Univerzita Hradec Králové

Přírodovědecká fakulta

Disertační práce

2024 Mirela Moldoveanu M.Sc.

Univerzita Hradec Králové

Přírodovědecká fakulta

Katedra aplikované kybernetiky

The use of ICT in a HE institution in the field of social sciences

Využití ICT ve vysokoškolské vzdělávací instituci v oblasti sociálních věd

Disertační práce

Autor: Mirela Moldoveanu M.Sc.

Studijní program: P0688D140009 Informační a komunikační technologie ve vzdělávání

Školitel: prof. RNDr. Eva Milková, Ph.D.

Konzultant: Mgr. Simona Pekárková, Ph.D.

Hradec Králové únor 2024

Declaration

I declare that this doctoral dissertation entitled “The use of ICT in a HE institution in the field of social sciences“ is my own work, and that the research projects it is based on have been designed and carried out on my own effort, in their entirety. The content of this doctoral dissertation is the original work of the undersigned author, with some parts potentially being part of a published material in specialised journals at the time of the dissertation defence.

15.2.2024 Mirela Moldoveanu

Dedication

My greatest wholeheartedly thanks and appreciation go to my supervisor, prof. RNdr. Eva Milková, Ph.D., for always being deeply invested in making me strive to do better in my doctoral studies, and for her always valuable advice, patience, and inspiration. Moreover, I would like to express my deep appreciation to my loving husband and my dear son for the patience and support they showed throughout my doctoral studies. Finally, I would like to wholeheartedly thank my friend and colleague Mgr. Jitka Cirklová M.A. Ph.D. for always believing in me, and for personally and professionally providing the needed support to complete my doctoral degree.

Abstrakt

ICT je základem světa 21. století a jeho vznik souvisí s technologickou transformací, která pokročila exponenciálním tempem po roce 1970. Avšak žádná z technologií by se nemohla rozšířit do všech oblastí našeho života, nebýt podpory lidské schopnosti učit se a adaptovat, předávat informace a uchovávat je pro budoucí generace. Tyto činnosti tvoří základ vzdělání. Vzdělávací činnosti se stále více opírají o nástroje ICT pro výuku učiva, rozvoj dovedností, a podporu nové generace zachovávat cyklus využívání, tvorby a přenosu informací přizpůsobený jejich časovému plánu a kontextu. Pro zachování tohoto cyklu vzdělávání v oblasti ICT je však zapotřebí efektivní využívání současného ICT a rozvoj digitálních dovedností u studentů i učitelů.

Tato disertační práce předkládá dvě studie, které zkoumají, jak malá soukromá vysoká škola zaměřená na oblasti společenských věd využívá ICT ve vzdělávání a jaké má toto využívání dopad na výkonnost studentů. Studie se také zaměřují na exo-systémové faktory studentů jako jsou procesy, které škola implementovala pro zahrnutí ICT do svých vzdělávacích a správních aktivit, které nakonec ovlivňují výkonnost studentů prostřednictvím přímého nebo nepřímého vlivu na to, jak je výuka navržena a prováděna.

Pro sběr a triangulaci dat, které odpovídají čtyřem výzkumným otázkám stanovených v této práci, byly využity jak kvantitativní (dotazníky, hodnocení výkonu na seminářích), tak kvalitativní (polostrukturované rozhovory, analýza obsahu, tematická analýza, pozorování ve třídě) výzkumné metody.

Závěry předkládaného výzkumu naznačují, že používání více ICT nástrojů při výukových aktivitách není jediným a nejvlivnějším faktorem ovlivňujícím výkonnost studentů. Ve skutečnosti non-ICT pedagogické metody spolu s ICT nástroji používanými ve výuce mají doplňkový účinek na výkonnost studentů za předpokladu, že jsou použity k rozvoji a využití určitých klíčových dovedností u studentů, jako jsou kritické myšlení, komunikace nebo digitální gramotnost, které mohou studentům dále pomoci s pochopením učiva, splněním seminárních úkolů a přípravou na zkoušky. Navíc, aktivní role digitálně zručných učitelů ve výuce přímo v třídě je považována za jeden z důležitých faktorů pro efektivní učení, a to díky jejich schopnosti vybrat vhodné ICT nástroje, které mohou posílit výkonnost studentů.

Klíčová slova

ICT ve vzdělávání, digitální dovednosti, úroveň digitální zralosti

Abstract

ICT is the foundation of the 21st century world, and its emergence is connected with the technological transformation that advanced at an exponential rate after the 1970s. Yet, none of the technology could become widespread in all the fields of our life hadn't it not been supported by human ability to learn and adapt, pass on the information, and store it for future generations. These activities, computation, communication, and storage of information, constitute the basis of education. Nowadays educational activities employ continuously more ICT tools to teach subject matter, develop skills, and help new generations perpetuate the cycle of information use, creation and transfer adapted to the agenda and context of their time. However, the basis of perpetuating this cycle of education in ICT is the effective use of current ICT and the development of digital skills in students and teachers alike.

This thesis presents two studies which investigate how a small private higher education institution in the field of social sciences uses ICT in education and the impact of this use on the students' performance in class. The studies also investigate the students' exo-system factors, such as the processes the school implemented to include ICT in its educational and administrative activities that ultimately impact the students' performance through their direct or indirect influence on how classes are designed and performed.

The studies use both quantitative (questionnaires, seminar performance rating) and qualitative (semi-structured interviews, content analysis, thematic analysis, class observations) research methods to collect and triangulate data that answer the four research questions set by the researcher.

The findings indicate that using more ICT in class activities is not the only and most influential factor for the students' performance. In fact, non-ICT pedagogical methods along ICT tools used in teaching have complementary effects on student's performance, provided that they are used to develop and harness certain key capabilities in students, such as critical thinking, communication or digital literacy, that can further assist the students with the subject matter comprehension, seminar assignment completion, and exam preparation. Furthermore, the active role of a digitally skilful teacher in an in-person class is considered one of the important factors for effective learning, for their ability to choose the adequate ICT tools that can propel the students' performance. The approach taken in these studies to combine the used research methods for triangulation allows also to discuss the findings using a more comprehensive framework of linking the identified and/or measured factors with a role in the use and impact of ICT in education, using an ecological system theory.

Keywords
ICT in education, digital skills, digital maturity level

List of abbreviations

ADM-KDA – administration key domain area
CL – capability level
CV – critical variable
CR – Czech Republic
CSU - Český statistický úřad
DIGCOMP – Digital competences (name of digital skills framework)
DigEULit – Digital European Literacies (name of digital skills framework)
DM – digital maturity
DMHEI – digital maturity of the HEI
DMC – digital maturity of the class
DS – digital skills
EC – European Commission
ECDL – European Computer Driving License
EP – Economic policies (the name of Course 3)
EP – European Parliament
EQF – European qualification framework
GES – Global economic studies (the name of Course 2)
HE – higher education
HEI – higher education institution
ICDL – International Computer Driving License
ICT – information and communication technology
ICTE – information and communication technology in education
INF-KDA – infrastructure key domain area
IS – information system
ISTE – International society for technology in education
K-12 – acronym for education period from kindergarten to the 12th grade
KDA – key domain area
MAN-KDA – management key domain area
MM – maturity model
MŠMT - Czech Ministry of Education, Youth and Sport
NCCA – National Council for Curriculum and Assessment
OECD – the Organisation for Economic Cooperation and Development
OS – operating system
PEofEU – Political economy of the European Union (the name of Course 1)
PISA – Programme for International Student Assessment
SDGs – sustainable developmental goals
SES – social economic status
STU-KDA – students key domain area
TEA-KDA – teachers key domain area
UN – United Nations
UNESCO – The United Nations Educational, Scientific and Cultural Organisation

Table of Contents

1. INTRODUCTION

1.1. ICT in the Information Society and Education

Information and Communication Technology (ICT), an extension of the term Information Technology as we know it today, is a relatively new domain in the human society development compared to long our anthropological evolution. ICT first emerged as a concept in mathematics, connected with computing and communicating information in the 1950s. Soon after mathematics, its use its use extended to private and public economic and public administration fields (etc. military, research, diplomatic) (Kline, 2006; Spariosu, 2006). Its huge potential for social and economic development made it to quickly spread into other fields, such as health, and education. Compared to a century ago, at least in developed and many developing countries (ITU, 2022), we cannot conceive our life, personal, academic, and work, without the use of ICT tools. Despite little confidence that ICT will be part of educational facilities (Chadi, 2004), nowadays ICT is part of virtually every classroom and school administration in what Manuel Castells calls Information Society (Garnham, 2000).

Our understanding the use and effect of ICT on any domain is based on its three main characteristics: computation power, communication power, and storage power (Hilbert & Lopez, 2011). These characteristics define the relationship between ICT and three social (and deeply philosophical, and connected to how physical world is understood through science) concepts: meaning (for the domain in which ICT is used), space (that information can cover when it travels), and time (for/after which that digital information can be stored, retrieved, and (re)used). Our economies rely on these three aspects of ICT to continuously improve themselves to create, maintain, increase, and redesign networks of information and commodities exchange within ever changing legal, cultural, and technological contexts that create the framework of human activity and, nowadays, define its daily existence.

At the same time, the same three activities, giving meaning to empirical or even projected data to transform it into information, communicating it, and storing it to be passed to further generation as knowledge, constitute the basis of social development (Hernandez, 2017), starting with information about natural phenomena and the creation and use of tools for survival. These three characteristics are also the pillars of education and the functionalities of ICT tools. Thus, because the realms of ICT, education and social development overlap on their main objectives (to inform, assist with decision-making, develop domain/application-specific skills, and create new content that should further be stored, adapted and perpetuated for further generations of learners), it is not surprising that ICT can easily provide new dimensions to how teachers investigate and package the meaning of, communicate, and store class content for their students, in ways a traditional pen-an-paper school cannot (Hernandez, 2017).

However, these changes of the used technology in teaching and learning raise further questions about integrating them into the current curriculum, training teachers to use them effectively, evaluating and developing students' digital skills, and assessing the benefits and gaps of using ICT in education (Spariosu, 2006; Garnham, 2000; Tsin et al., 2014), additional to recent issues about parents asking school to remove/restrict access to certain digital or physical content considered intellectually or emotionally damaging for students (Alter, 2023).

Moreover, solely using ICT as tools mediating the process of reaching educational objectives may not have the same range of results as a set of educational tools and strategies chosen, adapted, and combined for specific classes and fields by a skilled teacher, or even using a student-centred approach, as opposed to a teacher-centred approach (Wastiau et al., 2013; Simons et al., 2016; Souders et al., 2017). The social component of learning is perhaps the main reason why today, with all the knowledge and technology available to us, teaching is not performed fully online, using only digital tools and content, or applying only technology in class to mediate the transmission and transfer of content. Lev Vygotsky founded his theory on the use of linguistic communication between child and teacher to enhance students' understanding of scientific principles in an era without digital tools (Vygotsky, 1962); Seymour Papert applies Vygotsky's theory to devise games with a social component that would implicitly teach children scientific principles (Tsalapatas, 2012; Harel & Papert, 1991), while other researchers state that digital platforms in learning may not be sufficient for an increase knowledge acquisition, or skill development (Kim et. al, 2013; Stensaker et al., 2007). The use of technology in class by students may have a distracting role for both students and teacher (Langan et al., 2016; Wood et al., 2012). Even for the adult population, studies show that there is little transfer between domains for the cognitive abilities developed using digital devices, such as games or brain teasers (Simons et al., 2016; Souders et al., 2017). HE-based research findings indicate that the use of off-task digital tools impacts the performance on low-order tasks (e.g. knowledge, comprehension), but not on high-order tasks (e.g. essay writing) (Waite et al., 2018), and that it affects the quality of notes taken and class performance (Wood et al., 2012).

