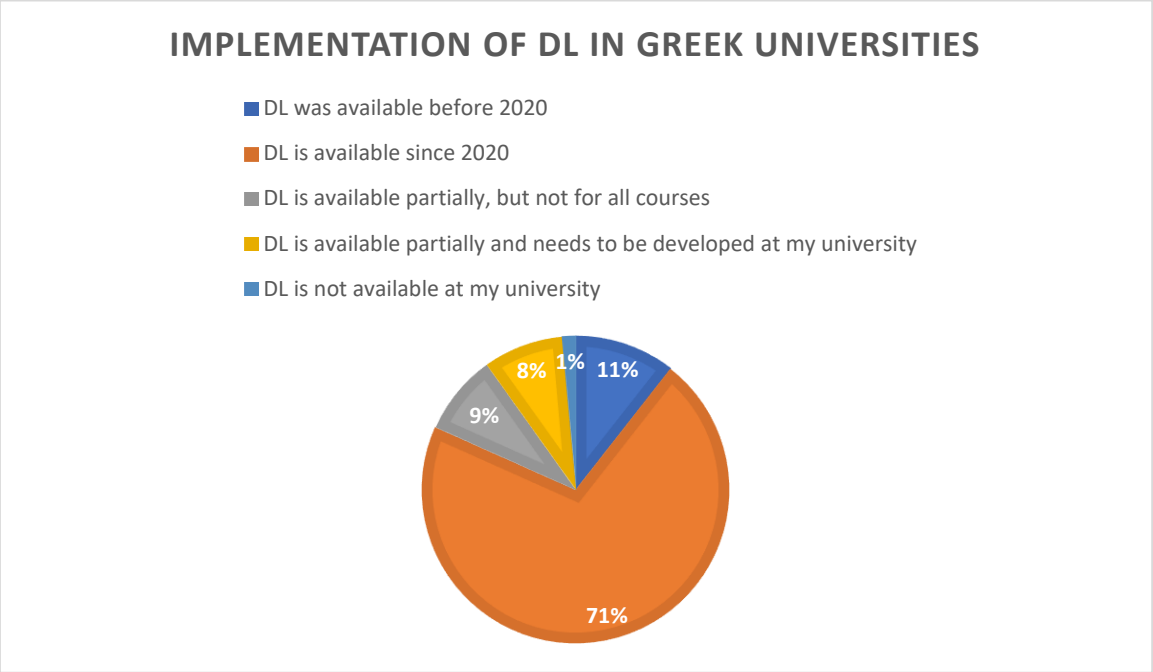

Figure 19*a*. Implementation of distance learning in Greek universities.

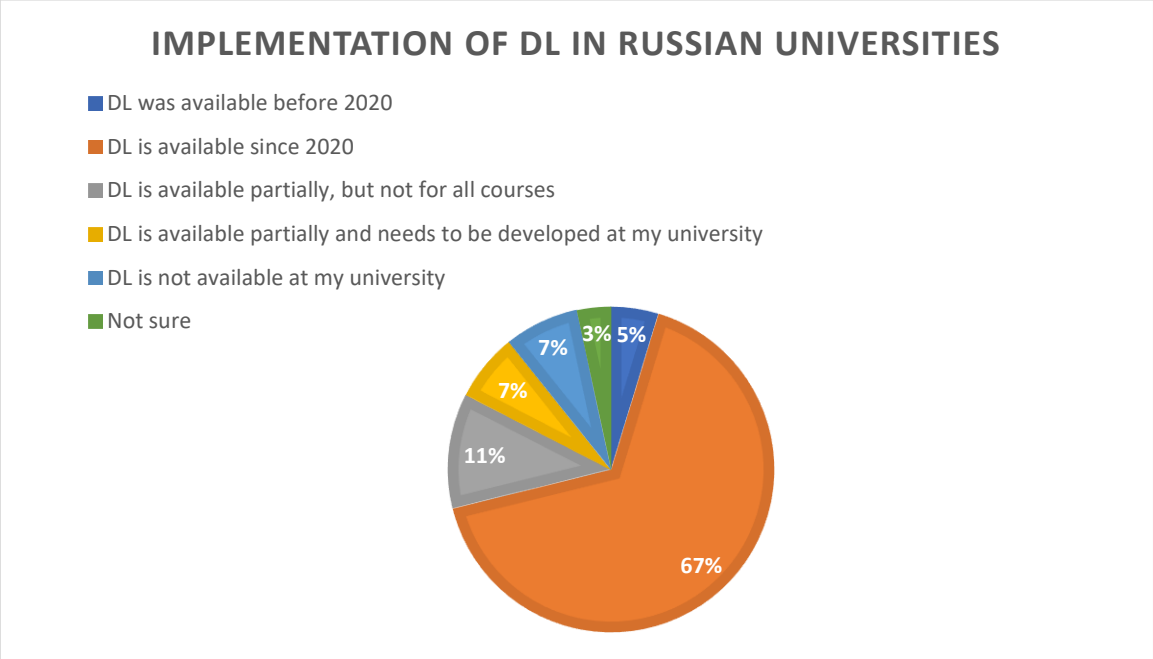

Figure 19*b*. Implementation of distance learning in Russian universities.

DL and Internet use are closely related. In this regard, it was of interest to find out how much time per day students from Greece and Russia browsed the Internet. The mean time spent on the Internet by Greek students per day was 5.2 ± 2 hours; median: 5; mode: 5. They spent this time on the Internet for the following reasons: education (including education as a part of the university's curriculum and extracurricular educational courses and lessons), entertainment (watching movies / videos, surfing the Internet, and games); communication with peers, teachers and family members; self-development and self-education; as well as work (including online part-time jobs) (Figure 20*a*).

The mean time spent on the Internet by Russian students per day was 6.6 ± 1.5 hours; median: 6; mode: 5. Russian students spent this time for the following purposes: education, entertainment, games, communication, self-development and self-education, work, or all of the above at once (Figure 20*b*). In the case of Russian students, games were placed in a separate category, since a large number of students (25%) considered them outside the entertainment category.

The t-test results are as follows: t-statistic: -3.07, p-value: 0.0033. Since the p-value is less than 0.05, we can conclude that there is a statistically significant difference in the mean time spent on the internet per day between Greek and Russian students.

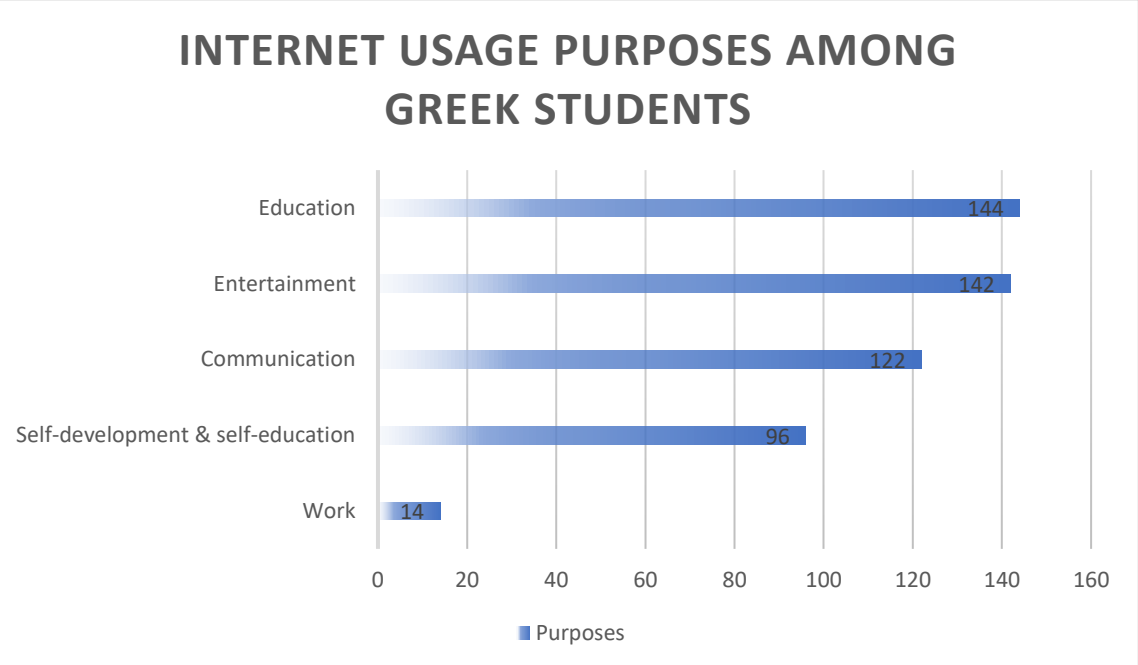

Figure 20*a*. Internet usage purposes among Greek students.

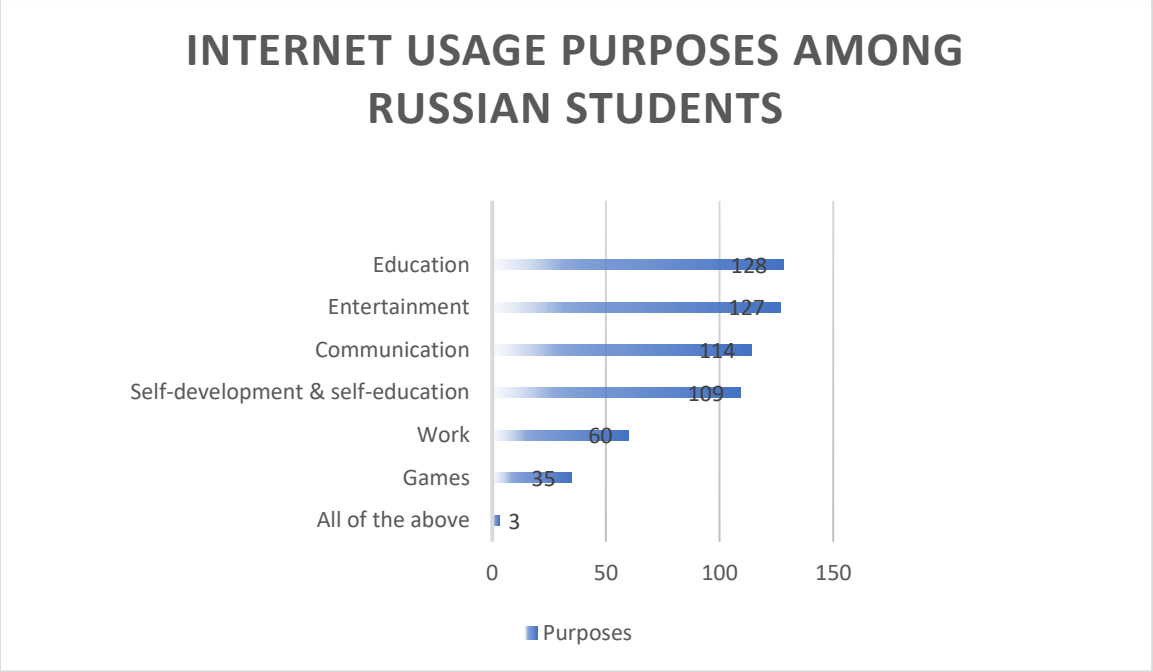

Figure 20*b*. Internet usage purposes among Russian students.

Since the basis of DL is Internet communication, students were asked about the ICT tools used by teachers to communicate with them. The most popular responses from Greek and Russian students were: online video conferencing tools, official websites of universities and their blogs, e-mail, and social networks (Figures 21*a* and 21*b*).

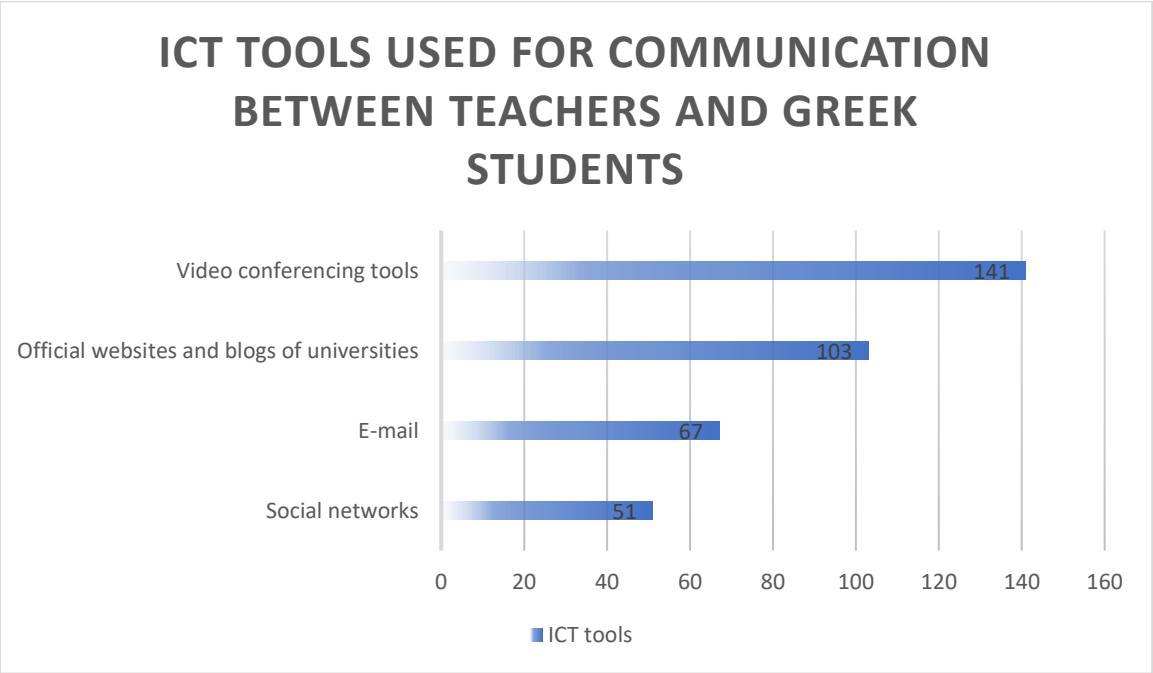

Figure 21*a*. ICT tools used for communication between teachers and Greek students.

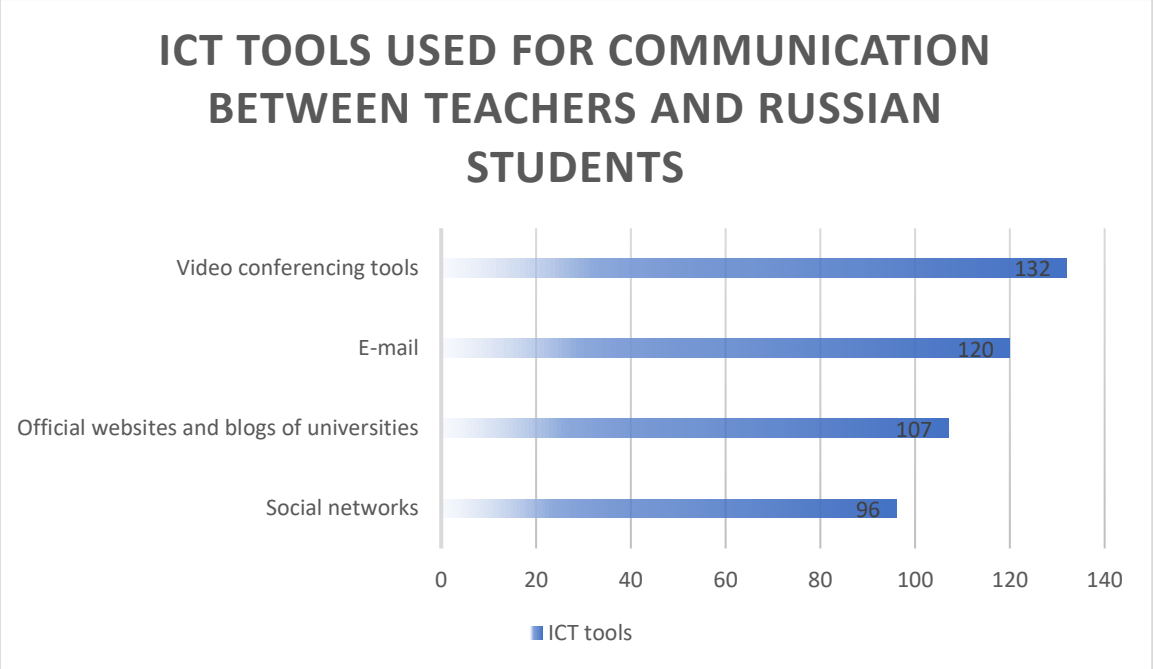

Figure 21*b*. ICT tools used for communication between teachers and Russian students.

Some students, both Greek and Russian, mentioned the names of the ICT tools (either applications or platforms) that they used to communicate in the course of DL. The most popular responses among Greek students included such ICT tools as MS Teams, Google Meet, Facebook & Messenger, Gmail, Yahoo mail, Skype, Zoom, and WhatsApp (Table 19).

The most popular responses among Russian students included Zoom, Big Blue Button, Gmail, Yandex mail, Discord, VK, Telegram, Skype, Viber, and WhatsApp (Table 23).

Table 23. Preferred ICT tools for communication among Greek and Russian students.

ICT tool name	Number of references by Greek students	Number of references by Russian students
Big Blue Button	–	39
Discord	–	15
Facebook & Messenger	11	–
Gmail	11	29
Google Meet	13	–
MS Teams	121	–
Skype	8	3

Telegram	–	6
Viber (Rakuten)	–	2
VK	–	10
WhatsApp	2	2
Yahoo Mail	9	–
Yandex Mail	–	16
Zoom	4	90

Also, the majority of Greek students (65%) and half of Russian students (50%) mentioned that the time they spent on the Internet increased significantly in the course of DL (Figures 22*a* and 22*b*).

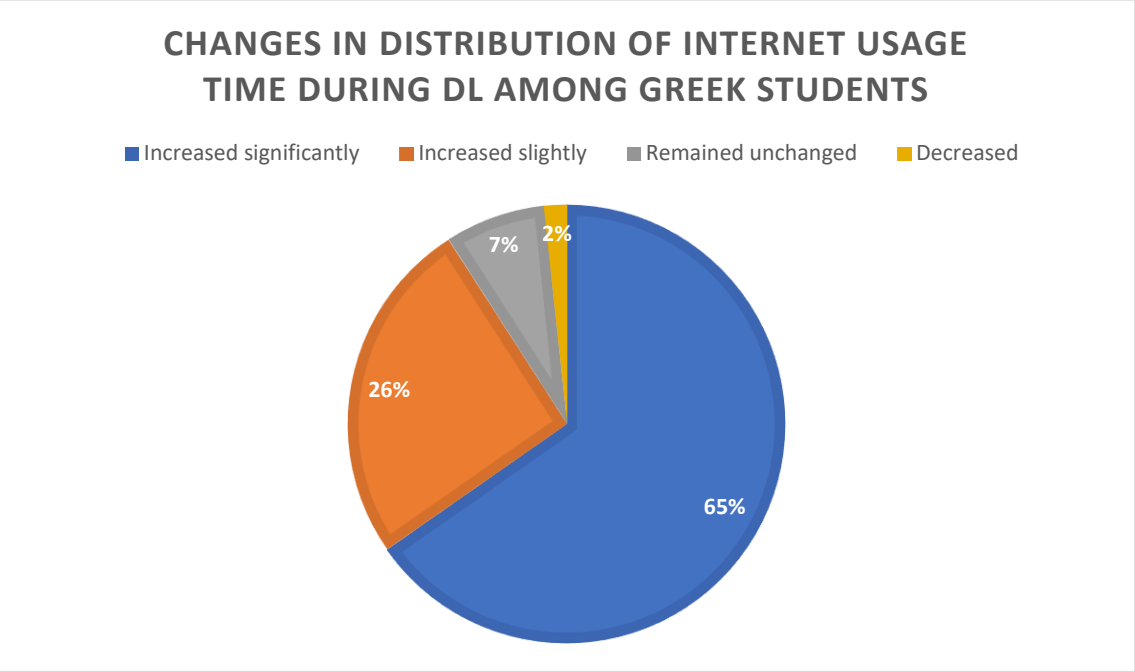

Figure 22*a*. Changes in distribution of Internet usage time during distance learning among Greek students.

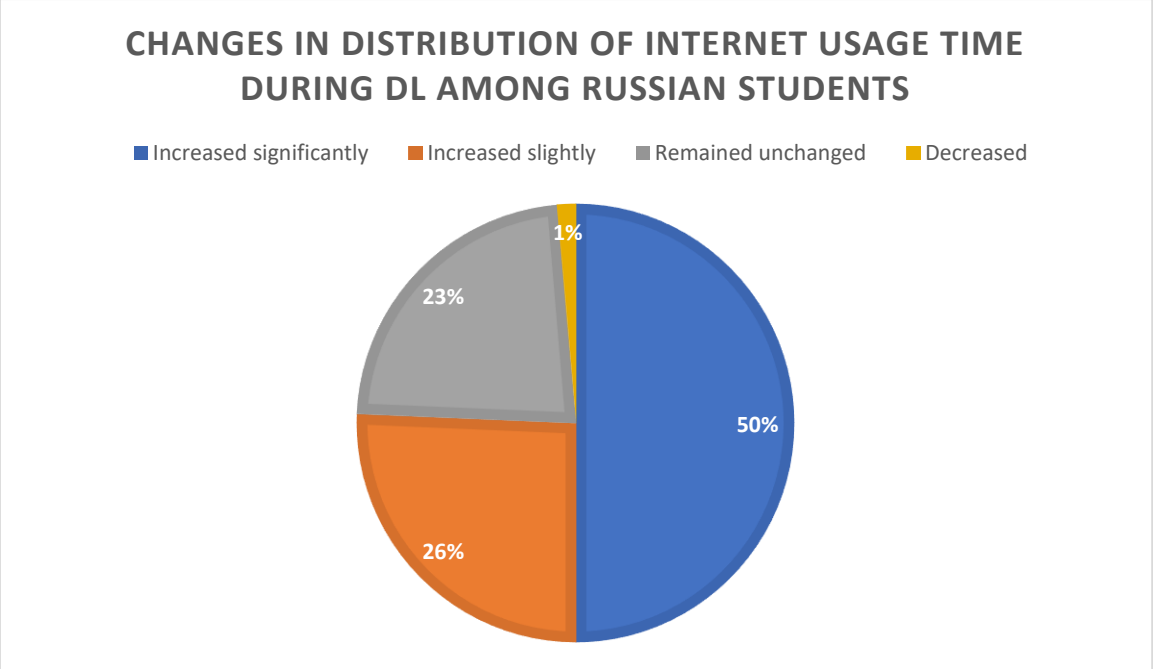

Figure 22*b*. Changes in distribution of Internet usage time during distance learning among Russian students.