In fact, most studies investigating the effects of ICT in teaching on student's learning, or of ICT in learning alone, state that there is a myriad of factors that corroborate their effects onto the students' performance (Lim et al., 2013; Hsin et al., 2014), from a micro level (e.g. the socio-economic status of the child's family) to meso and exo factors (teacher's attitudes towards ICT, school's location and access to infrastructure and other teaching sources), to macro factors (the country's or reginal policy in areas affecting education, telecommunication infrastructure or GDP, cultural and social values), and ultimately to chrono level factors (the evolution of technology in time) that generate generational differences in how technology is used for education, work, and personal activities. The benefits for the students exist as long as there are policies in place to motivate schools and train teachers to systematically and effectively incorporate ICT in teaching (Stensaker et al., 2007; Misuraca et al., 2013; Park & Weng, 2020). Recognising the benefits and disadvantages of using ICT in teaching found by scientific research is a steppingstone of harnessing ICT power for effective learning. As such, several countries decided to ban certain electronic devices in all schools, due to their scientifically reported disruptive effect of student's attention, which outweighs their potential benefits for learning (BBC News, 2023), which speaks volumes for the care of political leaders to integrate technology in children's education only if proven safe by science. At a macro level, Park & Weng (2020) found a positive relationship between students' PISA results and the country's GDP per capita, and student's interest and perceived ICT competence and autonomy, which shows the reverberations of state-level policies on generational competences level in ICT. Moreover, the UN ICT and Sustainable Development Goals (SDGs) unit mention access to ICT for education as a prerequisite for child development in an inclusive and equalitarian society (The Earth Institute, Columbia University & Ericsson, 2016), which is a testimony for the global recognition of the importance of ICT's role in education.

However, as mentioned above, a literature review on the benefits of ICT in school shows that research is far from concluding ICT in education has a as positive effect as in other commercially productive industries (Lim et al., 2013), and the positive effects that were found in education are mainly between the use of ICT and certain cognitive abilities in pre-K12 students (Hsin et al., 2014), though these may not be transferable between domains of activity (Simons et al., 2016; Souders et al., 2017). Despite repeated positive findings reported by research about the relationship between the use of mobile devices used in classroom and students' engagement, memory, and academic engagement and performance at K-12 and HE related (Ahmed & Parsons, 2013; Guerrero et al., 2016), several European countries evaluated the negative impact as higher than the positive one on students' overall development, and decided to ban (the Netherlands) or propose banning of mobile devices (smart phones, tablets, smart watches, etc) from school due to their negative impact on students' attention span revealed by research, and mental health (Armstrong, 2023; Therrien, 2018; Walsh et a., 2018).

The lack of conclusive findings may be due to the complex nature of the relationship between the adoption of technology by non-commercial fields, such as education, research-based frameworks that drive educational curricula and regulatory policy regarding ICT, and cognitive and social development of ICT users. In order to understand the effects of ICT in education we need to understand the digital skills required to use ICT tools, and the digital skills required to use ICT tools develop while using them, they are not innate, hence the difficulty to understand the cause and effect of this complex and dynamic relationship between the use of ICT tools in education and their effect on performance, mediated by digital skills. At the same time, technology adoption in institutions following a standardized framework is much slower than its adoption in private life (Radjep et al., 2021), yet these effects can be confounding. Additionally, the initial research on the effects of ICT on student's abilities performed over almost two decades to inform regulatory policies and assessment frameworks of digital skills become outdated because of the fast pace at which technology takes over more aspects of our life before it enters education. To counteract this aspect, Gibson et al. (2018), a study part of the UNESCO SDGs 2030 initiative, recommends the steps to take to align the frameworks of data collection tools on ICT in education, to make its effects more comparable, and also more inclusive of all the factors that may influence students' performance, such as country and school infrastructure and funding, teachers' beliefs, a learner-centred approach, and mobile learning, factors mediated by the student's and teacher's level of digital skills, and which are elements of student's micro, meso and macro systems (Rosa & Tudge, 2013).

2. CURRENT STATE OF THE FIELD

The evaluation of the current research of ICT in education, inclusive of any research on tertiary education, needs to include an overview of the theoretical frameworks defining digital skills, which are required on both teacher’s and student’s side for the use of ICT in education to be effective.

2.1. Digital skills and their link to ICT in education

ICT comprises all the tools allowing us to search, use, create, change, and store information in a digital form. For these purposes the user needs to make use of their digital skills. Digital skills (DS) represent a concept that focuses on the technical, social, communication and emotional skills involved in the manipulation of ICT. Theoretical frameworks of digital skills continuously change over time as technology progresses and theories need to be updated to reflect the onboarding of new technologies for mass use and the implicit skills needed from the users to be able to use them.

A few paradigms will be reviewed in the first section of this paper, exploring not only their theoretical basis, but also their situatedness in their social context, especially from an educational perspective.

The concept of digital skills is associated with a variety of terms in the specialised literature. Some of these terms are: digital competences, ICT skills, digital literacy/literacies, e-skills, e-literacy and others, which overlap to a lesser or greater extent. The proficiency in using ICT for one’s work, business object, or studies in the effort to adapt to an increasingly digital environment to maintain one’s competitiveness is defined as digital maturity (Aslanova & Kulichkina, 2020), while in education it is recognised conceptually as the institution’s ability to incorporate ICT in managerial, administration, teaching and learning to facilitate the teaching process for teaching, the learning process for students, and the institution’s transformational capacity to continuously integrate the latest technological processes, software, and hardware, to be able to access and use the latest information and create new information and knowledge using technology (Durek et al., 2018; Al-Ali & Marks, 2021). As well as the concept of digital skills, digital maturity can be measured at individual level, averaged at a group level, or assessed at an organisational/institutional level. The meaning of the term is important as it drives the theoretical framework in which it is situated and based on this framework specific measurement tools are developed for its constructs.

2.2. Theoretical and conceptual frameworks for Digital Literacy

i. Gilster's definition and conceptualisation of the term "digital literacy"

The 1998 definition of digital literacy proposed by Gilster states that holding such skills goes beyond the technical ability to use the keyboard for specific commands. Selecting, analysing, evaluating, and deciding what is the value of and what to do with the result of those keyboard commands, returned as information, represent the basis of digital literacy concept in Gilster's view (as cited in van Laar, van Deursen, van Dijk, & de Haan, 2017). Gilster's definition does not list particular skills or technologies. He rather provides a general idea of the attitudes towards technology which guide our capabilities to integrate the information acquired using networked devices with information from other sources to expand/consolidate our understanding and knowledge of a general or specific nature (Bawden, 2008). The clarification of the content of this definition was left open and it generated more streams of understanding of what skills digital literacy/literacies cover(s) and a wide range of terms with more or less overlapping meaning, as specified above (Helsper & Eynon, 2013).

Nevertheless, further theories on digital literacy or digital competence follow a similar pattern of conceptualising the object of their research by including not only technical capabilities, but also cognitive, socio-emotional, communication and even ethical skills to master an ever-increasing range of digital activities. Additionally, the classification and content of various theoretical frameworks reveal the psychological perspective of their authors, guiding our understanding of the areas of applicability and validity of each theory.

Gilster's definition of digital literacy is largely considered the starting point of the development of further theoretical and empirical frameworks regarding digital skills/literacies. Thus, in developing further theories or classifications used for skills measurements in this field, researchers do use this definition as a granted premise for further concepts in this area, and only clarify the terms which proved unclear in previous studies (van Laar, van Deursen, van Dijk & de Haan, 2017) .

This review considers that Gilster rightfully used more than technical skills in defining digital literacies and foreseen the development of soft skills to enable users to manage and responsibly and efficiently use the digital information, even if at that point the digital world was still emerging and the range of possible ways of development of the virtual landscape was wide, which made precise predictions about its future use very difficult. This is one more reason why Gilster's conceptualisation of the term is used for theory development, as it is grounded in a context where many outcomes were possible, and it covers many perspectives which could now explain the emergence and development of digital literacies.

ii. Eshet's framework for digital literacy

One of the early theoretical frameworks for digital literacy was authored by Eshet in 2004 and it comes from a cognitive psychological perspective. Eshet, as many other researchers on this topic, recognized the confusion around the terminology of digital skills/literacy/competences in the absence of a clear conceptualisation of the terminology (Eshet, 2004; Aviram & Eshet-Alkali, 2006; van Deusren & van Dijk, 2008; Helsper & Eynon, 2013; van Laar, van Deursen, van Dijk & de Haan, 2018) and proposed five main groups of literacies underpinning the users' learning activities in the digital environment, clarifying the involved literacies conceptually and exemplifying the skills encompassed by each group. These literacies cover a large range of cognitive skills which can be measured in the user's performance (Eshet, 2004; Aviram & Eshet-Alkalai, 2006).

Eshet's framework was originally useful mainly for capturing the skills of employees learning and working in digital environments, but she stated that given it is based on cognitive skills applicable to the entire healthy population, the model may be used for other purposes and age groups than the ones it was designed and tested on (Eshet, 2004).

The proposed literacies groups are:

1. Photo-visual literacy (understanding, learning and working using images and text).
2. Reproduction literacy (creating meaningful and original content after having processed existing material).
3. Branching literacy (non-linear searching of and connecting information from different domains in order to acquire/create new knowledge)
4. Information literacy (using effective filters to select and evaluate the relevant information and discard the irrelevant and/or misleading information, toward a specific creative/learning goal).
5. Socio-emotional literacy (using branching and information literacies to critically assess and avoid the dangers of cyberspace communities and interactions).

One benefit of Eshet's model is that the premise for learning to work with a digital device and in a digital environment is having a set of cognitive skills, and it is stipulated that every healthy individual has such a set. This is one of the reasons why Eshet's model has been repeatedly reported as a general conceptual framework for all ages (Ala-Mutka, 2011; Ferrari, 2012). Additionally, Eshet points also towards certain dependencies between some of the models' literacies/constructs (Eshet, 2004) (such as the socio-emotional literacy depending on branching and information literacies), information which should better guide the design of replicability/testing studies. Eshet's model was used by employers to inform the design of learning software for their employees and to understand how learning from electronic devices differs from learning from paper material. It was reported that in terms of performance, learning from paper material yields better results than when studying on electronic devices (Ackerman & Goldsmith, 2011; Singer & Alexander, 2016).

The limitations of the model are related to the small-sample research to originally test its constructs, which reflects the availability of the infrastructure and ideas needed to conduct such research two decades ago. The photo visual literacies in the original study, for example, is reported to be based on a study with three primary school children and the conclusions were transferred into a model applicable to the adult workforce (Eshet, 2004). Other constructs are based on pilot studies with little description given, which raises questions about the reliability of the proposed literacies. Those questions were gradually addressed in further studies (Eshet & Chajut, 2009) testing the reliability of each construct. Eshet and Chajut found that the initial results stand after a five-year period of experience with digital technology. However, they found that older participants were better off on the technological skills tasks (which were mapped against their own model as photovisual and branching tasks). However, on the tasks which required more critical and creative skills (reproduction and information tasks), the five-year experience was detrimental to the groups of high-school and college students (Eshet & Chajut, 2009), as older users benefit from a wider work and life experience to guide their critical thinking, problem solving, and decision-making. The authors mapped the tasks with the ones of other frameworks on digital skills, which makes their model transferable to other perspectives. However, their study may be affected by researcher's bias, which is to build a study design that stands out from the existing ones, and/or interpret the statistical results so that they support the research hypothesis and remain blind to alternative designs and interpretations which can disprove that research hypothesis.

iii. Martin & Grudziecki's framework for digital literacies

Another proposed framework for digital literacies was advanced by Martin and Grudziecki (2006) within the DigEuLit program. The purpose of their initiative was to provide a clear framework for digital literacy concept for researchers, educators and learners to use the term according to its established content in their practice and reduce the confusion around the then existing terminology. Creating a European framework for digital literacy allows European countries to compare performance across educational institutions and professions and allows a higher student and workforce mobility (Ferrari, 2012).

The authors departure in their initiative from the general definition of Gilster and added on top of the ICT skills, by which they understand the skills to technically manipulate a connected digital device, levels of skills which cover the communication, strategic and creative activities the user can perform online.

Martin and Grudziecki proposed three levels of digital literacy (Martin & Grudziecky, 2006):

1. Digital Competence – seen as underpinning digital literacy and structured in thirteen distinct categories of digital activities/processes (statement, identification, accession, evaluation, interpretation, organisation, integration, analysis, synthesis, creation, communication, dissemination, reflection). The proficiency levels within each process are: Aspirant, Practitioner and Consultant, based on the proficiency levels of teaching activity.
2. Digital Usage – using the digital competences from level 1 within specific domains (profession, leisure, entertainment, etc.), which gives the user more focused and in-depth competences. Because it is embedded into a context, the output of digital usage bears consequences onto that context or on other contexts, too.
3. Digital Transformation – is reached when the digital competences are used to produce original, progressive and creative work for one domain or another. However, DigEuLit states that the digital transformation level is not a mandatory condition to be digitally literate. Digital literacy can be reached also in the absence of digital transformation.

The three levels of digital literacy are mapped against the three phases of computer/ICT literacy concepts proposed by Martin before the DigEuLit framework. The Digital Competence level overlaps with the Mastery phase, the Digital Usage with the Application phase and the Digital Transformation level overlaps with the Reflective phase. While these phases are recognized to have evolved in time with the development of technology and the users' and society's understanding of its effects on them, in the DigEuLit framework they are integrated in the development of the user's digital literacy in time, for a given technological level of their social and individual context. The authors do not stop at proposing a framework for digital skills, but they propose several educational and supporting tools in order to achieve the framework's proficiency levels, used to both teach (for trainers) and acquire (for students) digital literacy.

The benefit of the framework is that it proposes a way to teach digital literacies in a controlled environment, based on a common curriculum and generating comparable skills. It is based on the idea of technological determinism, that the skills are developed and acquired when specific technologies are available.

However, it misses to acknowledge that new and emerging technologies, as any new commodity, are not immediately and efficiently regulated and initially they are distributed only among the population with the available resources and infrastructure to access them, while the policies meant to allow access to them to the rest of the population usually lag behind the innovation rate and can be behind the digital divide in developing countries (Wallsten, 2005). Additionally, social factors translated into individual differences in terms of (access to) education and financial power can also impact the individual's level of engagement with digital technology, and, hence, it impacts their digital skills' level (Livingstone, 2004; Livingstone, 2012; Helsper & Eynon, 2013), while cultural factors can reduce the openness of certain population segments to policies promoting technological changes (Tsatsou, 2011). Thus, the expectations for a homogenous adoption of the DigEuLit framework by the European countries, each with their own pace and direction of development regardless of some countries being (older or more recent) members of the EU, proved a risky endeavour.

While the previous frameworks were designed to be primarily conceptually comprehensible, there are more recent models which are designed to make the digital literacies/skills more effectively measured, meaning, to generate better measurement tools. With this goal in mind, the authors group the skills so that they cover as much as possible only one construct related to (self-perceived) performance.

As mentioned above, despite the evaluated advantages of DigEuLit as a theoretical and educational framework, the program was not adopted by the European countries as hoped by its proponents. Nevertheless, this framework still serves as a conceptual benchmark in other studies while it did not fulfil its potential for the educational and workforce fields.

iv. Helsper & Eynon's framework for digital skills as a mediating factor

One such model was proposed by Helpser and Eynon (2013) having the purpose to link specific digital skills as a mediating factor between contextual and personal resources which underpin the development of various digital skills, and specific engagement in online activities. The authors chose to use the word "skills" as opposed to "literacy/literacies" used extensively in previous literature, to emphasise the premises of their model is to outline skills sets as a mediator factor between resources and online engagement.

The four skill sets proposed in this framework are:

1. Critical skills
2. Social skills
3. Creative skills
4. Technical skills

The benefit of this framework is that the skill groups are applicable to more domains and proficiency levels, thus depending on the target population researchers can include items relevant for specific age groups, domains of activity and/or proficiency level, narrowing their research scope as suitable for their research questions.

However, the skill sets do not have particular descriptions of their content and the questionnaires measuring these four specific constructs include only two items per construct from which one can only infer the type of skills belonging to each group in the absence of a more detailed description and exemplification. Thus, it can be that some skills may be interpreted as both Critical and Creative, or Social and Critical and such overlaps must be carefully identified, accounted for and avoided whenever possible by any study using this framework.

The Helsper & Eynon (2013) framework is identifiable in survey tools, such the EUKO questionnaire, but at the same time as categories of various frameworks overlap so it is difficult to confirm which framework is the source of inspiration for the available survey tools.

v. Van Deursen & van Dijk's framework for conceptualising and measuring digital skills

One very comprehensive framework was developed by van Deursen and van Dijk in 2008 and revised later in cooperation with van Laar to create a new framework designed to meet the required digital skills for the 21st century technology. The focus of their initial study was to provide a framework that makes the measurement of digital skills more accurate while conceptually clarifying the content of each group. In this way they address some of the issues in other frameworks which focus mainly on one or the other of these two elements, but not on both simultaneously.

Van Deursen and van Dijk propose there are four groups of skills that underpin digital literacy (van Deuren & van Dijk, 2008). They use interchangeable the terms digital skills with Internet skills, appearing to have the same meaning in their work.

The four groups of skills in their framework are:

1. Operational skills (operating digital media using search engines, menus, links, bookmarks, etc.)
2. Formal skills (abilities to use specific structures on digital devices, such as functions in menus, hyperlinks, links, etc. to remain oriented in the pool of information available for selection and evaluation for a given purpose)
3. Information skills (ability to search, select and assess the retrieved information)
4. Strategic skills (ability to use the available digital information for a specific purpose, personal or work-related).

In comparison with Hargittai (2005) who found that the years using the Internet explains 11% of the user's skills, or Eynon & Geniets (2015) who cite studies showing a positive correlation between the lengths of experience using the Internet and the range of activities in which the users engage, van Deursen & van Dijk (2008) reported only a weak link between length of use and formal, information and strategic skills' levels. However, they report a stronger correlation was found for operational skills. This result is a good indication that the proposed framework is more refined to differentiate between the types of skills underpinning digital literacy.

Van Deursen and Van Dijk's revised framework of digital skills created in cooperation with van Laar and de Haan (2017) takes into account more skill sets and refines the concept of digital skills based on its progress with the technology of and its use in the 21st century. Thus, the group of researchers proposed the following list of skills:

1. Technical skills (using digital devices, including mobile ones, for specific practical tasks; navigate the online platform to complete specific tasks)
2. Information management
3. Communication
4. Collaboration
5. Creativity
6. Critical thinking
7. Problem solving

The authors recognise the advancement in technology, under the overarching name of Internet of Things (IoT), require an advancement in users' skills to operate and navigate them, as they become more and more complex. For example, chatting in a chat room in Web 1.0 required basic communication skills, but in the complex Web 2.0 social media environment they require in addition collaborative and social skills to both perform the technical operations, engage in and navigate the complex virtual social network with deeper implication on the users' offline social life (van Deursen & Mossberger, 2018; van Deursen & Helsper, 2015). With the progress in information storage and display, creating content requires less operational and formal skills and more creative and strategic skills.

Moreover, van Deursen and van Dijk's theoretical framework is connected with the problematic of digital divide which is a problematic with deep social implications (Livingstone & Helsper, 2009; van Deursen & Mossberger, 2018). Thus, the measuring tool based on their theoretical model can assist with building a comprehensible map of the location of different social groups on the proficiency spectrum of various digital skills categories, which are (likely to be) related to specific social issues, such as (un)employment, political and social engagement. A study which can lead to skills mapping was run with Dutch respondents (van Deursen & Helsper, 2015), but it addressed the usage of internet in order to clarify the third-level digital divide, which affects societies in which the internet access is no longer an issue among different social groups, while it remains interlinked with the second-level digital divide (classification of digital skills and their proficiency). The connection between theoretical frameworks on digital literacies and the social implications was one pillar for founding a further framework initiated by the European Commission (EC), the European Computer Driving Licence (ECDL), which will be discussed last in this section.

vi. Ferrari's framework for digital competence

Ferrari's framework was proposed as a result of her research on digital competences frameworks and measuring tools, done also for the EC. Her analysis acknowledged the confusion around the conceptual frameworks and the consequential overlapping or conflicting terminology used in research and various tools developed for measuring digital literacies (Ferrari, 2012). Ferrari tool into account the existing frameworks (the main source of inspiration being eCompetences framework for ICT professionals, available at www.ecompetences.eu) and consulted her proposal with other researchers and stakeholders and only after consolidating all these inputs she proposed the final version of DIGCOMP framework.

The framework is meant to conceptually clarify what digital competences are, according to the researcher's results. At the same time, Ferrari recognizes the need to measure digital competence and proposes a measuring tool with five groups of competences, each with a three-level proficiency scale. In Ferrari's view a competence includes knowledge, attitudes and skills (Ferrari, 2013). Therefore, her self-assessment tool measures digital competences within this definition.

However, her conceptual framework exemplifies on the content of each competences group which makes it easier to understand the included items and evaluate her classification. Moreover, the framework is set on five dimensions which clarify how to understand digital competences. The five dimensions are as follows (summarised competences described in Ferrari, 2013):

1. Competences areas – to which the framework is applicable (**Information, Communication, Content creation, Safety, Problem Solving**).
2. Competences – the content of each identified area (**Information** – identify, locate, store, organise, retrieve, evaluate information; **Communication** – communicate, share, interact, link, participate in digital environments and multi and cross-cultural online communities; **Content creation** – create, compile, re-elaborate, produce, integrate new content and media expression, within the copyright legislation applicable to that content; **Safety** – personal, data and identity protection, use consistently protective measure online; **Problem solving** – identify digital resources and needs, create solutions for these needs, generate new technologies, increase own and others' competences, solve conceptual and technical problems using and used within digital environments).
3. Proficiency levels – gradual progress in the digital competences identified (**Foundation, Intermediate, Advanced**).
4. Exemplification of knowledge, skills and attitudes included in each competences group, per each competence item and each proficiency level.
5. Applicability of the identified competences – Learning and Employability (exemplification of activities which constitute the application of a specific competence in Learning and Employability).

The first three competences proposed by Ferrari (2013) are described as linear, meaning that they include very specific activities and they can be identified and measured through these activities. The last two competences are transversal, meaning that they can be applied to any of the activities found in the first three competences. At the same time, linear competences can underpin other linear competences or transversal competences, such as Information-related competences are needed for the Content creation and Problem solving competences.

The fifth dimension, applicability of competences, was developed by Ferrari only for Learning and Employability and that makes the framework applicable for individuals of all ages. Ferrari also states that this dimension can be extended to other practical areas, such as Leisure, Entrepreneurship or Well-being.

The author provides also a cross-reference analysis among competences, as well as a guide to identify the proficiency level of digital competences and their relevance of the other seven key Lifelong Learning competences defined by the European Commission policies (European Parliament and Council, 2008) and used in the European Qualification Framework publications. The complexity of the model allows it to cover several limitations of other frameworks and that is most likely because it was designed after thorough review of the existing frameworks on digital literacies. These benefits are identifiable because the author clearly situated her theoretical framework among and in relation to other frameworks and detailed it conceptually. DIGCOMP also covers dimensions rarely covered by other frameworks, such as applicability. Applicability for learning and employability was the aim of the DigEuLit and DIGCOMP uses this intention for the two areas while building a guideline to extend its applicability to other domains. At the same times it recognises the cognitive basis of certain competences (e.g. Information, due to the application of algorithms that personalise search, or policies that restricts content per specific regions, etc), which is the basis of (lifelong) learning for any individual and this is also the premise of Martin and Grudzincki's framework.

vii. NCCA e-competences framework

NCCA – National Council for Curriculum and Assessment, Ireland, developed this institutional framework (e-Competence framework for ICT users) to be implemented in the school's curriculum and assessment tools based on the previously developed framework for ICT professionals and European Qualification Framework (EQF). It is structured on four dimensions, but it also clarifies terms such as "competence", "skills", "knowledge" and "attitudes" which are used to outline the content of the four dimensions of their theoretical model.