Finally, Greek and Russian students were asked whether they consider DL the relevant format for contemporary Greek and Russian educational systems, respectively. Half of Greek students (49%) considered DL partially or completely relevant for Greek universities, as well as more than half of Russian students (53%) perceived DL partially or completely relevant for Russian educational institutions (Figures 23*a* and 23*b*).

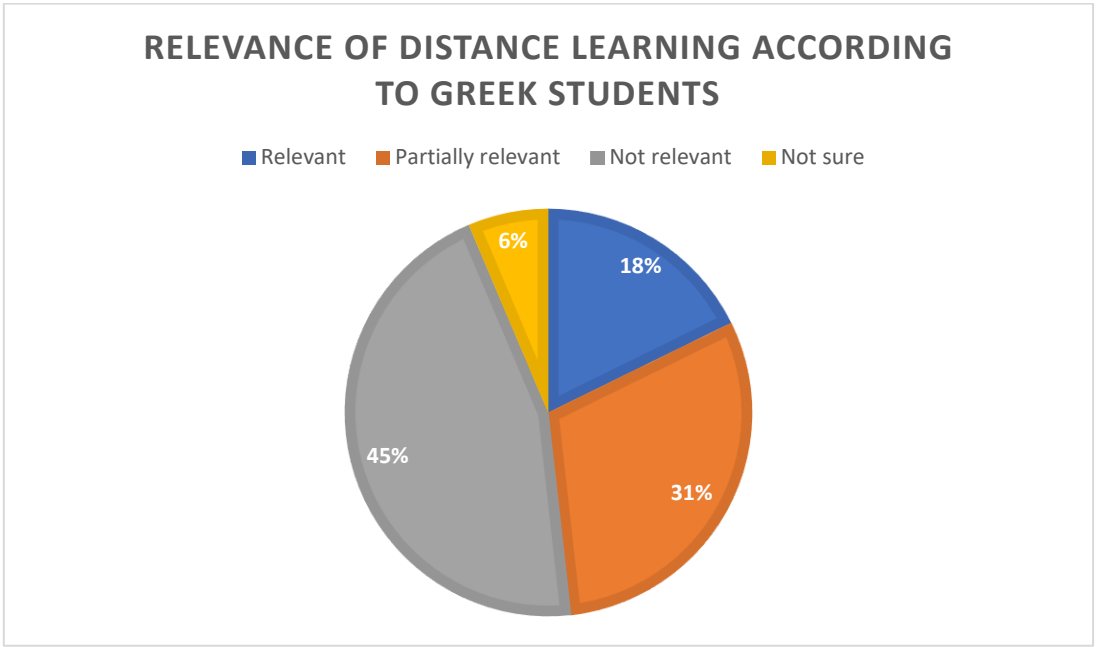

Figure 23*a*. Relevance of distance learning according to Greek students.

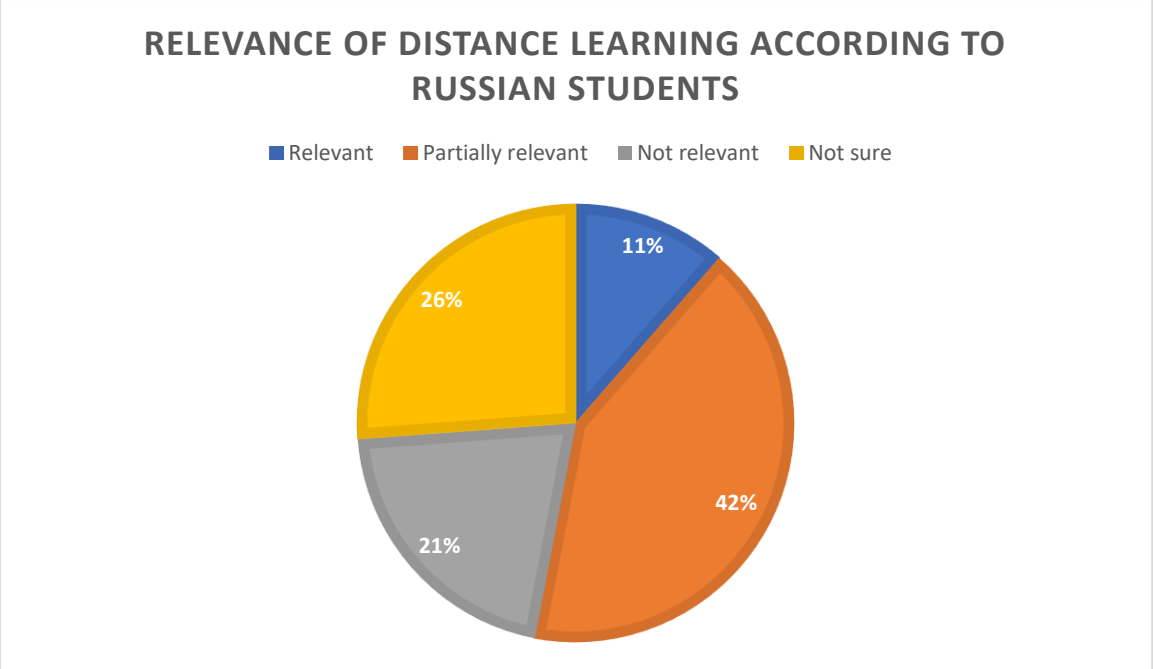

Figure 23*b*. Relevance of distance learning according to Russian students.

In addition, we asked Greek and Russian students whether they faced any challenges during the DL. For students from both countries, the biggest challenge was the large amount of information. Students also noted a lack of technical equipment and digital skills, as well as a lack of communication, concerns about the future and other issues (Figures 24*a* and 24*b*).

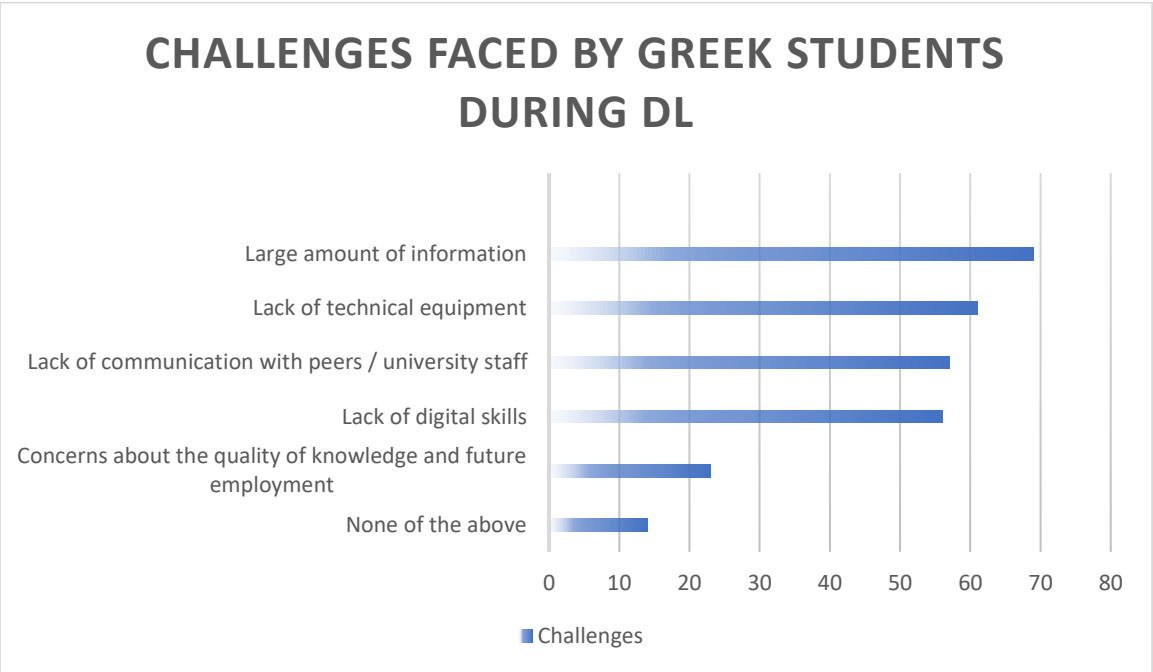

Figure 24*a*. Challenges faced by Greek students during distance learning.

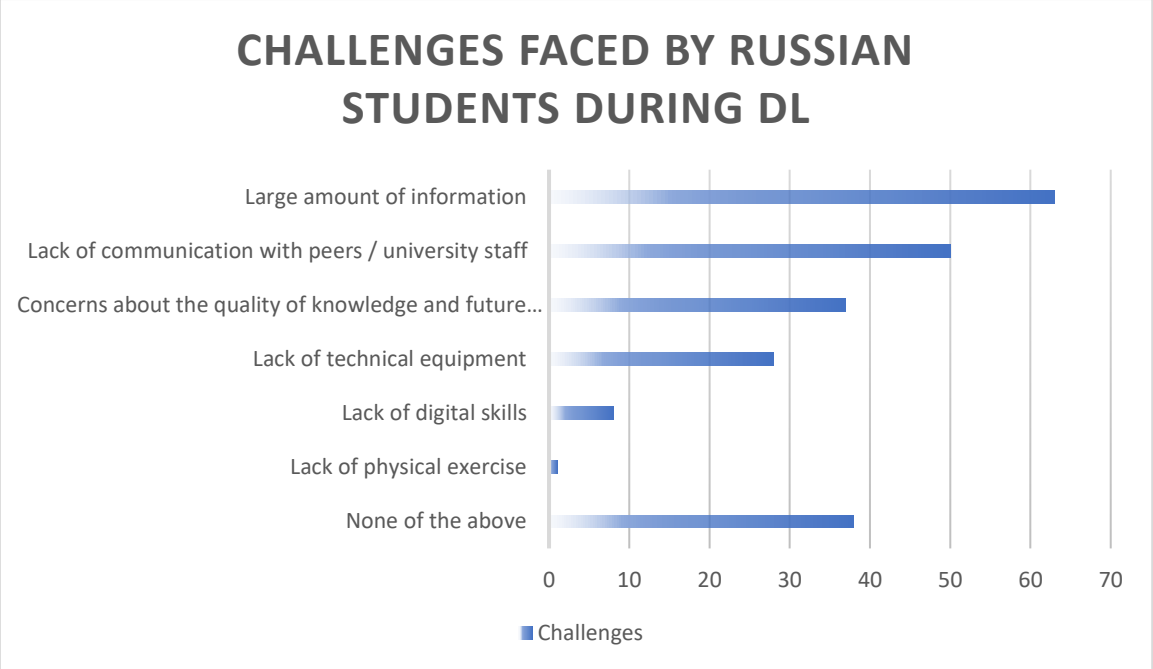

Figure 24*b*. Challenges faced by Russian students during distance learning.