The dimensions proposed by NCCA are as follows:

1. Areas/categories of ICT user e-competences (Word processing, Spreadsheets, Presentations, Web Browsing and Searching, Communications, ICT Security, Database Use, Web editing, Image manipulation, etc) – which is a list in progress.
2. ICT user e-competences – includes competences for each area defined in the first dimension.
3. Proficiency levels – Foundation, Intermediate, Advanced, which are mapped against the EQF proficiency levels.
4. Examples of knowledge and skills for each competence.

The NCCA dimensions are the source of inspiration for Ferrari's framework on digital competences, though Ferrari developed further her theoretical model, making it both more complex and more detailed.

NCCA states, according to Ferrari, Punie & Redecker (2012), that all digital frameworks are tool-dependent, situating them in the deterministic perspective on digital skills. The NCCA and the European Computer Driving Licence assessment tools for e-competences are based on Windows OS and MS Office applications, which are predominantly used in schools, state institutions and by average and below average SES users. It could be a point to take for the future by researchers to include in their e-competences measuring tools items to assess the operating system (OS) the user is using in order to adjust the operation-related questions accordingly.

The theoretical frameworks on digital skills are not issue-free and the next section will try to present and evaluate some of the most pending issues in digital literacies literature.

viii. ICDL – International Computer Driving License

Mainly based on the frameworks of van Deursen and van Dijk (2008) and Ferrari (2013) for defining its digital skills domains and subdomains, all the while using a practical approach for assessment, a new framework emerged, the European Computer Driving Licence (ECDL), which later became ICDL. ICDL and its original European counterpart ECDL (commissioned by the EC), which has country-based offices, has as a mission to educate and instruct users in order to build their digital competencies to at least minimum basic level that allows them to gain more access to information, better engage in educational and workforce activities, and reduce the risk of a digital exclusion of certain social classes. It is available for all ages, and it serves as a certification center of digital competences for employers.

UNESCO joined ECDL in 1999, and ECDL (https://www.icdleurope.org/; https://ecdl.cz/o_projektu.php) became ICDL (https://icdl.org). The framework was aligned with the International Society for Technology in Education (ISTE) standards 2016, though ISTE standards have evolved since then to incorporate more functionalities of the mass-accessible technology.

As a user or trainer requiring an ICDL, they must pass certain module-based exams. The modules are specific to an area of functionality of the involved application (e.g. Word processor, Spreadsheet processor, Presentation, Email, etc.), and there are multiple proficiency levels the user can be tested on. Depending on one's experience with ICT, the tests do not build on each other and one can be tested directly at the highest proficiency level. Also, depending on the testing centre tests scenarios may be available on more than one OS, and in more than the local language. In most cases, the offered languages are the national one, and English, for an additional fee.

Though there may be limitations to the platforms on which the user tests are available, and the language of the test, the tested skills are transferable into many jobs, and in education, both for students and teachers, which makes it a very valuable and useful framework for evaluating digital skills of students, teachers, and generally of employees in any organization.

The EC funds partially such training and testing centres that help with the integration of workforce, or with providing a basic digital capability certification to primary and secondary students, which motivates the school to be more inclusive of ICT in teaching and learning.

For the purpose of understanding better the requirements for ICT competencies at an international level, which generates internationally recognised proficiency certificates required by some employers, the author of this study attended the ECDL CZ training to become an assessor for ECDL testing centres.

ix. ICT in education (ICTE) maturity model (MM) - ICTE-MM

Solar et al. (2013) build a 3D model of ICDL by adding domains and key domain areas with their own capability layers, similar to the NCCA framework, but using criteria based on ISTE 2016 model, designed by a mathematician, David Moursund and educators from K-12 educational institution and the University of Oregon with the purpose of educating, standardising and certifying the ICT knowledge and abilities of students and teachers at a national level in US (ISTE was formerly named National Educational Technology Standards-NETS). The model will more thoroughly described in Study 1 – Research Instruments section, and its full description is in Table 2 (Appendix – Section 13.1.), but it is important to emphasise that the model emerged by adapting and incorporating several well researched models, and that it evolved to answer the current needs of ICT capabilities in schools and the workplace. This study uses the model to assess the digital skills not only of students, as many of the first frameworks on digital skills targeted, but also of the teachers, managerial and administrative staff of a HEI. This approach will be further described in the next section.

2.3. Digital skills, competences and literacies clarified

Though there are many frameworks that attempted to define and/or measure specific skills, competences or literacies developed because of and used in the digital space, there is still confusion around the terminology used to link certain digital activities/tools with a concept.

ECDL Czech Republic in its mission to standardise these activities and certify users defined these terms clearly so that the users know what level and areas of expertise can expect to achieve from their training. Similarly, employers care guided by these definitions in their expectations of the expertise from their candidates.

ECDL.CZ (ECDL, n.d.)outlines three areas in the overall pool of digital activities:

1. Digital skills are defined as the user’s practical skills of working with a specific(s) digital technology.
2. Digital competences include the practical skills, cognitive abilities, and theoretical knowledge to work with ICT tools for specific purposes.
3. Digital literacies which must include specific competences, motivation of working with ICT and/or developing certain skill/competences, and the strategic knowledge of knowing the risks and benefits of working with ICT and digital information.

Digital competences cand be operational, which in turn can be transferable, non-transferable, and specific, and professional, which are certified outside ICDL (ECDL, n.d.).

Transferable competences can be wider or narrower, and that gives them the expertise level. Having practical skills and theoretical knowledge in one or two areas of ICT (e.g. Word processor, Number processor, Presentations, File management, etc.) gives the user the competency level of Digital Awareness. Four-to-five areas of competences translate into competency level of Digital Literacy. Having mastered specific modules at level B1 and including specific modules, such as working with images and videos or digital marketing, gives the user the competence level of Digital Competence. The highest level of digital competences, Digital Expert, requires specific skills on top of those in the prior level, such as data processing, or financial analysis, and are required for highly specialised jobs and activities (ECDL, n.d.).

ICDL outlines the need to split the terms based on their content and other frameworks aligned with ICDL (or vice versa), such as ISTE or DIGCOMP, use such a conceptual taxonomy implicitly. The philosophy of the taxonomy is not always explicit on country sites, but it can be summarised as a gradual development of one’s engagement with ICT by starting from a practical skill and building up competences by adding knowledge and practical experience in more areas, while understanding the risks and benefits of digital technology overall and in specific activities in our digital society.

In this thesis, the concepts of digital skills and digital competences will be used according to the ECDL.CZ taxonomy and definition.

2.4. A multi-layered reality of ICT use and digital skills in education

In the absence of a single research framework to capture the complexity of digital skills and use of ICT in education (Gibson et al., 2018), this thesis proposes that the multi-layered reality of the adoption of ICT in education and its effects on students' academic performance should be investigating using the bioecological model, or the ecological system theory proposed by Uri Bronfenbrenner, applicable from human to systemic development, and from social to cognitive and digital skills (Rosa & Tudge, 2013; Edwards et al., 2016).

Bronfenbrenner proposed there are several interdependent levels which affect the way experience (as information processed by the unique processing pattern of the individual) is understood, internalized, and transformed into values and beliefs that underpin further information processing, behaviour and decision-making, thus influencing the entire development of the individual (Rosa & Tudge, 2013; Bronfenbrenner & Evans, 2000). The layers of his bioecological theory, which is the latest version of his theory, were named, and their content was outlined, as follows:

- the microsystem (items in direct proximity and interaction with the developing individual);
- the mesosystem (the interactions between two or more microsystems in which the individual is an active participant);
- the exo-system (the system which indirectly affect the individual's development though they are not an active participant or determinant in its activities);
- the macrosystem (items of influence over a larger group, such as political, educational, social systems);
- the chronosystem (important historical events which influence the dynamic of the setting in which the developing person is active, and that can be normative or non-normative).

When analysing the ecology of ICT in teaching and its effect on students' performance in this study, several factors from Bronfenbrenner's theory are considered, measured, and combined within the given design, in order to produce an accurate image of how the ICT systemic and individual factors interact to influence the efficiency of ICT in HE. Such an approach has been used by other researchers to investigate the digital disconnect phenomenon between home and education institutions and its effect on children's digital skills (Edwards et al., 2016). The presented studies are based on the premise that digital skills are continuously developing within an ecological system framework, with an input level of participants' digital skills, school infrastructure, and teacher abilities that help students acquire knowledge and develop further their digital and reasoning abilities.

The micro-system factors considered in the present studies part of the thesis are the student's own digital skills, the ITC and non-ICT methods students used in their learning and that were made available to the students in classes (which are reflected in the intervention implemented in classes), as well as other factors identified in the semi-structured interviews (Study 2) related to students' and teachers' abilities to enhance learning using ICT and non-ICT methods and tools, and student's motivation to learn.

The meso-system factors are related to the interaction between specific micro-system factors, and the interaction between micro and exo-system factors that can influence the performance of students (e.g. the intensity of ICT use in class, for communication with teachers, administration and peers, etc).

The exo-system factors considered are the HEI DM indicators as measured in the questionnaire and interview with the HEI departments about the existence of internal procedures and policies for using ICT in the management and administration of the school, and its infrastructure development, the HEI size (small) and field of its educational programmes (social sciences). The size of the HEI can determine the financial support received to design the school processes, its organisation, split of roles, adoption of technology in its functioning, and the selection of the academic and non-academic staff to meet its strategic and short-term goals. Larger HEI require the inclusion of ICT to a higher extent to manage a higher number of students and staff, and to optimise its core activities, and being a small private HE does poses budgetary constraints to these activities (AL-Ali & Marks, 2021). The field of study may determine the range of ICT tools that can be implemented in teaching as a minimum standard, with technical universities requiring a larger inclusion of ICT in delivering the technology-based subject matter, compared to social sciences HEIs.

A similarly important and focused on evaluating the use of ICT in education however ubiquitous the ICT tools are, is the Lifecycle approach, or M3 evaluation framework (Vavoula et al., 2009). It proposes the evaluation of the use of a specific ICT tool as the focal point in a system created by the interaction of ICT and other educational methods.

The M3 framework has three levels (Vavoula et al., 2009), whose meaning should not be confused with the levels of the ecological system theory bearing the same names:

(1) Micro level – the individual use of technology to engage in learning a specific subject matter;

(2) Meso level – the overall learning experience and its interaction with other learning experience on the subject matter;

(3) Macro level – the long-term learning and educational experience using technology and other teaching methods, with effects on students, teachers, and educational institution alike.

The M3 levels of technology use in education will be one framework included in the discussion of the findings of the two included studies, though the study designs are not purposefully mapped for its use, but because these theoretical frameworks partially overlap, they can be employed in discussing the findings. However, the greatest disadvantage of the M3 model is the focus on a single ICT tool at a time, which implies a research design in which no other ICT tools can be used at the same time, or else confounding results may be generated.

The field of study may also determine the teacher's expectations about students' digital skills needed to complete their assignments, but also it may inform the teachers' level of digital competencies. More technical subjects have a higher basis of both teachers' and students' operational and technical understanding of the used digital tools. Nonetheless, in fields more distant from technology, such as social sciences, adopting technology in teaching may create resistance from teachers who have more difficulties using technology, reflecting the importance of teachers' digital and pedagogical skills and attitude toward technology on the use of ICT in teaching (Shelton, 2016; Prestridge et al., 2019; Langan et al., 2016).