Some of the Greek students gave their feedback in anonymous online comments. Hence, some comments were positive about DL, while some other students were not happy with DL. One of the Greek students reported that, *"Thanks to DL, we can study from anywhere. This is convenient in emergency situations and allows us not to be interrupted from the educational process."* The opposite opinion was expressed by another student stating that, *"DL takes more energy from me than the traditional way of learning and requires constant focus throughout the day, and not just during class hours. Moreover, I need more time every day to prepare for classes, because all results of my studies within DL must be shown online."*

Russian students also provided their feedback. One of the students spoke about the lack of digital competences among teachers rather than students. That student made the following comment, *"It was difficult for the teachers to master DL and ICT tools. As a class monitor, I had to help and advice. Often teachers simply did not know how to work with the online learning platforms, because they simply were not explained clearly enough. There were instructions, but still, there were challenges. Although for me the instructions were very detailed. But it was worth showing the process at work once, the next time the teachers had no difficulties."* Another student expressed the opinion that the traditional learning format is preferable, stating that, *"It takes a long time to get used to*

the DL. There are pros and cons, but the traditional way of learning is time-tested and preferable!". There were also statements in support of DL: *"DL is the future."*

According to this study, some of the students were faced with the fact that during DL they began to spend significantly more time on the Internet. The main purposes for them to use the Internet were education, entertainment, and communication. Most of the surveyed students believed that DL would be partially or entirely preserved in the future. In the course of DL, educational institutions frequently offered students to communicate via video conferencing tools, e-mail, and social networks. Also, according to our data, during DL, students faced challenges associated with large amounts of incoming information, anxiety about the future, as well as with a lack of communication. Some surveyed students reported a lack of technical support and / or digital skills.

Our findings revealed that Russian students tended to spend their time engaged in online entertainment, particularly games. They underscored an importance of integrating gaming elements into the educational experience, be it in remote or on-site settings. On the contrary, Greek students did not express comparable preferences or desires in this regard.

In the 21st century, the Internet has become an essential and indispensable tool for studying during emergencies such as a pandemic, as well as for personal needs, including entertainment, communication, and search for information. Since emergencies are usually unpredictable, it is prudent to prioritize distance learning at universities to ensure the quality of education. Accordingly, it is very important that universities would plan for their students more online courses, educational webinars, online conferences, as well as develop innovative approaches to the procedure of testing the acquired knowledge.

4.4 Exploring the Impact of Digital Game Integration on Student Engagement and Learning Outcomes: An Experimental Study with Prospective Teachers

This study investigated the effects of integrating the digital game (Classcraft) into the Educational Programs Using ICT course of the Department of Early Childhood Education at the University of Ioannina during the spring semester of the 2022-2023 academic year. Volunteering undergraduate students were randomly assigned to either the experimental group (n=30) that utilized Classcraft, or the control group (n=30) that followed the

standard course curriculum without the gamified platform. The mean age of the students was 24.31 ± 6.3 years.

The experimental group underwent a comprehensive introduction to Classcraft during the first week, which included guidance on its seamless integration into the course. For this study, the instructor created various quests to demonstrate to students how the game works and to explore how integrating digital games impacts student engagement and learning outcomes. The quests were developed under the supervision of the professor, who oversees the course. Figures 25*a* and 25*b* displayed here are examples of these quests, showing a visually rich and interactive environment where students can navigate through different challenges and learning activities. Each quest is designed to motivate students, promote collaboration, and enhance their problem-solving skills.

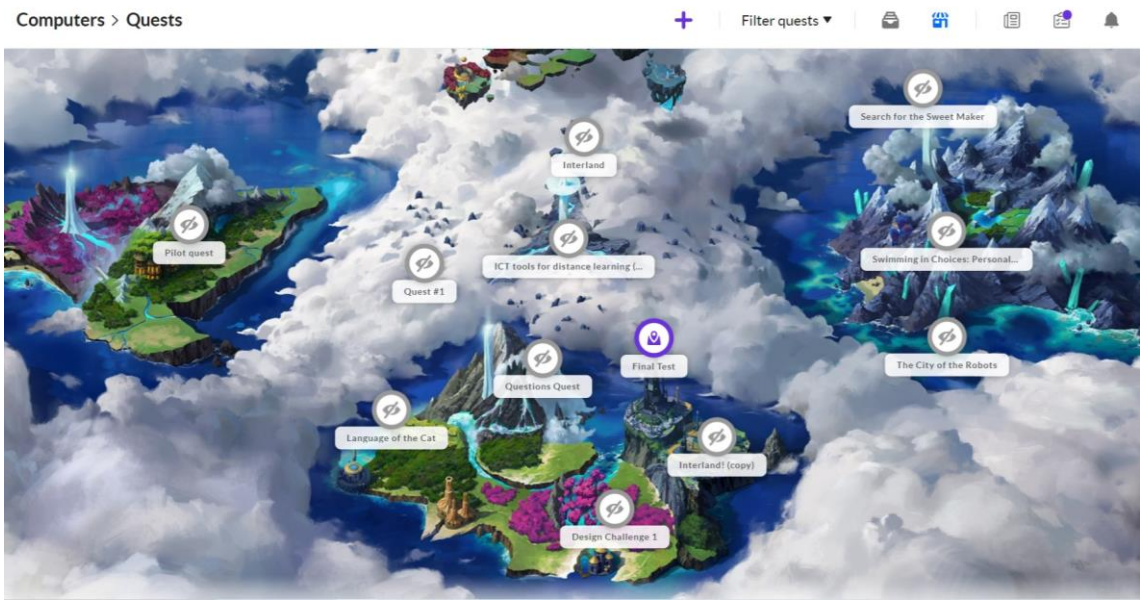

Figure 25*a*. Quests created in the Classcraft game by the instructor.

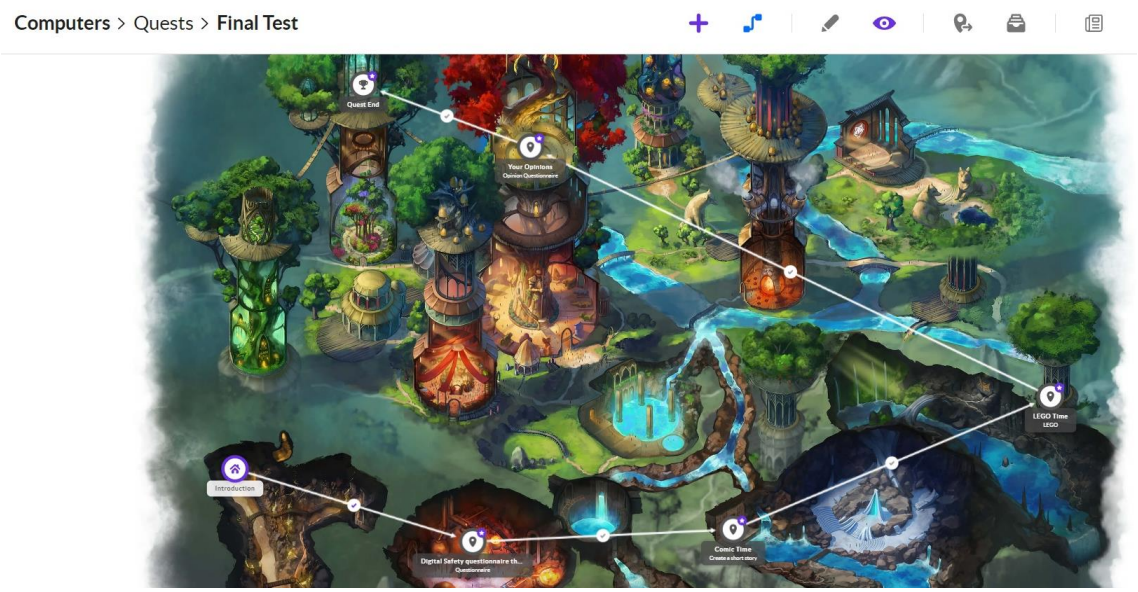

Figure 25*b*. Quest created in the Classcraft game by the instructor (1).

Throughout the semester, both groups were monitored for engagement metrics, such as participation in discussions, completion of assignments, and attendance. Classcraft-specific metrics, including in-game participation, achievements, and collaboration, were observed in the experimental group. For both groups, learning outcomes were assessed through regular quizzes, exams, and a final project.

Pre- and post-course interviews were administered to both groups to elucidate expectations and perceptions. Additionally, qualitative feedback regarding the impact of Classcraft on engagement and learning was collected.

Descriptive statistics was employed to compare academic performance and engagement metrics between the experimental and control groups. The group that utilized Classcraft demonstrated greater academic performance, achieving higher grades both at the conclusion of the course and in their final projects compared to the group that did not use the game.

This study contributed to the ongoing dialogue on the efficacy of gamification in educational settings. The outcomes of this study could elucidate potential benefits or limitations of integrating Classcraft via providing valuable insights for educators and researchers in the field. We conducted more in-depth outreach to the students who used Classcraft to gain a deeper understanding of the impact of this game.

4.4.1 Four-level Evaluation of the Classcraft Game

Throughout the semester, undergraduate students in the experimental group were engaged in the preparation of quests utilizing Classcraft. Students were actively involved in the game, where they collaboratively constructed virtual worlds for their peers to explore. Through this process, students developed quests encompassing diverse topics. As they progressed, the students demonstrated elevated proficiency in comprehending the intricacies and significance of the game.

Our substudy aimed at evaluating the perceived impact of Classcraft implementation in university courses based on Kirkpatrick's four-level model. Thirty students responding to a questionnaire with 12 questions on a 10-point scale at three different time points: the beginning (I), middle (II), and end of the course (III). We present all means and standard deviations in Table 24.

The fact that the scores are approximately equally distributed between the four dimensions (reaction, learning, behavior, and results) is noteworthy. This finding suggested that students' positive perceptions were not confined to a single aspect but encompassed a holistic view of the Classcraft experience.

From an educational standpoint, the improvement in scores over time could indicate a growing familiarity with (and appreciation for) the Classcraft approach. The direct effect may be associated with increased engagement, enhanced learning experiences, and a direct influence on students' behavior and academic outcomes.

Considering the positive dynamics, educators may find these results encouraging. The findings suggest that integrating gamified elements, such as Classcraft, can lead to positive shifts in students' responses, learning experiences, behavior, and academic results. Educators might consider leveraging these insights to refine instructional strategies, tailor interventions, or further enhance the implementation of similar gamification approaches in their teaching.

While these practical results are promising, further research could explore deeper into understanding the specific elements of Classcraft that contributed to the observed improvements. We believe that conducting qualitative research would help better understanding of the observed patterns.

Table 24. Calculation of the sample mean and standard deviation for UoI students' responses to a series of questions based on Kirkpatrick's 4-level model: experimental group analysis.

	Reaction			**Learning**			**Behavior**			**Results**		
questions / **time points**	1. Satisfaction with Classcraft experience	2. User interface and features	3. Ease of use and comprehensibility	4. Classcraft's contribution to knowledge and skills	5. Enhancement of problem-solving skills and out-of-the-box thinking	6. Enhancement of digital skills	7. Direct effect on Classroom behavior	8. Enhancement of collaboration and teamwork skills	9. Remote and disciplined use of Classcraft	10. Direct impact on academic performance	11. Contribution to the overall learning environment	12. Willingness to use Classcraft in future teaching practice
I	6.5 ± 1.2	5.8 ± 1.5	6.2 ± 1.3	5.9 ± 1.4	5.6 ± 1.3	5.7 ± 1.2	6.1 ± 1.4	5.8 ± 1.3	5.9 ± 1.2	5.7 ± 1.3	5.8 ± 1.2	6.0 ± 1.2
II	7.8 ± 1.0	7.2 ± 1.2	7.5 ± 1.1	7.3 ± 1.1	7.0 ± 1.0	7.1 ± 1.0	7.4 ± 1.1	7.2 ± 1.0	7.3 ± 1.0	7.1 ± 1.0	7.2 ± 1.0	7.3 ± 1.0
III	8.9 ± 0.8	8.4 ± 0.9	8.7 ± 0.7	8.5 ± 0.9	8.2 ± 0.8	8.3 ± 0.8	8.6 ± 0.9	8.4 ± 0.8	8.5 ± 0.8	8.3 ± 0.8	8.4 ± 0.8	8.5 ± 0.8

4.4.2 Thematic Analysis: Exploring Prospective Teachers' Perspectives on Classcraft

This substudy aimed to explore the experiences and perceptions of prospective teachers from the experimental group regarding the use of the Classcraft game in their Educational Programs Using ICT course. Thematic analysis of in-depth interviews with the undergraduate students revealed several key themes that elucidated the multifaceted impact of Classcraft on their future teaching practices.