One macro system factor considered for the purpose of building a model of the works of ICT use in HEI is the attitudes toward technology in the Czech Republic. At an institutional infrastructure level in the Czech Republic (CR), and specifically in Prague where the included HEI is located, such a level evaluated from the collected data form the respondents, and separately by the author against the Czech national ratings, based on figures from the National Statistics Office (Český statistický úřad - CSU) against an EU average. Among the considered figures are 2022 CSU reports that show that the enrolment in tertiary education in ICT field is slightly over the EU average, while in CR the drop-out level is almost 15%, and almost 90% of students are male, which gives us a benchmark of digital skills in ICT fields, while students enrolled in social sciences HEI would rank behind ICT and other technical and natural science HEIs. Additionally, on average ICT HEI infrastructure in Prague-based HEI allows on average

16% of classrooms to be connected to internet, 57% to have an intranet system, 95% to have a school Wi-Fi connection, and 62% allowing their students to use their own device in class (Český statistický úřad, 2022). Along with figures showing that in 2022 100% of students over 16y of age were using internet for various personal and educational activities, 81% of the general population is using the internet, and that 31% of the CR population (non-legal entities) and 6.4% of population representing a legal entity has an internet subscription registered on their name (not at a household level), these figures indicate that in the Czech republic is a rapid technology adopter, and its evolution is close to the EU average levels (Český statistický úřad, 2022) despite it becoming a private capitalist democratic state, and an EU member later than many of its members.

Regarding Czech national figures on digital literacy in adults that would represent the majority of academic staff, reports show that a maximum of 12.4% of individuals over 45y of age (which represents almost 70% of the teaching staff at the HEI included in this study) can use a software to create a presentation, on average 14.5% of individuals 45y or older can use a Word processor to include images or graphs, and on average 10.4% can use certain functions (e.g. filters) in a number processor. The percentages are higher for individuals with a higher education without a split per age groups, but on average in the education field 39% of individuals can use a presentation software, 44% can use a Word processor with additional functions, such as inserting images and graphs, and 26,6% can use a numbers processor with additional functions, such as filters, or functions. For the group age of 45y and older, CR remains behind the EU average on several digital literacy sections, however it is slightly above EU average in the group of individuals with a higher education degree per all age groups (Český statistický úřad, 2022).

From a macro-system perspective it is clear that there is a plethora of taxonomies of digital skills per more or less technical competences, or aligned with specific computer applications (Martin & Grudziecky, 2006; Eshet, 2004; Aviram & Eshet-Alkalai, 2006; van Deursen & van Dijk, 2008; Helpser and Eynon, 2013), and the need of a standard framework triggered in the last decade international governmental institutions, such as the European Union, and UN, to allocate grants for the development of, and selected several platforms that outline digital skills more consistently with the current use of ICT in education and employment (Volungevičienė et al., 2021). The current study uses an ICT assessment tool which is aligned with the UNESCO SDGs standards, the NETS (Solar et al., 2013; ISTE, n.d.), and aligned with the ECDL criteria used to assess ICT users' digital skills (ECDL, n.d.).

The studies included in this project propose that assessing the effectiveness of using ICT in education by the impact on the student's performance in class cannot be separated from the level of digital skills and competences of students, and from the digital skills and competences of teachers, administrators, and managers of the HEI in which they learn. They are all members of a connected system, and the students are at the less powerful end of this system, thus being more influenced by it than the HEI can be by its students' digital capabilities.

3. RESEARCH OBJECTIVES

Social sciences make less use of digital tools in teaching and rely more on conservative means in teaching and assessments (Langan et al., 2016). This research project uses a combination of methods, in an overall case study using both quantitative (structured questionnaires and experimental interventions) and qualitative (semi structured interviews, class observations, qualitative feedback, interview with IT employees) methods within a case study, to understand whether introducing ICT in the teaching of non-technical social sciences subjects (social sciences – Economic Policies, Global Economy Studies, Political Economy of the EU) can increase the performance of the students on understanding the subject matters.

These subjects are taught traditionally without the aid of any application, or with a minimum use of MS Office apps (PowerPoint presentations for the lecturer, MS Outlook and/or IS email and MS Teams for teacher-student communication, MS Word and PowerPoint for seminar assignments). The intervention in the project consisted of:

1. The use of applications and sites appropriate for the course content in the delivering of the course material and basing the seminar exercises on ICT resources' functionalities.

2. The design of class assignments that are based on the use of certain applications, databases, and SW making use of ICT skills (creativity and innovation, communication, technology and operations concepts and skills, critical thinking and research planning, digital citizenship, research and information fluency) part of ICTE maturity model proposed in Solar et al. (2013), based on ISTE (2016).

The research aims are as follows:

1. To assess the digital skills and competences of the students participating in the study and interviews, who study at small private HE institution operating in the field of social sciences, or attended the courses as Erasmus students for the period of the research project;
2. To identify whether there is any relationship between the students' digital skills and competences and their performance in class, and to measure any such found relationship(s) using appropriate statistical tests;
3. To evaluate whether varying the use of ICT-based teaching methods in class changes the students' performance in class, and to measure any such found relationship using appropriate statistical tests;
4. To assess the overall digital maturity level of the HEI using an ISTE-based maturity model;

5. To identify whether there is any relationship between the digital maturity of the higher-education institution and the students' performance in class, and to measure any such found relationship(s) using appropriate quantitative and qualitative methods;
6. To identify the common themes occurring in students' views on the role of ICT used by the higher-education institution in teaching, communication, and administration, using qualitative research methods;
7. To use the existing frameworks of understanding digital skills and competences in an integrative manner in order to capture the complexity of the use and development of such skills and competences in real educational activities and settings;
8. Depending on the research findings, to create a list of areas of improvements in the use of ICT for education and administration purposes that the institution's management and teachers can implement to improve the quality of the teaching activities.

Based on the above research aims, the research questions set for this study are:

RQ1. What is the relationship between students' digital skills and competences and their performance in class?

RQ2. What is the relationship between the intensity of ICT use in teaching and the students' seminar assignment performance and exam performance?

RQ3. What is the relationship between the digital maturity (DM) of the higher-education institution (HEI) and the student's performance in class?

RQ4. What is the perceived role of ICT in teaching from the perspective of the students?

4. RESEARCH STUDIES

4.1. Study 1 – Measuring the Maturity Level and Digital Skills in a HEI in the field of social sciences

4.1.1. Design

The study is a case study focused on the assessment of digital skills and competences in students and the digital maturity of a HEI in the field of social sciences. The study also assesses the use of ICT tool in teaching the three courses at the centre of the research. For this purpose, the author used a pedagogical intervention by including ICT tools in each of the courses to a different extent.

The study includes several sources of data, to ensure triangulation. The assessments are done using quantitative measurements of ICTE-MM capabilities.

The students' seminar assessments were assessed by two teachers, and the coder alignments Cohen's Kappa was computed in SPSS.

The students' digital competences were assessed outside the classroom's tasks by the HEI's teachers using Google forms questionnaire based on the ICTE-MM criteria (Solar et al., 2013; ISTE, 2016).

In addition, the students participating in the three included courses completed a self-assessment questionnaire of their digital skills, based on a comprehensive Information Technology Self-Assessment Tool developed by Virginia Niebuhr, Donna D'Alessandro and Marney Gundlach in 2009, who are researchers at the University of Texas Medical Branch (Niebuhr et al., 2009).

The institution`s DM was assessed by the HEI employees from the IT department, administration, management, and academic staff, using Google forms questionnaires based on the ICTE-MM criteria (Solar et al., 2013; ISTE, 2016) for their respective are of work, and in the case of IT and management there were in-person questionnaires completion and clarification questions. The DM scores of the school and included courses were also quantified by students in the semi-structured interviews.

The institutional data was triangulated by collecting qualitative data from the IT department, and observations of classes of seven teachers who taught in our department in the academic year 2022/2023, to which all the included students belonged, to corroborate them with the information from the questionnaire-based assessments and the semi-structured interview from the second research study.

No triangulation of data from methodical observations or interviews was possible for the data collected from the administrative staff. Event-based observations and data were used to assess the maturity level for this domain aside from the questionnaire-based data.
At the end of each course examination, which were performed orally for the purpose of this research, each examined student was asked about the teaching methods, digital or traditional, that were helpful for them to comprehend the course material, which allowed the extraction of qualitative material from a total of 33 students, for three courses, but with a total of 56 feedbacks as some students attended two or all three courses.

4.1.2. Pedagogical intervention

The author has received no guidelines from the HEI about the use of ICT in teaching or any other teaching methods for the classes. The available HW infrastructure and SW were sufficient to display a PowerPoint presentation and start a live streaming of the course using MS Teams, and it also allowed with difficulties, due to the settings, to switch from presentation to browser or to other SW, indicating there was little consideration given to the range of ICT materials that could have been used in class.
The materials for the three classes taught by the main author of this paper were designed to have different proportions of ICT tools used in teaching and the additional seminar activities. The number of taught classes was of 12 for one course (Political Economy of the EU – Course1), and of 24 (12 lectures and 12 seminars) for the other two courses (Global Economy Studies – Course 2, Economic Policies – Course 3).
The detailed use of ICT tools for each class are captured in Table 1. All lectures and seminars for all courses made use of ICT in the form of: MS PowerPoint presentation (for teaching and as seminar assignment), video projector, PC, manual presenter, MS Teams for class streaming and communication with students during streaming and outside class, school and MS email, school Information System (IS), course handouts uploaded in IS, reading material in electronic form, TedTalks videos.
In addition to these ICT tools, Course 1 made use of:

- specific websites to view EU institutions' video streaming, informational databases, and other information for public use (EU Commission, Council of the EU, EP and EP multimedia center, European Court of Justice, Council of Europe);
- mobile applications that allowed the user to learn about EU policies for specific states and regions, about the citizens' rights and initiatives, European Parliament's events, etc

(EU Simulator, EU Council Voting Calculator, EU Council, EU Committee of the Regions, Europe flags and maps, European Solidarity Corps, Citizens' App, EP Events).

- a browser-based EU Council voting simulation application;
- statistical data platforms where students could search for and retrieve data on EU member states (https://ourworldindata.org/, https://www.digitalatlasproject.net/).

In addition to the common ICT tools, Course 2 made use of:

- specific websites to statistical data relevant to the course content (https://www.marinetraffic.com/, https://free.flightradar24.com/, https://ourworldindata.org/, https://www.digitalatlasproject.net/, https://data.worldbank.org/, https://stats.oecd.org/);
- course specific videos (e.g. Yuval Noah Harari on nationalism and globalism, Ambassador Alan Wolf on the resilience of multilateral trading system)

In addition to the common ICT tools, Course 3 made use of:

- specific websites to statistical data relevant to the course content (https://ourworldindata.org/, https://www.digitalatlasproject.net/, https://data.worldbank.org/, https://stats.oecd.org/);
- specific information source for economic policies (https://www.rand.org/).
- course specific videos (e.g. Political Theory – John Maynard Keynes, Kate Raworth TedTalk on sustainable economy design).

Conservative non-ICT teaching methods, such as lectures, discussions on course content, were also used in all three courses. In addition to these, non-ICT methods such as policy proposal, negotiation and voting simulation on an EU policy (only for Course 1), and field trips to sites relevant for the subject matter were included in the course activities for all courses.

Table 1. Teaching teachniques used in the courses included in the study

Teaching techniques	Course 1	Course 2	Course 3
ICT-based	Links to data and news	Links to data and news	Links to data and news
ICT-based	Videos	Videos	Videos
ICT-based	Presentation	Presentation	Presentation
ICT-based	Handouts	Handouts	Handouts
ICT-based	Reading materials	Reading materials	Reading materials
ICT-based	Projector	Projector	Projector
ICT-based	MS Teams	MS Teams	MS Teams
ICT-based	IS	IS	IS
ICT-based	Email	Email	Email
ICT-based	Facebook	Facebook	Facebook
ICT-based	Links to institutional data/instructions/legislation	Links to institutional data	Links to legislation
ICT-based	Mobile applications		
ICT-based	Live streaming of EU communications		
ICT-based Practical	Activity simulation (negotiation and voting)		
Practical	Field trip - exhibition 18.10 https://matterof.art/2022 https://www.ghmp.cz/en/exhibitions/biennale-matter-of-art-2022/	Field trip 8.12 https://www.ghmp.cz/en/exhibitions/john-wehrheim-paradise-lost/	Field trip - CNB 3.11 23.11 https://www.dox.cz/en/visit-us
Practical	Discussions	Discussions	Discussions
Conservative	Lecture	Lecture	Lecture

4.1.3. Research measurements

As a measure of students' digital skills and competences applied to the courses' knowledge, the course assignments were in the form of a presentation on a course topic. The content and form of the presentation, including the digital citizenship level (e.g. presence of citations, citations' style, bibliography), were assessed using the ICTE-MM criteria (Solar et al., 2013) for students. Exam grades were also recorded as relevant for the performance to assimilate and evaluate course-relevant material delivered using ICT tools and traditional methods.

Qualitative feedback on the teaching methods was recorded for each examined students, as well as in lengthier semi-structured interviews with 11 students.

4.1.4. Research Procedure

The course intervention was delivered per the agenda set in the beginning of the semester. The assignments were presented in class by students starting with week 7, after the course lecture, within the last 40 minutes of the class. The questionnaires for students were made available from the first week of the course throughout the academic year. The questionnaires for the HEI staff were made available in mid-October 2022 and closed in June 2023. The interviews with the HEI IT employee and the school rector were performed in January 2023. The class observations were performed throughout the school year, starting with November 2022.

The class exams took place on several days in December 2022 and January 2023. For each class there were three different dates made available when students could come and take the exam (one in December 2022, two in January 2023). The course feedback was obtained after the oral exam from each participating student (N=33) with a total of 56 feedback responses for all 3 courses.

4.1.5. Research Sample

The participants in Study 1 were three IT employees of the HEI, three managerial employees, 43 teachers (respondents to questionnaires), 7 teachers (class observations), three administrative employees, and 34 students.

The HEI where the participants were working or studying at the time of the study is a small private think tank, with bachelor and master programs in Czech and English languages accredited by the Czech Ministry of Education, Youth and Sport (MŠMT). According to the official extracts provided to the author by the school administration and IT, the school employs 170 teachers, out of which 41 are female and 139 are male, with the average age per gender of 51 years. Out of the 170 teachers in the school data base, based on author's verification of teachers active in the academic year 2022/2023, in the fall semester only 89 teachers had at least one course in their schedule, and in the spring semester 72 teachers had at least one active course in their schedule, and 54 of all had active course in both the fall and spring semesters. Several teachers not teaching regular class in the academic year 2022/2023 were active as guest lecturers, but their number could not be confirmed.

Out of the 45 registered students for the three courses, the collected data was only from 34 students due to late registrations, no attendance, no assignment submission and/or no participation in the exam. Out of the 34 students 28 were evaluated in Course 1, 13 from Course 2, and 14 from Course 3, which shows some overlapping of the groups between courses.

4.1.6. Research Instruments

The sssessment of students' digital skills as performed with the Information Technology Self-Assessment Tool (Niebuhr et al., 2009).

For the digital maturity of the institution the ICTE – MM from Solar et al. (2013) was used for Management and Infrastructure, updated with the new entries from ISTE 2016 standards for School administrators, Teachers, and Students.

The ICTE-MM in Solar et al. (2013) includes five domains: Management (MAN), Infrastructure (INF), Administration (ADM), Teachers (TEA), and Students (STU), evaluated using questionnaire tailored for each domain.

Each of the five ICTE-MM domains (D) included specific Key Domain Areas (KDA), and each KDA includes specific Critical Variables (*CV*). For each *CV* there is a Capability Level (*CL*) rating, on a scale of 1-5 (1 being the lowest) and the *CL* of each KDA is calculated using the following general formula:

$CL_{KDA} = Average[\text{CAP}(CV_1)*W_1, \text{CAP}(CV_2)*W_2, \ldots, \text{CAP}(CV_n)*W_n]$ (Solar et al., 2013, p.2013)

For this study the used KDA with their respective CV are listed in Table 2 (Appendix – Section 13.1.). For the ADM and TEA and domains, Solar et al. (2013) collapsed the *CV*s into a KDA definition, that correspond to the National Educational Technology Standards (NETS) for administrators, and teachers. The TEA questionnaire included five KDA-based questions for the respondent's own performance and five similar questions asking the respondent to evaluate the overall performance of the HEI teachers on the same KDAs.

The STU CVs used in the questionnaires for the HEI teachers were used in the seminar assessments evaluated by the author and a second teacher independently.

Determining the Digital Maturity (DM) of an organisation can be done in four ways, according to Solar et al. (2013):

1. Establishing the minimum *CL* among all KDAs;
2. Calculate the average *CL* of all KDAs
3. Using a pre-determined KDA configuration from an existing model
4. Configuring a model with all high-priority KDAs, using a set of minimum *CL* values for all KDAs included.

The DM of the analysed HEI was calculated by averaging the *CL* of each KDA per the respondents' answers in the domain-specific questionnaires (option 2). The approach was different from the one used in Solar et al. (2013) (option 4), as the analysed institutions differ and the high-priority KDAs could not be aligned without further information from the HEI management.

The answering scales used were carefully designed to match the CV in the question, per Solar et al. (2013) model, as listed in Table 3 (Appendix – Section 13.1.). All the answering scales were coded from 1-to-5, with 1 being the lowest level of the assessment.

The capability level of each KDA Maturity Level (ML) score was evaluated on a scale from 1-5 with the following definitions (Solar et al., 2013):

1 – "Initial" - the capability is lacking for the specific KDA; 2 – "Developing" - there is an unstructured and informal capability; 3 – "Defined" - there is a structured and documented capability; 4 – "Managed" - there is a structured capability, it is formally defined and measured using automatic tools based on which it is assessed and improved; 5 – "Optimised" - there is a structured capability, it is formally defined and measured using international standards and best practices, and automatic tools based on which it is assessed and improved.

HEI teachers' evaluations of students' digital competences are compared with the seminar evaluations of the digital competences in the courses included in this study.

The ML computed using option 2 of Solar et al. (3013) methodology was triangulated with information from class observations for KDA_{TEA}, from interviews for KDA_{INF} and KDA_{MAN}, and event-based observations for $KDA_{ADM.}$ For KDA_{STU} the data was triangulated with quantitative data from seminar assignments (evaluated by a second coder) and qualitative data from exam feedback and semi-structured interviews. Two measurements of the ML were computed, one using the questionnaire data, and a second using the data from the triangulation methods employed.

The statistical analysis of the collected data includes:

- descriptive statistics to compare the means of students' performance in each course evaluated by teachers in questionnaire and seminar assignments, and the differences between the teachers' self-assessment of digital and pedagogical skills and their assessment of the others teachers' skills.
- descriptive statistics to report the levels of students' self-reported digital skills, the HEI digital capability levels reported by administrative, IT and managerial staff.
- independent t tests to investigate whether there are differences in digital skills between gender groups.
- linear regression tests to investigate which ICTE-MM areas are statistically significant predictor of exam scores.
- correlational tests to investigate the relationships between students' digital skills, assignment scores, exam scores and the DM of the HEI and of the classes.
- frequencies of occurrence of key words when performing content analysis of course qualitative feedback.
- Cohen's Kappa coder agreement rate between assignment evaluations coded by two teachers.

The criteria for each domain of the ICTE-MM used in assignments evaluation were agreed upon by the two coders before handing over the assignments to the second coder. An example assignment was used to work out the application of the criteria for the coder's evaluations. Certain criteria were excluded from the coders' agreement computation due to the impossibility for Coder 2 to evaluate them. Communication criterium was excluded because in Coder 1's evaluation was included also the oral presentation of the information, at which Coder 2 was not present. Plan and Conduct Research and Manage Projects were excluded because in Coder 1's evaluations of these factors were included the timeframe of assignment submission and the student's level of comprehension of assignment's requirements in the context of the provided information in class, aspects to which Coder 2 was not privy to the needed extent to compare the evaluations.

Coders agreed to evaluate the ratings of the field where Cohen's Kappa is lower than .7, indicating a threshold between medium and strong agreement. A review was not needed, as the lowest rating was .707 in Creative thinking.

The procedure of interpreting the data includes comparisons between results from various sources to capture the complexity of the factors influencing the range and methods of using ICT in education with its potential effects on the students' performance. The discussion proposes interprets the results based on the statistical tests and qualitative methods results (content and thematic analysis) and interprets the differences between data collected from different sources for triangulation purposes by grouping them by sphere of influence on the use of ICT in education using the ecological system theory, and as described in the introduction. In the study discussion results from the qualitative study are incorporated (class observations, event-based observations, semi-structured interviews), as well as national statistics from the Czech Statistics Office that capture institutional and individual use of ICT in education and generally, to set a national benchmark for the use of ICT against the included HEI is evaluated. The results are also thoroughly discussed against the included literature.

The questionnaire data was collected using Google forms, in several cases using assisted manual entering of the data in Excel, and all the data was processed using SPSS v28.

The qualitative data collected through course feedback was recorded manually by the teacher (author) and processed using content analysis. Frequencies for each category were computed using SPSS v28.

4.1.7. Study 1 results

The HEI is a small private think tank, with bachelor and master programs in Czech and English languages accredited by the Czech Ministry of Education, Youth and Sport (MŠMT). According to the official extracts (Figures 1-3) provided to the author by the school administration and IT, the school employs 170 teachers, out of which 41 are female and 129 are male, with the average age per gender of 51 years, out of which 54 had at least on active course in both the fall and spring semesters. The distribution of all registered teachers in the school database per their age, gender and type of contract is illustrated in the figures below (Figures 1-3).