The first identified theme was gamification as engaging pedagogy. Undergraduate students regularly expressed how Classcraft's gamified elements engaged them in the learning process during the course.

One of the prospective teachers told us that, *"Quests created in Classcraft are very attractive. Presented in a modern design, they make learning more enjoyable and less like traditional classes."* Another student added that, *"It felt like we were on a learning adventure, and it motivated me to participate more actively in class."*

We see that the engaging nature of Classcraft emerged as a significant factor that influenced participants' perceptions of the learning environment, suggesting its potential as a pedagogical tool to enhance students' engagement.

The second theme that we revealed in students' responses was social dynamics and collaboration. The social features of Classcraft, such as team collaboration and rewards, were highlighted by participants as contributing to a positive and supportive classroom environment.

One of the students preparing to become a teacher stated that, *"Working with my classmates as a team in Classcraft taught me the value of collaboration. It's something I'd like to incorporate in my own teaching."* Another student noted that, *"The rewards and team achievements created a sense of camaraderie, making learning more enjoyable."*

The emphasis on collaborative learning and the positive impact on social dynamics underscored the potential for Classcraft to foster a sense of community within classrooms.

The third theme that was identified among students' responses was the theme regarding the strategies of behavior management. Our students noted the effect of Classcraft on

behavior management strategies, providing insights into how gamification could be employed to address the classroom discipline.

One of the students preparing to become a teacher told us that, *"The behavior point system in Classcraft made me reflect on how positive reinforcement can shape behavior. It's a strategy I'd like to explore as a future teacher."* Another student mentioned that, *"Seeing how the game positively influenced behavior made me rethink traditional disciplinary approaches."*

The application of behavior management strategies from Classcraft suggested that gamification may serve as an effective tool for promoting positive behaviors in a classroom setting.

Finally, the fourth and final theme was related to reflection on assessments and results. Undergraduate students reflected on how Classcraft influenced their perception of assessments and outcomes, highlighting the potential for gamification to impact student achievement.

The following was said by one of the students: *"Classcraft made me think about assessments differently. It's not just about grades; it's about the journey and the learning process."* Another student emphasized that, *"Seeing the results in the game made me realize the importance of continuous assessment and feedback."*

Thus, the shift in participants' perspectives regarding assessments and results highlighted the potential for gamification to promote a more holistic view of student achievement.

There was also one critical comment, *"While Classcraft is engaging, some students found the point system a bit arbitrary. Providing clearer explanations on how points are earned and emphasizing the educational value behind each quest could enhance the game's transparency and align it more closely with learning objectives."* We regard the appearance of a critical comment as a good sign, showing that the students were not mindlessly completing the assigned task, but were also striving to contribute to improving the gameplay.

This thematic analysis of prospective teachers' experiences with Classcraft revealed multifaceted insights into the potential of gamified learning environments. The themes identified encompassed engaging pedagogy, social dynamics, behavior management, and reflections on assessments and results. These findings contributed to the ongoing

discourse on the integration of gamification in teacher training programs via offering valuable implications for future educational practices.

4.4.3 Quality Assessment for Digital Quests

For this substudy we asked a group of 8 students who were previously interviewed and participated in our experiment during the semester to create quests within the Classcraft game. While we provided a broad topic (Statistics) the students were granted the autonomy to select the target age group for their lessons, decide on the ICT tools to employ, and determine the aspects of the topic to cover. Subsequently, our research team comprising 5 individuals conducted an assessment of these quests. The latter was conducted using criteria outlined in Tse et al. (2021) and tailored to align with specific requirements of our research. Each of the seven criteria was evaluated on a 10-point scale. The assessment results are presented in Table 25.

All quests exhibited a high level of creativity with mean scores ranging from 7.1 to 8.8. This suggested that the students put effort into developing imaginative and original content.

Quests generally scored well in user-friendliness with mean scores ranging from 7.2 to 8.5. The 8 quests were designed with the end-user in mind making them accessible and easy to navigate.

The educational content exhibited variability with mean scores ranging from 7.0 to 8.5. While some quests excelled in educational value, others had room for improvement.

The use of multimedia received positive evaluations with mean scores ranging from 7.2 to 8.2. This implied a good incorporation of multimedia elements contributing to a richer learning experience. It is important to point out that students voluntarily incorporated puzzles, quizzes, comics, and online mini-games into their quests. This deliberate inclusion aimed to enhance students' engagement with the subject matter and bring diversity to their learning experience.

The story structure of the quests was generally well-received with mean scores ranging from 7.2 to 8.4. This implied that quests demonstrated a coherent and engaging narrative. In some instances, we requested the creators of certain quests to incorporate additional structural elements such as introductions, goals, conclusions, etc.

Table 25. Means and standard deviations across eight quests: scores determined by the research group.

Quest	Creativity	User-friendly	Educational content	Multimedia used	Story structure	Presentation	Quality of the story
1	8.2 ± 0.9	7.8 ± 1.1	8.5 ± 0.7	7.2 ± 1.3	8.0 ± 1.0	8.1 ± 0.8	8.4 ± 0.6
2	7.5 ± 1.2	8.0 ± 0.9	7.8 ± 1.0	7.5 ± 1.2	7.9 ± 0.8	7.6 ± 1.1	7.7 ± 1.0
3	8.8 ± 0.6	7.6 ± 1.0	8.2 ± 0.9	8.0 ± 0.8	8.4 ± 0.7	8.6 ± 0.5	8.3 ± 0.6
4	7.1 ± 1.3	7.2 ± 1.4	7.0 ± 1.1	7.8 ± 0.9	7.2 ± 1.2	7.4 ± 1.0	7.1 ± 1.1
5	7.9 ± 0.8	8.5 ± 0.6	8.1 ± 0.7	8.2 ± 0.6	7.8 ± 0.9	8.0 ± 0.8	8.2 ± 0.7
6	8.3 ± 0.7	7.7 ± 1.2	8.4 ± 0.6	7.9 ± 0.8	8.1 ± 0.9	8.2 ± 0.6	8.5 ± 0.5
7	7.6 ± 1.1	7.9 ± 0.8	7.5 ± 1.2	7.6 ± 1.1	7.7 ± 1.0	7.8 ± 0.9	7.6 ± 1.0
8	8.0 ± 0.9	8.3 ± 0.7	8.3 ± 0.8	8.1 ± 0.7	8.2 ± 0.6	8.4 ± 0.5	8.1 ± 0.8

The presentation of the quests received high scores: mean scores ranged from 7.4 to 8.6, which suggested that the students effectively communicated their ideas and concepts.

Finally, the quality of the story in the quests was consistently high (mean scores ranged from 7.1 to 8.5). This indicated that students were successful in creating compelling and impactful narratives.

The ANOVA test indicates no statistically significant difference in the mean ratings across the different quests, as $p > 0.05$ (F-Statistic: 1.23; P-Value: 0.29).

Students demonstrated strong creative abilities in crafting their quests, showcasing a variety of skills in user interface design, educational content development, and storytelling. While educational content scores showed some variability, this provided an opportunity for targeted improvement in certain areas. The positive evaluations across multiple criteria suggested that incorporating student-created quests in Classcraft could be a valuable and engaging educational strategy.

Below are the most captivating quests for your consideration (Figures 26*a*-26*d*).

Figure. 26*a*. Quest created in the Classcraft game by a prospective teacher (1).

Figure 26*b*. Quest created in the Classcraft game by a prospective teacher (2).

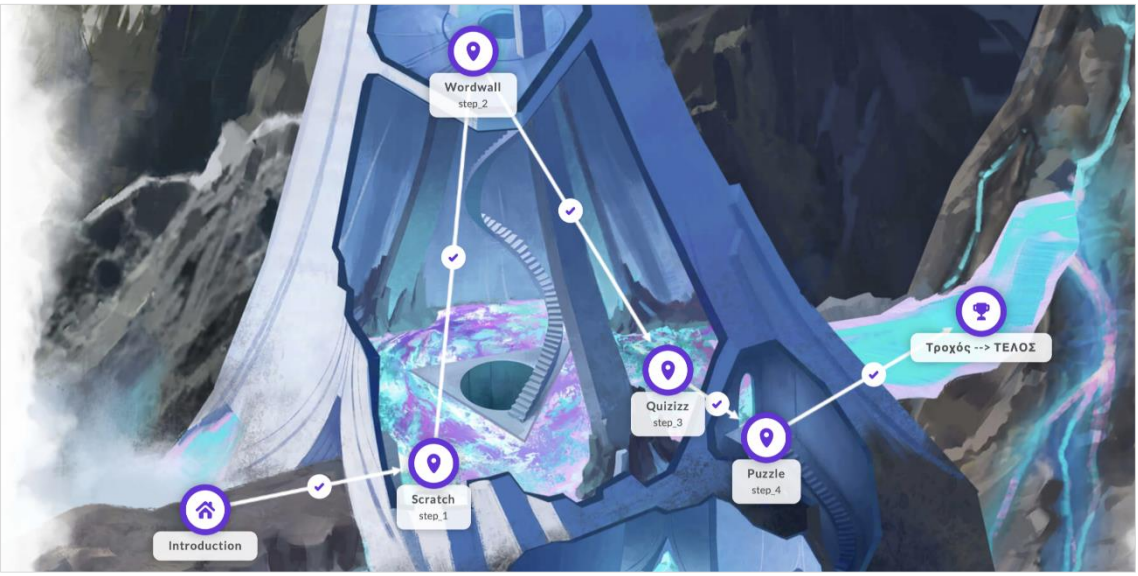

Figure 26*c*. Quest created in the Classcraft game by a prospective teacher (3).

Figure 26*d*. Quest created in the Classcraft game by a prospective teacher (4).

4.5 Enhancing Educational Experience through the Integration of Educational Games in Greek Universities (A proposal)

In previous studies, we compared the competences of professors and students in ICT tools and, among other things, reported the adoption and enjoyment of educational games (including Classcraft) among teachers and students of the two countries. Surprisingly, while Greeks initially showed a preference for other ICT tools, a shift occurred when we implemented Classcraft in the classroom setting for prospective teachers. This proposal aims to advocate for the integration of educational games, particularly Classcraft, in Greek universities to enhance the overall educational experience.

We state the following objectives:

1. To introduce and implement educational games in various academic settings within Greek universities.
2. To assess the impact of incorporating educational games on student engagement, motivation, and overall learning outcomes.
3. To provide professional development opportunities for educators to effectively integrate educational games into their teaching methodologies.

The rationale of our proposal:

- Educational games have demonstrated the ability to enhance student engagement by transforming traditional learning experiences into interactive and dynamic activities.
- While there could be initial hesitancy regarding educational games, our study revealed that attitudes can shift positively, as seen in the case of prospective teachers in Greece.
- Educational games not only reinforce subject-specific knowledge but also promote teamwork, critical thinking, and problem-solving skills, contributing to a well-rounded education.

The implementation plan includes:

1. Pilot programs: initiating small-scale pilot programs in select departments or courses to assess the feasibility and effectiveness of integrating educational games.
2. Professional development workshops: conducting workshops and training sessions for educators to familiarize them with educational games by providing guidance on how to seamlessly incorporate those into their teaching practices.
3. Feedback mechanism: establishing a continuous feedback loop involving students and educators to monitor the impact of educational games on the learning environment, making necessary adjustments based on the received feedback.

We expect several positive outcomes from the implementation of educational games in the educational process. First and foremost, we predict augmented student engagement, along with increased participation, motivation, and overall satisfaction with the learning process. Additionally, we expect that the implementation of educational games in the educational process would cultivate an environment that encourages collaboration, as well as emphasizes teamwork and effective communication through the integration of games such as Classcraft. Ultimately, we anticipate a positive association between the utilization of educational games and enhanced academic performance leading to improved learning outcomes.

The incorporation of educational games, such as Classcraft, into Greek university classrooms, presents an exciting opportunity to revitalize the educational experience. Our research showed that initial perceptions can evolve leading to higher enthusiasm and positive outcomes. By embracing this approach, Greek universities could position themselves at the forefront of modern effective educational practices.

4.6 Chapter Conclusions

In this chapter of the doctoral thesis, a comprehensive exploration unfolded, unraveling the intricate landscape of digital competences among professors and students in the contexts of Greece and Russia. The findings presented a nuanced understanding of the challenges and potentials associated with the integration of ICT tools in educational settings.

The cross-cultural analysis illuminated common challenges faced by professors in both Greece and Russia when engaging with certain ICT tools. Notably, Greek professors encountered difficulties with the utilization of educational games, in stark contrast to their Russian counterparts who exhibited a commendable proficiency in game-based learning.

While challenges were apparent, there emerged a positive narrative. Professors demonstrated a commendable level of knowledge of certain ICT tools coupled with a genuine enthusiasm for furthering their digital competences. Such keen interest paves the way for potential advancements in the realm of digital education.

We also explored the preferences of students in both countries concerning distance learning and the utilization of ICT tools. Although some students expressed a negative attitude towards the distance learning format, it is noteworthy that all students actively engaged as users of PCs and ICT tools.

The exploration extended to students of the UoI revealing a diverse landscape of digital preparedness. Some students demonstrated proficiency with specific ICTs, while others mastered specific tools, particularly educational games echoing issues observed among teachers.

The next study was based on the educational experiment with the Classcraft game among Greek students. The results portrayed an encouraging trend: as the duration of game usage increased, so did students' practical satisfaction. Positive feedback echoed through the students implying the potential efficacy of gamified learning experiences.

Culminating from provided insights, a forward-thinking educational proposal emerged. The proposal advocates for the integration of educational games into the academic landscape of Greek universities envisioning an enriched educational experience that would contribute to innovative pedagogical approaches.

Conclusions

The exploration of ICT in education, in this doctoral thesis, has covered topics, including fundamental concepts and the practical aspects of digital competences among professors and students in Greece and Russia. An overview of the main reflections and insights triggered by the results of this study follows.

Fundamental concepts of ICT use in educational settings are presented and discussed in this thesis. It was found that applications of ICT in education and comparison of the educational systems of Greece and Russia have common issues on ICT use. Similar teaching approaches, and common digital competences in both countries were present according to our investigations.

Professors from Greece and Russia, while sharing teaching similarities, faced distinct challenges of using ICT tools in the classroom. Notably, the use of educational games in the classroom presented difficulties for Greek professors contrasting with the fluent utilization demonstrated by their Russian colleagues.

By examining the proficiency levels on ICT use of professors and the digital readiness of students, we found that despite the challenges, a positive effect emerged. Professors in both countries have demonstrated commendable knowledge of certain ICT tools and expressed genuine interest in enhancing their digital skills. Students, following their teachers, have shown a great ability of application of digital competences, with some ICT tools posing challenges, especially educational games.

For the needs of this thesis, a practical study was conducted on the use of the Classcraft game in classroom activities, which showed an increasing trajectory of practical satisfaction among students. Positive feedback highlighted the potential effectiveness of gamified educational experiences.

Building on these insights, a forward-looking educational proposal emerged. Envisioning an enriched educational experience, the proposal advocates for the strategic integration of educational games into the academic background in many departments of Greek universities.

Additionally, the study showed that the introduction of non-traditional approaches of using ICT in the classroom had a positive impact on learning management.

Communication improved among students, and between students and teachers, leading to an increased interest in teaching and learning. Students from Russia and Greece appreciated the role of ICT use, and their teachers expressed interest in organizing the educational process using up-to-date teaching methods.

Students in both Greece and Russia were tired using online learning during the COVID-19 period and did not advocate for distance learning, citing problems such as the overwhelming volume of online information, lack of digital equipment, and social complexities such as communication and collaboration barriers, social expectations. Despite the obstacles, students recognized the positive effect of ICTs utilization, incorporating them into their learning processes and communication with both peers and instructors.

In summary, this doctoral thesis presents a comprehensive exploration of ICT use in classroom settings and proposes theoretical foundations with empirical findings. It uncovers challenges and highlights opportunities for transformative practices in digital education. This doctoral thesis points towards a future where the integration of ICTs, and especially educational games, could uphold innovation, create a common ground for student engagement, and enrich learning environment in Greek and Russian universities.

Forthcoming Research Proposals

Considering the insights gained from this doctoral thesis, several promising avenues for future research proposals emerge:

1. Longitudinal study on educational games. Conduct a more extensive and longitudinal study on the impact of educational games on both professors and students. This could involve tracking changes in digital competences and attitudes over an extended period, providing a deeper understanding of the long-term effects.
2. Cross-cultural analysis beyond Greece and Russia. Extend the cross-cultural analysis to include additional countries, further broadening the understanding of how digital competences and challenges vary across diverse educational landscapes. This could involve exploring regions with different cultural, educational, and technological contexts.
3. Comparative analysis of ICT utilization at different educational levels. Delve deeper into the challenges faced by educators and learners concerning the integration of digital technology. Identify specific barriers, concerns, and potential solutions to facilitate a more effective adoption of technology in diverse environments.

These future research proposals aim to build upon the foundations laid by the current thesis, offering opportunities to explore new dimensions, address limitations, and contribute valuable insights to the evolving landscape of digital education.

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Appendix 1 ISCED 2011 Levels of Education

Table 26. ISCED 2011 levels of education as presented in Wikipedia (Wikipedia contributors, n.d.-f).

Level	Label	Description
0	Early childhood education (01 Early childhood educational development)	Education designed to support early development in preparation for school and society. Programs designed for children below the age of 3
	Early childhood education (02 Pre-primary education)	Education designed to support early development in preparation for school and society. Programs designed for children from age 3 to the onset of primary education
1	Primary education	Programs typically designed to provide students with fundamental skills in reading, writing and mathematics, and to establish a solid foundation for learning
2	Lower secondary education	First stage of secondary education that is built on primary education, typically with a more subject-oriented curriculum
3	Upper secondary education	Second/final stage of secondary education preparing for tertiary education and/or providing skills relevant to employment. Usually with an increased range of subject options and streams
4	Postsecondary non-tertiary education	Programs providing learning experiences that are based on secondary education and prepare for labor market entry and/or tertiary education. The content is broader than secondary but not as complex as tertiary education
5	Short-cycle tertiary education	Short first tertiary programs that are typically practice-based, occupationally specific, and prepare for labor market entry. These programs

		may also provide a pathway to other tertiary programs
6	Bachelor's or equivalent	Programs designed to provide intermediate academic and/or professional knowledge, skills and competences leading to a first tertiary degree or equivalent qualification
7	Master's or equivalent	Programs designed to provide advanced academic and/or professional knowledge, skills and competences leading to a second tertiary degree or equivalent qualification
8	Doctorate or equivalent	Programs designed primarily to lead to an advanced research qualification, usually concluding with the submission and defense of a substantive dissertation of publishable quality based on original research

Appendix 2 Common Classcraft and Game Terms

Adventurer – Characters without assigned classes; they are considered adventurers and lack unique powers but have access to various gear sets and pets.

Background – Both students and teachers can select the background they wish to display in their profile view with new random backgrounds unlocking periodically.

Boss – In gaming terminology, a boss is an especially formidable monster often testing a player's acquired skills. In Classcraft, formative reviews are also referred to as Boss Battles acting as quizzes to evaluate student's comprehension of the course material.

Characters – Starting in the Exploration phase, each student can have a unique character representing him or her in the game, and they may choose their character's appearance.

Character class or type – Students can choose from three-character classes unlocked in the Collaboration phase: Guardians, Healers, and Mages, each with distinct gear sets, pets, and powers.

Guardians (Figure 27) – Character class known for toughness, using magical shields to protect peers from dangers.

Healers (Figure 28) – Character class specializing in healing by using ancient artifacts; healers bond with mystical sprites to heal themselves and others.

Mages (Figure 29) – Character class with elemental abilities; they are capable of transferring Crystals to allies but require protection from teammates.

Figure 27. Guardians character class from Classcraft as presented in Classcraft (n.d.-a).

Figure 28. Healers character class from Classcraft as presented in Classcraft (n.d.-a).

Figure 29. Mages character class from Classcraft as presented in Classcraft (n.d.-a).

Class Dashboard – The main interface displaying students allowing the allocation of points and accessing profiles to utilize unique powers.

Class Progression – A guiding feature leading users through the entire Classcraft experience, setup steps, and tutorials. The progress bar advances automatically with the granting of Experience Points to students.

Class Tools – Features to gamify lessons and curriculum including Random Events, the Volume Meter, the Stopwatch and Formative Reviews.

Crystals – Resources allowing students to activate unique powers earned by leveling up; they are represented by a blue symbol and are crucial for character progression.

Damage – The loss of Hearts in the game inflicted when students are attacked or make mistakes. In Classcraft, teachers can deduct Hearts for misbehavior or during activities with Class Tools.

Delayed damage – The option to defer damage consequences, allowing the class to continue without immediate interruption.

Experience Points (Figure 30) – Points collected by students for positive behavior and completing Class Tools activities or Quests. Accumulating enough points leads to advancing to the next level up.

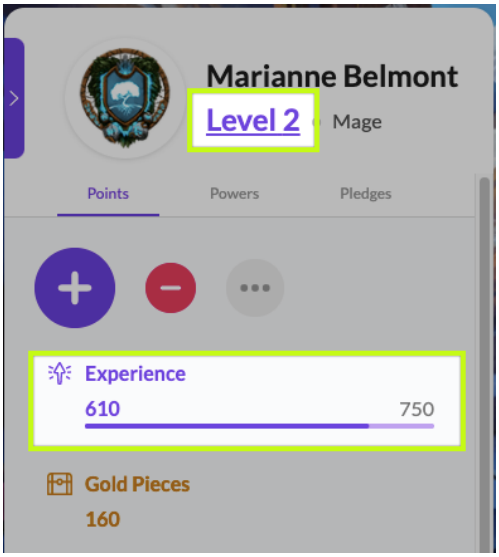

Figure 30. Experience Points from Classcraft as presented in Classcraft (n.d.-a).