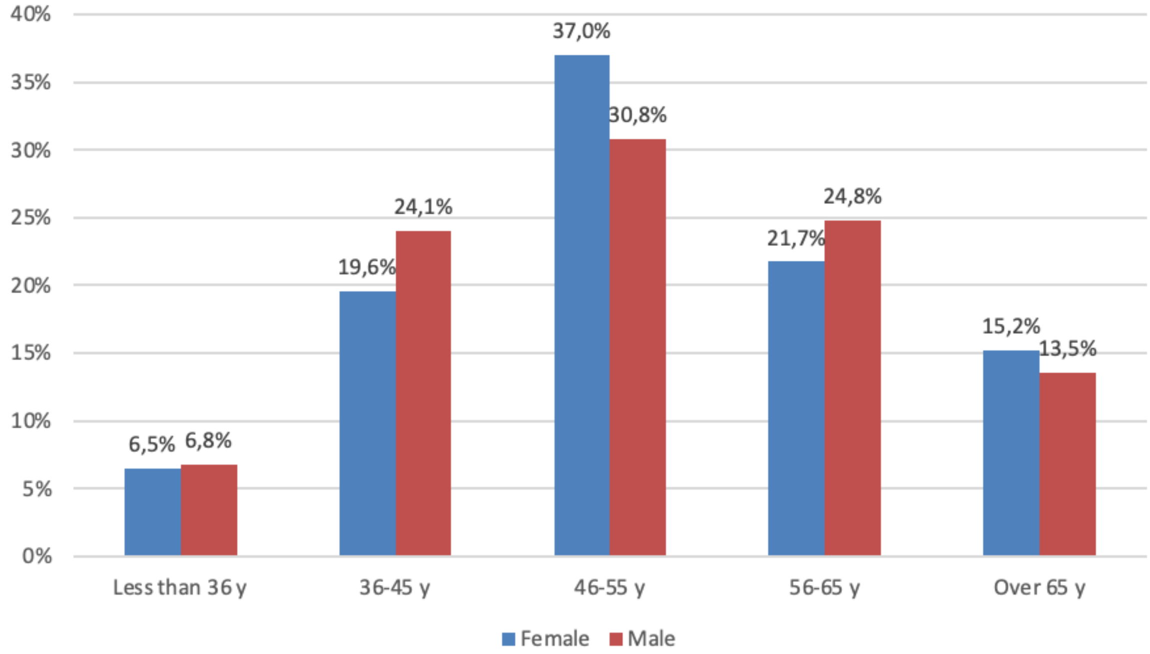

Figure 1. The distribution of teachers in the HEI per gender and age groups

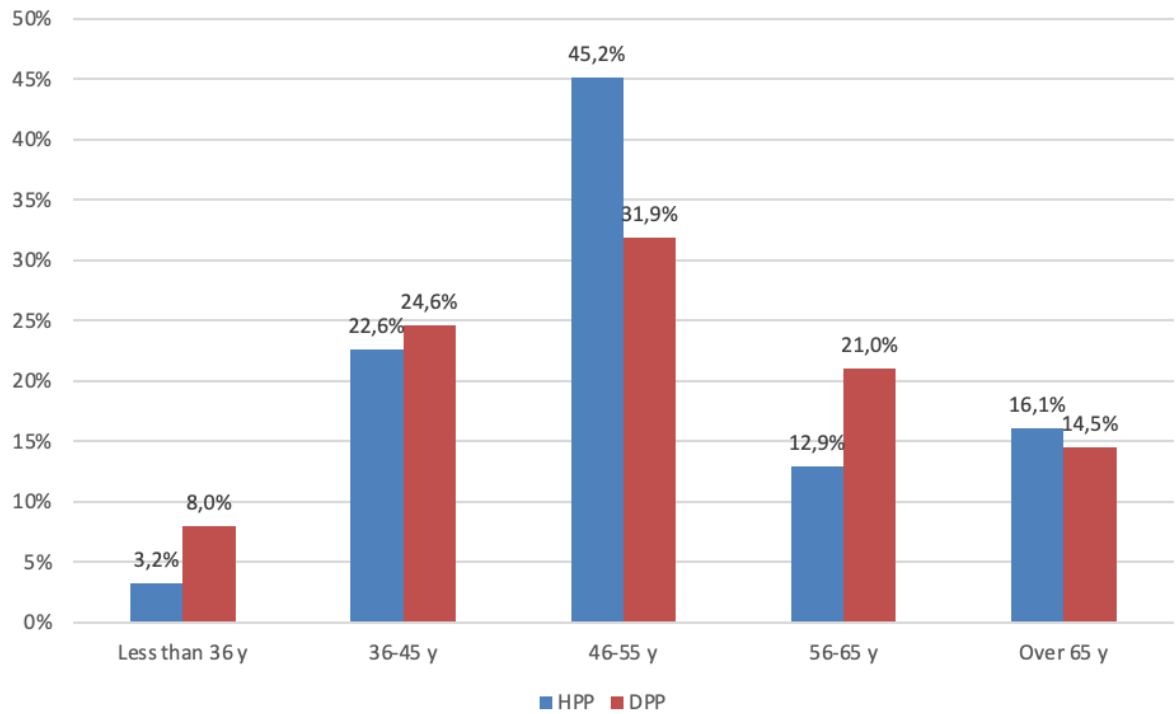

Figure 2. The distribution of teachers in the HEI per type of contract and age groups

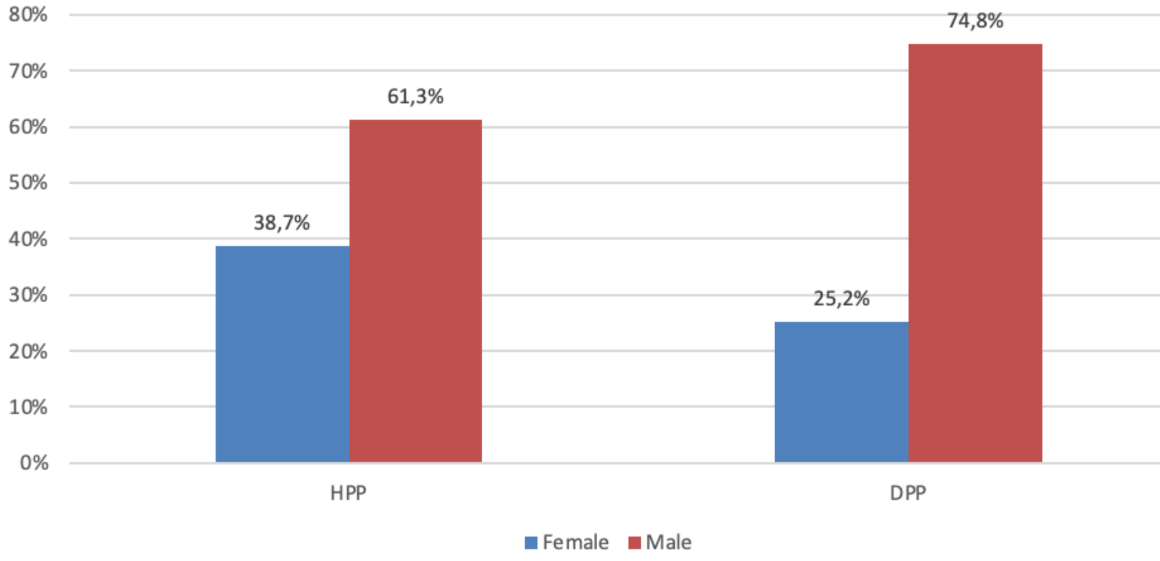

Figure 3. The distribution of teachers in the HEI per type of contract and gender groups

Part of this thesis' objective is the assessment of the HEI's DM, which can be done in four ways, according to Solar et al. (2013) (p. 35 of this document).

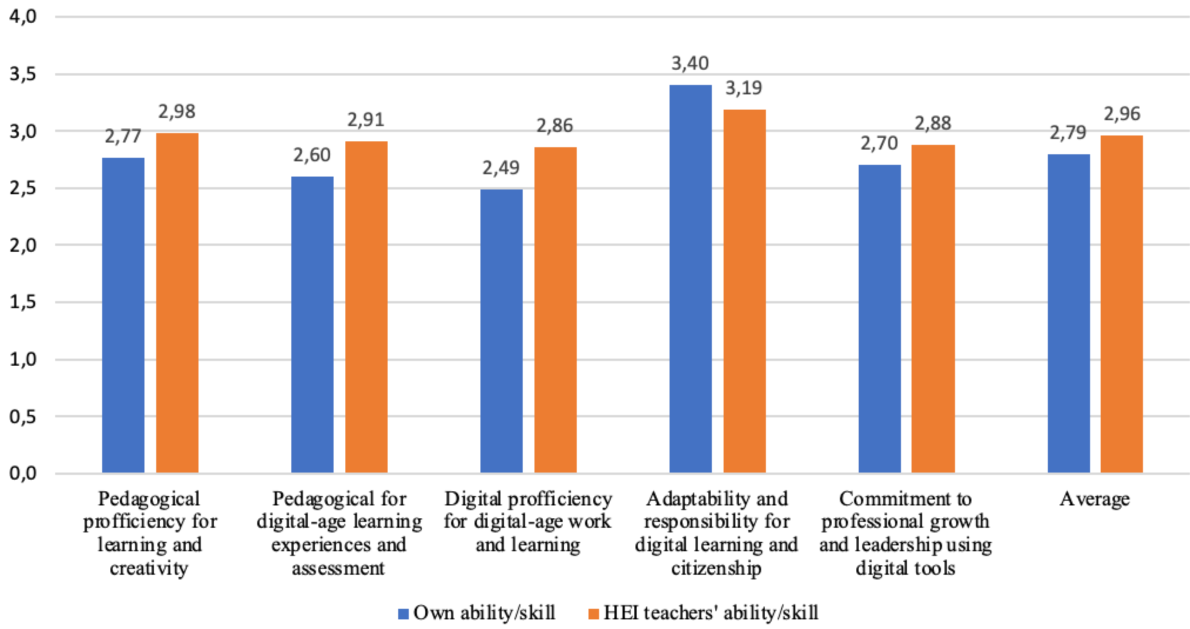

Figure 4. Mean estimate of own and other teachers' ICT-related abilities/skills

The figures resulted from the ICTE-MM-based questionnaire will provide information for answering RQ3. As such, Figure 4 shows that teachers consistently evaluated their own digital competences as lower than the overall level of the HEI teachers, except for one KDA – Adaptability and responsibility for digital learning and citizenship. The figures indicate that overall teachers are aware of the importance of adopting ICT in their teaching, and possibly of the gaps in their own skills and/or competences compared to those of their peers.

Teacher's evaluation of students' digital competences compared to the evaluations of the digital competences in the courses included in this study (Figure 5) are lower on most criteria, except Communication and Collaboration, where most teachers consider students communicate and collaborate more using ICT than observed and measured in the three courses. It is important to emphasise that the other HEI's teachers evaluated students without any guidance about the content of each criterium, nor using a systematic evaluation of their class activity. This overall evaluation of other teachers is compared in this study with the author's evaluation of students' performance based on their seminar work.

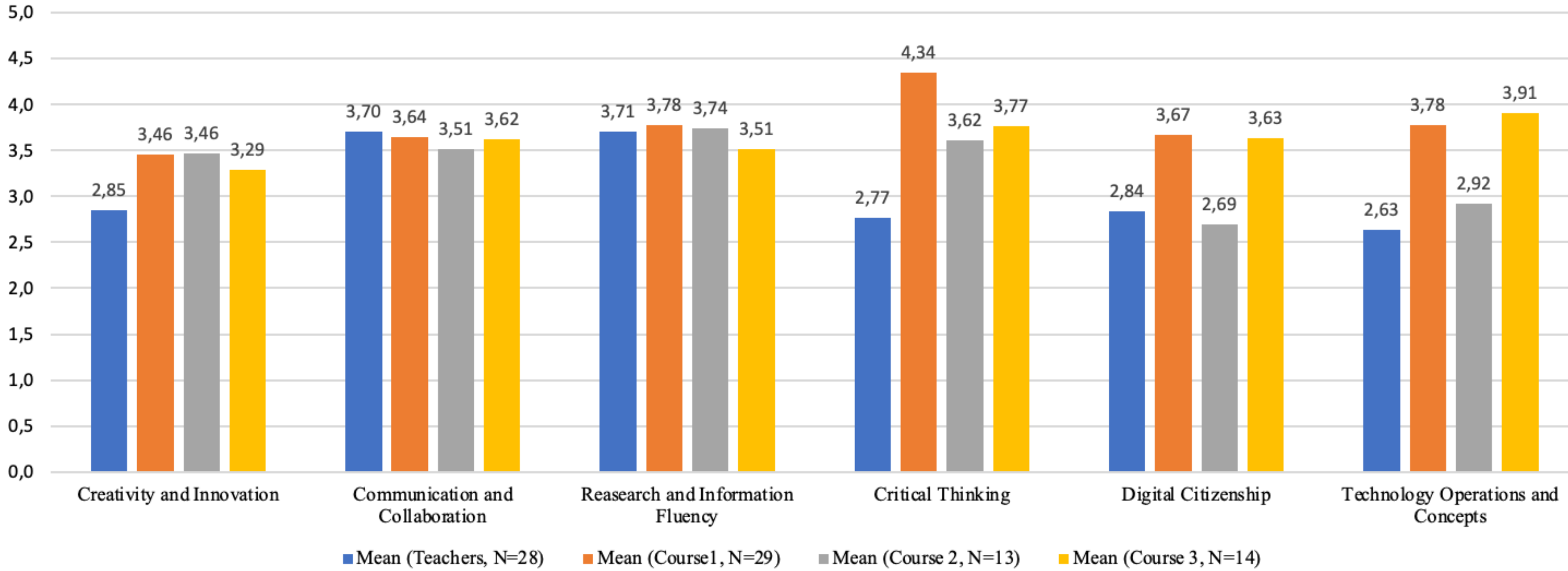

Figure 5. Evaluations of students' digital competences by HEI teachers compared to Courses 1-3 seminar evaluation scores

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
Management (N=3)	School Management	2,44	2	2	Based on the manual data collection with the school's rector formal plans had not been drafted, so ML was assessed as 2. There were only 3 individuals listed under managerial staff, one of which was an external collaborator. Some of the administrative employees had partial
	Vision, strategies and Policies	2,67	3	2	
	Organisation & ICT Management	2,58	3	2	
Infrastructure (N=3)	Software	2,00	2	2	OS-Closer to expiration, or there is an upgrade planned, there is a preparation for the upgrade. Upgrade is done at every two versions, or more. Authority lies with IT, IT prepares a budget a year prior to the upgrade. The management needs to approve the budget. Some differences between the required and approved budget can happen - nomber of licenses, etc. Meeting ad hoc with the management about the needs of the school. Long-term plan for the basic SW, MS Office, MS Tems - basic, MS 360. Licenses for the number of devices. For students only the browser version is bought, not the installed application. IS - full functions - guidance from MUNI, Upgrade and invoices every 6 months.
	Network	2,00	2	2	Network of T-Mobile, if the provider offers an upgrade, the approval is requested by IT for the additional budget. Max 2 months needed for approval if HW upgrade is needed. Wi-fi is supplied by a different supplier O2 - is more overloaded, and it is separate from the internal network. Firewall is only on the internal network, it's planned to extend it to Wifi. Certain pages and applications are blocked.
	Hardware	2,00	2	2	Upgrade serveru after 7 years, migration is gradual, refresh is done ever 5-7 years. DR site - basic data is saved. Security is set per user (management, administrative, IT, students, teachers) for oneDrive and Intranet. Standard procedure for the computers in classrooms. Individual login credentials for each individual. Students and teachers can use the classroom computer with a generic ID or own ID. Generic ID and password and instruction for login are available next to every notebook in each class. Notebook, projector, cameras, presenter are basic. Additional HW is requested and evaluated on merits.
	Maintenance Plan	2,33	2	2	Lifecycle maintenance - servers Notebook, cameras, projector - issues addressed on incidence-basis There was no device maintained on a regular formal plan There are some spare parts or new devices in storage - are used on incidence occurence - there is no immediate purchase to have a minimum number of items in storage. Spare parts and projectors are replaced immediately, not to affect the teaching process. Servers, notebooks, are not immediately replaced. There is a formal plan for the DR site storage, archive of email communication. - outsourced - communication ad hoc, every quarter.