Fall – Occurs when students lose all their Hearts, which requires them to complete a random pledge and potentially cause teammates to lose Hearts as well.

Game feed – A record of all game activity accessible in the game feed Activity Center's To-Dos, and Notifications.

Gamemaster – The teacher serving as the guide and facilitator of the game.

Gear – Attire and armor for characters, purchasable with Gold Pieces to create a unique look or unlock character class-specific gear sets.

Gear sets – Sets unlocking periodically, each including a full range of gear pieces. Completing a set automatically unlocks a new pet.

Gold Pieces (Figure 31) – Currency earned by students when advancing to the next level up, training pets, or as a reward for exceptional behavior. They are used to purchase gear or items from the School Store.

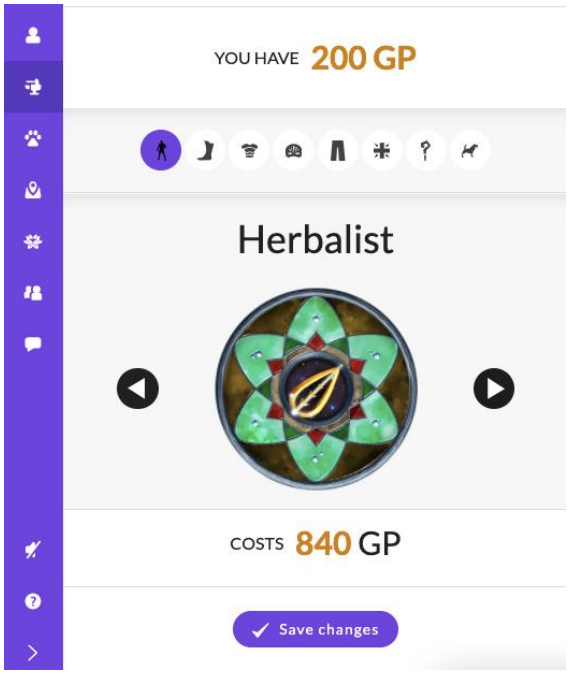

Figure 31. Gold Pieces from Classcraft as presented in Classcraft (n.d.-a).

Guide – Contains all the steps, videos for students, and tutorials for teachers when using Quick setup.

Hearts (Figure 32) – Represent life energy; students lose Hearts for misbehavior or during activities involving Class Tools with a maximum amount allotted by their character class.

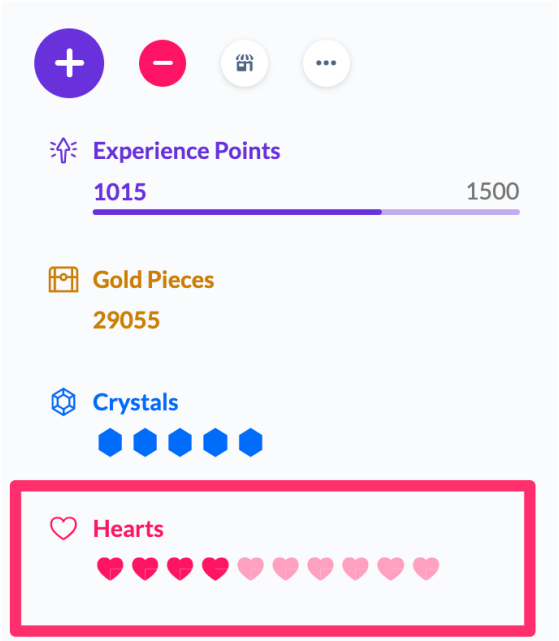

Figure 32. Hearts from Classcraft as presented in Classcraft (n.d.-a).

Hero Pact – A resource where students commit to playing the game; it is signed by both teacher and students.

Kudos – Short uplifting messages students can send to peers to highlight positive actions.

Level – An indicator of a student's overall progress reflecting earned Experience Points and positive behavior in class.

Level cap – The number of Experience Points required for students to level up.

Level Track – Displays rewards and levels unique to each character class accessible by clicking a student's level in the Profile view.

Level up – The result of gaining enough Experience Points to fill the bar and attain a new level by unlocking new powers and privileges.

Multi-Class – Occurs when a student plays a single character in multiple classes (available with a school license).

Mystery rewards – Rewards hidden from student view until specific game phases are reached.

Oron's Lantern – A list of student pledges after falling; it is checked off upon completion.

Pets – Unlocked by purchasing complete gear sets, these magical companions can be trained for extra Gold Pieces and are displayed alongside the character.

Phases – Segmented features guiding users through the process of using Classcraft to avoid overwhelming access.

Players – Individuals participating in the game referring to students in Classcraft.

Pledge – A consequence students receive when falling; typically, it involves tasks or conditions chosen by the teacher.

Powers – Skills or special abilities that grant students privileges. Activated with Crystals, powers can be universal, character-specific, game-based, or collaborative.

Premium – A license type providing additional features such as Gold Pieces as rewards, longer Quests, and Pets.

Quests – Personalized learning adventures that students embark on to earn gold or progress in the game.

Quick setup – An option during class creation for a streamlined setup focusing on core steps only.

Random Events – Special, randomized conditions setting the tone for the class day with positive, negative, or silly implications.

Regen/Regeneration – Automatic regeneration of Crystals and Hearts at midnight each day unlocked during the Mastery phase.

Role-playing game – Classcraft exemplifies a fantasy RPG, where players assume the role of a hero adventuring in a fantasy land.

School license – A license type paid by a school or district providing access to all features for admins, teachers, and students.

Shields – In Proactive mode, powers that prevent damage grant Shields to the target; they are displayed as Shield icons beside the Hearts bar. One Shield can prevent a student from losing one Heart.

Status – Icons appearing on a student's profile after using a power altering how certain game elements function.

Appendix 3 Questionnaire for UoI Professors

Digital competences of professors of UoI

Dear professors! Thank you for your participation in this study devoted to the comparison of competence in ICTs of professors in Russian and Greek universities. This is a part of my doctoral thesis and I kindly ask you to answer the following questions. In some of them, it is necessary to reply using your own phrasing, while in others, you have to choose one answer from an offered set. This questionnaire is anonymous. The questionnaire will take no more than 10 minutes. In the last question of this questionnaire, you can leave detailed comments or suggestions for the questionnaire (optional). Thank you!

Affiliation *(optional)*

_____

Age

_____

Gender

- Male
- Female
- No answer

Field of expertise

_____

Years of teaching

_____

The current digital competence level *(select only one option)*

- Newcomer (A1)
- Explorer (A2)
- Integrator (B1)
- Expert (B2)
- Leader (C1)

□ Pioneer (C2)

Respond to the following statements *(select only one option per line)*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I constantly use technology to communicate with my students and colleagues (e.g., email, social media, etc.)					
I actively develop my digital skills					
I regularly participate in online webinars for my job					
I am constantly looking for new educational approaches using ICT					
I encourage my students to use ICT tools for educational purposes					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good
Word processor (e.g., MS Word)					
Spreadsheet (e.g., Excel)					
Presentation tools (e.g., PowerPoint)					
Image processing (e.g., Paint)					

Video editing (e.g., Movie Maker)					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good
Digital collaborative tools (e.g., MS Teams)					
Cloud systems (e.g., Google Drive)					
Social networks (e.g., Facebook)					
E-mail (e.g., Gmail)					
Video communication tools (e.g., Skype)					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good
Learning management systems (e.g., Moodle)					
Tools for creating content (video, audio)					
Tools for interactive whiteboards (e.g., SmartBoard)					
Educational games (e.g., Classcraft)					
Quizzes platforms (e.g., Kahoot!)					

How often do you apply *(select only one option per line)*

	Almost never	Seldom *(Less than once per month)*	Sometimes *(1-3 times a month)*	Often *(1-3 times a week)*	Always *(More than 3 times a week)*
Copyright rules online					
Privacy rules online					
Evaluation rules of the reliability of digital material					

Respond to the following statements. A teacher... *(select only one option per line)*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Should have a positive attitude towards ICT					
Should use ICTs in teaching practice					
Must be proficient in ICT in order to diversify teaching methods					

List your five favorite ICT tools (either platforms or programs) and their features for use in the classroom. *Example: "MS Word for writing lectures; PowerPoint for creating presentations; <...>"*

_____

_____

Please, leave any comments regarding the previous questions and responses or provide us your feedback *(optional)*

_____

Appendix 4 Questionnaire for SSTU Professors (in Russian)

Цифровая компетентность преподавателей СГТУ имени Гагарина Ю.А.

Уважаемые преподаватели СГТУ имени Гагарина Ю.А.! Благодарим вас за участие в исследовании, посвященном сравнению цифровых компетенций преподавателей российской и греческой систем высшего образования. В рамках анкетирования вам необходимо честно ответить на ряд вопросов. В некоторых из них необходимо написать ответ 1-2 словами, в других – выбрать один вариант ответа из множества. Будьте уверены, что исследование анонимное и не направлено на оценку ваших персональных знаний. Прохождение анкеты займет не более 10 минут. В последнем вопросе анкеты вы можете оставить развернутые комментарии или пожелания к анкете (не обязательно). Спасибо!

Институт / подразделение *(не обязательно)*

_____

Возраст

_____

Пол

- Мужской
- Женский
- Без ответа

Область научных знаний

_____

Опыт преподавания (количество лет)

_____

Персональная оценка уровня владения информационно-коммуникационными технологиями (где новичок – низшая оценка, а пионер – высшая) *(отметьте только один вариант из предложенных)*

- Новичок (A1)

- Исследователь (A2)
- Интегратор (B1)
- Эксперт (B2)
- Лидер (C1)
- Пионер (C2)

Насколько вы согласны или не согласны с нижеприведенными утверждениями *(отметьте только один вариант для каждой строки)*

	Не согласен	Скорее не согласен	Затрудняюсь ответить	Скорее согласен	Согласен
Я постоянно использую современные технологии для коммуникации со студентами, их родителями, коллегами (напр., e-mail, социальные сети, веб-сайт учреждения и т.д.)					
Я активно развиваю свои цифровые навыки					
Я регулярно участвую в онлайн мероприятиях, в т.ч. образовательных вебинарах, онлайн курсах повышения квалификации, и т.д.					

Я постоянно ищу новые образовательные подходы с применением технологий					
Я поощряю использование студентами инструментов ИКТ в образовательных целях					

Оцените свою компетентность в использовании *(отметьте только один вариант для каждой строки)*

	Очень плохо	Плохо	Ни хорошо, ни плохо	Хорошо	Очень хорошо
Текстовых процессоров (напр., Microsoft Word и др.)					
Электронных таблиц (напр., Microsoft Excel и др.)					
Инструментов для презентаций (напр., Microsoft PowerPoint и др.)					
Графических редакторов (напр., Microsoft Paint и др.)					

Инструментов для редактирования видео (напр., iMovie и др.)					

Оцените свою компетентность в использовании *(отметьте только один вариант для каждой строки)*

	Очень плохо	Плохо	Ни хорошо, ни плохо	Хорошо	Очень хорошо
Цифровых инструментов для совместной работы (напр., Microsoft Teams и др.)					
Систем облачного хранения файлов (напр., Google Drive и др.)					
Социальных сетей (напр., VK, Telegram и др.)					
Электронной почты (напр., Gmail, Yandex и др.)					
Инструментов онлайн (в т.ч. аудио и видео) связи (напр., Skype, Zoom и др.)					

Оцените свою компетентность в использовании *(отметьте только один вариант для каждой строки)*

	Очень плохо	Плохо	Ни хорошо, ни плохо	Хорошо	Очень хорошо
Систем управления обучением (напр., Moodle и др.)					
Инструментов для создания контента (видео, графического, аудио и т.д.)					
Интерактивных досок (напр., SmartBoard и др.)					
Развивающих игр (напр., Classcraft, Quizziz и др.)					
Систем коллекционирования ответов учащихся (напр., Google Forms, Kahoot и др.)					

Как часто вы применяете *(отметьте только один вариант для каждой строки)*

	Почти никогда	Редко (реже чем 1 раз в месяц)	Иногда (1-3 раза в месяц)	Часто (1-3 раза в неделю)	Постоянно (чаще чем 3 раза в неделю)
Правила авторского права в Интернете					
Правила конфиденциаль-ности в Интернете					

Правила оценки достоверности цифровой информации					

Насколько вы согласны или не согласны с нижеприведенными утверждениями. Преподаватель… *(отметьте только один вариант для каждой строки)*

	Не согласен	Скорее не согласен	Затрудняюсь ответить	Скорее согласен	Согласен
Должен положительно относиться к ИКТ					
Должен использовать ИКТ в педагогической практике					
Должен владеть ИКТ, чтобы разнообразить методы обучения					

Перечислите ваши любимые ИКТ инструменты (платформы, программы) и их функционал для использования на занятиях. *Пример: "Word для написания лекций; PowerPoint для создания презентаций; <...>"*

_____

_____

Здесь вы можете оставить любые комментарии относительно формулировки вопросов или ответов; дополнить свой ответ; дать обратную связь *(не обязательно)*

_____

Appendix 5 Questionnaire for UoI Students

Digital competences of students of UoI

Dear students! Thank you for your participation in this study, devoted to the comparison of competence in ICTs of students in Russian and Greek universities. This is a part of my doctoral thesis and I would like to ask you to answer the following questions. In some of them, it is necessary to reply using your own words, while in others, you have to choose one answer from an offered set. This questionnaire is anonymous. The questionnaire will take no more than 10 minutes. In the last question of this questionnaire, you can leave detailed comments or suggestions for the questionnaire (optional). Thank you!

Affiliation *(optional)*

_____

Age

_____

Gender

- Male
- Female
- No answer

Field of study

_____

Level of study

- Bachelor's student
- Master's student
- Doctoral student

Year of study

_____

The current digital competence level *(select only one option)*

- Newcomer (A1)
- Explorer (A2)
- Integrator (B1)
- Expert (B2)
- Leader (C1)
- Pioneer (C2)

Respond to the following statements *(select only one option per line)*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I constantly use technology to communicate with my classmates and university staff (e.g., email, social media, etc.)					
I actively develop my digital skills					
I regularly participate in distance classes and/or online conferences/webinars					
I am constantly looking for new educational ways using ICT					
I am enthusiastic about classes that encourage the use of ICT by students and/or teachers					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good

Word processor (e.g., MS Word)					
Spreadsheet (e.g., Excel)					
Presentation tools (e.g., PowerPoint)					
Image processing (e.g., Paint)					
Video editing (e.g., Movie Maker)					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good
Digital collaborative tools (e.g., MS Teams)					
Cloud systems (e.g., Google Drive)					
Social networks (e.g., Facebook)					
E-mail (e.g., Gmail)					
Video communication tools (e.g., Skype)					

Rate your competences when it comes to using *(select only one option per line)*

	Very poor	Poor	Neither good nor poor	Good	Very good
Learning management systems (e.g., Moodle)					
Tools for creating content (video, audio)					

Tools for interactive whiteboards (e.g., SmartBoard)					
Educational games (e.g., Classcraft)					
Quizzes platforms (e.g., Kahoot!)					

How often do you apply *(select only one option per line)*

	Almost never	Seldom *(Less than once per month)*	Sometimes *(1-3 times a month)*	Often *(1-3 times a week)*	Always *(More than 3 times a week)*
Copyright rules online					
Privacy rules online					
Evaluation rules of the reliability of digital material					

Respond to the following statements. A teacher... *(select only one option per line)*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Should have a positive attitude towards ICT					
Should use ICTs in teaching practice					
Must be proficient in ICT in order to diversify teaching methods					

List your five favorite ICT tools (either platforms or programs) and their features for use when you are studying. *Example: "I use MS Word to record a lecture or I use PowerPoint to create presentations; <...>"*

_____

_____

Please, leave any comments regarding the previous questions and responses or provide us your feedback *(optional)*

_____

Appendix 6 Questionnaire for Greek Students

Distance learning and the use of ICT tools by students in Greece and Russia

Dear students, this questionnaire was created to collect the opinions of students from Greece and Russia about distance learning and the use of ICT tools during distance learning. Your responses will be used for a comparative analysis of the opinions of university students from the two countries. The questionnaire is anonymous. It will take no more than 10 minutes. By filling it out, you give us permission for the collection and processing of data. Thank you for participating!

Gender

- Male
- Female
- No answer

Age group

- 16–18
- 19–21
- 22–24
- 25+

City of studies

_____

Name of the university / educational institute *(optional)*

_____

Field of study

- Formal sciences
- Social sciences
- Natural sciences
- Applied sciences

Distance learning at my university / educational institute… *(select only one option)*

- □ Was available before 2020
- □ Is available since 2020
- □ Is available partially, but not for all courses
- □ Is available partially and needs to be developed
- □ Is not available
- □ Not sure

How much time do you spend on the Internet per day (on average)? *(e.g., 30 min. / 4 h., etc.)*

_____

For what purposes do you use the Internet during the day? *(select several options if necessary)*

- □ Education
- □ Entertainment
- □ Work
- □ Self-development
- □ Communication
- □ Other _____

What communication channels (ICT tools) do you use during distance learning? *(select several options if necessary)*

- □ University website and blogs
- □ E-mail
- □ Video conferencing tools
- □ Social networks
- □ Other _____

What ICT tools do you use during distance learning to communicate? *(list their names*

_____

My Internet time during distance learning… *(select only one option)*

- Increased significantly
- Increased slightly
- Remained unchanged
- Decreased

In your opinion, is distance learning relevant for modern universities / educational institutes? *(select only one option)*

- Relevant
- Partially relevant
- Not relevant
- Not sure

What challenges do you face during distance learning? *(select several options if necessary)*

- Lack of digital skills
- Lack of technical equipment
- Lack of communication with peers / teachers
- Large amount of information
- Concernes about the quality of knowledge and future employment
- None of the above
- Other _____

Please, leave any comments regarding the previous questions and responses or provide us your feedback *(optional)*

_____

Appendix 7 Questionnaire for Russian Students (in Russian)

Дистанционное обучение (ДО) и использование инструментов информационно-коммуникационных технологий (ИКТ) студентами в России и Греции

Уважаемые студенты, целью этой анкеты является сбор мнений и предпочтений студентов из России и Греции относительно дистанционного обучения и использования инструментов ИКТ в период ДО. Ваши ответы будут использованы в сравнительном анализе. Анкета анонимная и займет не более чем 10 минут. Заполняя форму, вы даете нам согласие на сохранение, анализ и использование ваших ответов. Спасибо за участие!

Пол

- Мужской
- Женский
- Без ответа

Возрастная группа

- 16–18
- 19–21
- 22–24
- 25+

Город, в котором вы получаете образование

_____

Название учебного учреждения *(не обязательно)*

_____

В какой области вы получаете образование

- Формальные науки (математика, информатика, и т.д.)
- Социальные науки (социология, психология, и т.д.)
- Естественные науки (биология, химия, и т.д.)
- Прикладные науки (инженерные, медицинские науки, и т.д.)

Дистанционное обучение в моем учебном учреждении… *(выберете только один вариант)*

- ☐ Было доступно до 2020 г.
- ☐ Доступно с 2020 г.
- ☐ Доступно частично, не для всех курсов
- ☐ Доступно частично и должно быть улучшено
- ☐ Не доступно
- ☐ Не уверен(а)

Сколько времени вы проводите в Интернете ежедневно (в среднем)? *(например, 30 мин. / 4 ч., и т.д.)*

_____

Для каких целей вы используете Интернет? *(выберете несколько вариантов, если необходимо)*

- ☐ Образование
- ☐ Развлечение
- ☐ Работа
- ☐ Саморазвитие
- ☐ Общение
- ☐ Другое _____

Какие каналы коммуникации (инструменты ИКТ) вы используете в период дистанционного обучения? *(выберете несколько вариантов, если необходимо)*

- ☐ Веб-сайт и ресурсы учебного учреждения
- ☐ Электронная почта
- ☐ Видеоконференции
- ☐ Социальные сети
- ☐ Другое _____

Какие ИКТ инструменты вы используете в период дистанционного обучения для коммуникации? *(перечислите их названия)*

_____

Мое время в Интернете в период дистанционного обучения… *(выберете только один вариант)*

- Значительно увеличилось
- Незначительно увеличилось
- Не изменилось
- Уменьшилось

На ваш взгляд, актуально ли дистанционное обучение для современных учебных учреждений? *(выберете только один вариант)*

- Актуально
- Частично
- Не актуально
- Не уверен(а)

С какими трудностями вы сталкиваетесь при дистанционном обучении? *(выберете несколько вариантов, если необходимо)*

- Недостаток цифровых навыков
- Отсутствие технического оснащения
- Отсутствие коммуникации со сверстниками / учителями
- Большой объем информации
- Беспокойство о качестве знаний и будущем трудоустройстве
- Ничего из вышеперечисленного
- Другое _____

Пожалуйста, оставьте любые комментарии относительно предыдущих вопросов и ответов или оставьте нам обратную связь *(не обязательно)*

_____

Appendix 8 Questionnaire for UoI Students (Classcraft)

Level 1: Reaction

1. How satisfied are you with your experience using Classcraft in your classes, on a scale from 1 to 10?
2. Rate the user interface of the Classcraft platform and its features on a scale from 1 to 10.
3. Evaluate the ease of use and comprehensibility of the Classcraft game on a scale from 1 to 10.

Level 2: Learning

4. To what extent do you believe Classcraft helped students gain knowledge and skills related to their course, on a scale from 1 to 10?
5. How much did participating in Classcraft quests or challenges improve your problem-solving skills and out-of-the-box thinking, on a scale from 1 to 10?
6. How much did participating in Classcraft quests or challenges improve your digital skills, on a scale from 1 to 10?

Level 3: Behavior

7. To what degree did Classcraft positively influence students' behavior in the classroom, on a scale from 1 to 10?
8. How much did Classcraft enhance students' collaboration and teamwork skills, on a scale from 1 to 10?
9. To what extent do you see the opportunity to use Classcraft remotely and in a disciplined manner, on a scale from 1 to 10?

Level 4: Results

10. Do you believe that using Classcraft had a direct impact on students' academic performance, on a scale from 1 to 10?
11. How much in your opinion did Classcraft contribute to the overall learning environment in classes using ICT, on a scale from 1 to 10?
12. How willing would you be to use Classcraft in your future teaching practice, on a scale from 1 to 10?