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
	Security	Outsourced	1	1	Servers are protected by network's provider's security protocols. Only internal connections are set-up internaly: Wi-fi, computers in offices. IT can access them remotely, users have individual logins and one generic is used by all. Wi-fi password is visible to everyone, internal or external, not changed. No firewall for the Wi-fi network. Before the end of the second semester a security attack on the management's personal accounts occured, providing additional information abour the security level of the infrastructure under local management. Access to the building is not done always via ID student/employee card - security incidents occur when stranger enter the building and can remove digital HW from classrooms. Notebooks have a tracking chip which triggers a security alarm to local IT team.
Administration (N=3)	Leadership and Vision	3,33	3	2	Based on the information provided by students in interviews, the communication of the author with the admnistrative staff, and feeback from the academic staff in the author's department the ML was assessed as 2. There are only 7 administrative employees listed officially, two of which perform managerial activites as well. For example, several administrative (and some academic) employees replyed to the author's request to complete the questionnaire stating that they could not understand the questions, which indicates that they lacked the basic terminology to understand what the question required. There was no information provdided to the author as a new lecturer about the means and platforms of communication with the students, colleagues, management, or administrative staff. There was no organisational chart provided or processes to understand the ways to process any specific request. There was no process described in any format about the agreed ways to access, distribute and store study material. There was no documentation provided, or training scheduled, to ensure the teachers follow formal procedures and tools (ICT or conservative) for communication, teaching, assessment, evaluation, creation of teaching material, and evaluating students' work for legal and ethical practice. However, essentially, there was no objective data collection to triangulate the answers of the administrative staff. There were, however, informal discussions in the department about practices in teaching, usually prompted by specific events, and exchanges of ideas for the individual alignment of used tools in teaching based on this common understanding of best practices in teaching.
	Learning and Teaching	3,33	3	2	
	Productivity and Professional Practice	3,00	3	2	
	Support Management and Operations	3,67	4	2	
	Assessment and Evaluations	3,67	4	2	
	Social, Legal and Ethical issues	3,00	3	2	

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
Teachers (N=43)	Student Learning and Creativity	2,88	3	2	Observed class 1 - F 48y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to images and videos; videos on YouTube used as example for the topic, search engine used to find targeted information. Used digital information sources for approximately 40 minutes (video included). Topic discussed: resilience and resilient thinking in a changing global economy Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, evaluation of oppinions and facts, key takeaway, summary. Observed class 2 - M 65y ICT tools: none Topic discussed: financial institutions Teaching methods: conservative lecturing, flipchart for key concepts notes. Observed class 3 - F 35y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with bulletpoints content, links to sources (two links briefly accessed in class - 2min), static map - image embbedd on slide. Used digital information sources for approximately 30 minutes (presentation passively displayed in the background). Topic discussed: Security aspects of globalisation Teaching methods: presentation (using dispaly of presentation and conservative), discussion, questions and exchange of viewpoints on the topic, comparisson with other similar scenarios/topics. 30 minutes allocated for open discussion, no presentation displaoyed, no use of presentation content. Observed class 4 - M 55y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with bulletpoints content, graphs and tables to present information. Used digital information sources for approximately 30 minutes (presentation passively displayed in the background). Topic discussed: Financial institutions Teaching methods: presentation (using dispaly of pptx presentation and conservative), mainly conservative lecturing with the aid of the digital format to display content, calculations and graph drawing on flip chart. Observed class 5 - F 47y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to images and videos; videos on YouTube used as example for the topic. Used digital information sources for approximately 40 minutes (videos included). Topic discussed: The role of community practices and values in decision-making Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, evaluation of oppinions and facts, summary, reflexive exercise to apply concepts on own experience.
	Digital-Age Learning Experiences and Assessments	2,76	3	2	
	Digital-Age Work and Learning	2,68	3	2	
	Digital Citizenship and Responsibility	3,30	3	2	
	Professional Growth and Leadership	2,79	3	2	

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
					Observed class 6 - F 62y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to sites for more infromation. Topic discussed: Covid-19 catalyst. Irish Catholic survival, resistance and identity. Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, inquisitive storytelling to connect the topic with the audience's emotions and knowledge, open discussion to evaluate the presented facts as a group, summary. Observed class 7 - M 54y ICT tools: class HW (projector, notebook), MS TEams for online streaming, ptx presentation with mostly text, a few pictures, and graphs as content. Assistance needed to handle equipment. Topic discussed: CZ and Turkyie economy - using AI in financial activities Teaching methods: presentation as support for content, classic lecturing, brief Q&A at the end of the lecture.
Students (N=28)	Creativity and Innovation	2,85	3	3	Average score rounded to the closest integer based on the seminar assignments from all three courses.
	Communication and Collaboration	3,70	4	4	
	Research and Information Fluency	3,71	4	4	
	Critical Thinking, Problem Solving and Decision-making	2,77	3	4	
	Digital Citizenship and Responsibility	2,84	3	3	
	Technology Operations and Concepts	2,63	3	4	

Table 5. The assessed ML of the HEI based on the questionnaire, observations, interviews and seminar assessments.

Domain	ML (Questionnaires)	ML (teacher assessments, interviews, class observations)
Management (N=3)	3	2
Infrastructure (N=3)	2	2
Administration (N=3)	3	2
Teachers (N=43)	3	2
Students (N=28)	3	4

Table 4 and Table 5 show the difference between the observed and inquired scores and the perceptions of the HEI employees regarding their use of ICT in the institution's daily activities, be it for academic, managerial, administrative, or infrastructure-related purposes, the largest of which being in the administrative area. Interviews with the head of IT, class observations and other event-based information were used to assess the observed ML of the HEI. Such informative events for the ML in the administrative and teacher domain were the issuing of the reports needed for the demographic data of the HEI. The reports required by the thesis' author were not easily obtained in an automated manner due to the lack of knowledge of administrative staff on how this information is stored in and generated from the school IS. The reports about students were very unstructured though generated automatically from the IS, while the ones about the employees were manually created in Excel, not generated automatically. These findings show the little digital capabilities in administrative activities on both system and employees' side. Consequently, compared to the questionnaires-based rating, the observed ML of the HEI averaged 2, overall. This ML was evaluated by also considering the national statistics on ICT adoption and use (Český statistický úřad, 2022; Český statistický úřad, 2022; Our World in Data, 2022), which put the Czech Republic very close to the EU average and shows a rapid trend of technology adoption in private and commercial activities. This ML indicates there are capabilities to model a structured way of using ICT in the institution's activities, but those capabilities are not yet discussed, structured, nor formalized, to be communicated to the staff and students, and establish a process of using ICT for each KDA, which can be then monitored, measured against agreed standards, improved in time, and eventually optimized.

Table 6 (Appendix – Section 13.1.) shows a model of the ML for a secondary school with the high-priority KDA and their respective CLs (option 4). Compared to this model, the analysed HEI with an overall ML of 2, has many KDAs assessed at level 2 which are not included as high priority in the presented model (Solar et al., 2013), which adds value to the HEI's efforts towards a more formalised process of using ICT in their activities. Additionally, the evaluation of the HEI ML included the assessment of the students from two sources. One source were the teachers of the HEI, which on average used less ICT in teaching than the author in her classes, based on the data collected through class observation and student interviews, and the second source was the seminar assessments in the author's classes. The results presented in the next section indicate that using more ICT tools in teaching increases the CL for KDA_{STU}, even though their level of digital skills was not targeted to be improved using ICT in class. Rather, it was only stimulated through the used tools in teaching and by being required to complete seminar assignments and independent reading. However, there was no assessment of assignments and exams for other classes beside those of the author, therefore it is a matter of debate whether other teachers evaluate the ICTE-MM criteria as important in seminar assessments, and whether they can assess how these competences help students with their exam studies. The relationship between the HEI ML and class performance for RQ3 could only be assessed by looking how the HEI ML impacted the use of ICT in the three courses involved in the study, while placing the HEI ML as a mediator between the use of ICT in class and the students' class performance. Qualitative data from a second study were considered as well in the overall HEI ML evaluation. These aspects will be discussed in an integrative manner in the Discussion section.

The demographics of the students per the official extract from the school IS show that in the academic year 2022-2023 there were 288 students enrolled in either a Czech or English program at the HEI, 151 of which (52.4%) were female. In the sample of 45 students who were officially enrolled in the three courses included in this study, 17 were male and 28 were female. From this group of 45 students, due to withdrawal from course, late or no submission of seminar assignment, and/or no exam participation not all students were included in all the measurements. Table 7 shows the data of the entire vs included sample that supplied the data for the study, also with a split per gender of the students, showing a slight number of female students in the total sample, exam feedback and Course 1. The gender of the participants participating in the semi-structured interviews was more balanced with 5 female and 6 male students.

Table 7. Student participants in the study, per data source and gender

Study data	N	Female	Male
Total registered students	45	28	17
Only Course 1	17	11	6
Only Course 2	0	0	0
Only Course 3	1	1	0
Course 1-2	1	1	0
Course 1-3	4	3	1
Course 2-3	5	2	3
Course 1-2-3	7	4	3
Total Course 1	29	19	10
Total Course 2	13	7	6
Total Course 3	17	10	7
Total seminar assignments Course 1	29	19	10
Total seminar assignments Course 2	13	7	6
Total seminar assignments Course 3	14	7	7
Total exam feedbacks Course 1	28	18	10
Total exam feedbacks Course 2	13	7	6
Total exam feedbacks Course 3	14	7	7
Total semi-structured interviews	11	5	6
Total DS questionnaires	22	14	8

Providing answers for RQ1, the descriptive statistics skills per the entire sample completing this questionnaire (N=22) (Figure 6) indicate that students' greatest strengths in digital skills are in Word processors (Mean 4.71), Email (Mean 4.3), and Presentation creators (Mean 4.07). Their greatest skill gaps are in Statistical analysis applications (Mean 2.52) and Searching academic DB (Mean 2.66).

Further on, independent *t*-sample tests (Appendix – Section 13.4.) showed no significantly significant differences between female and male students, though in the critical aspect of academic DB searches female students scores mean was lower by one standard deviation than that of male students (2.24 vs. 3.02, Stand. Dev. = .76). The non-assumed homogenous variance condition for the groups showed a statistically significant difference between female and male students on this criterion with $t(20) = -2.012$, $p = .029$, but confidence intervals range does not confirm this significance (95% CI [-1.58; 0.29]).

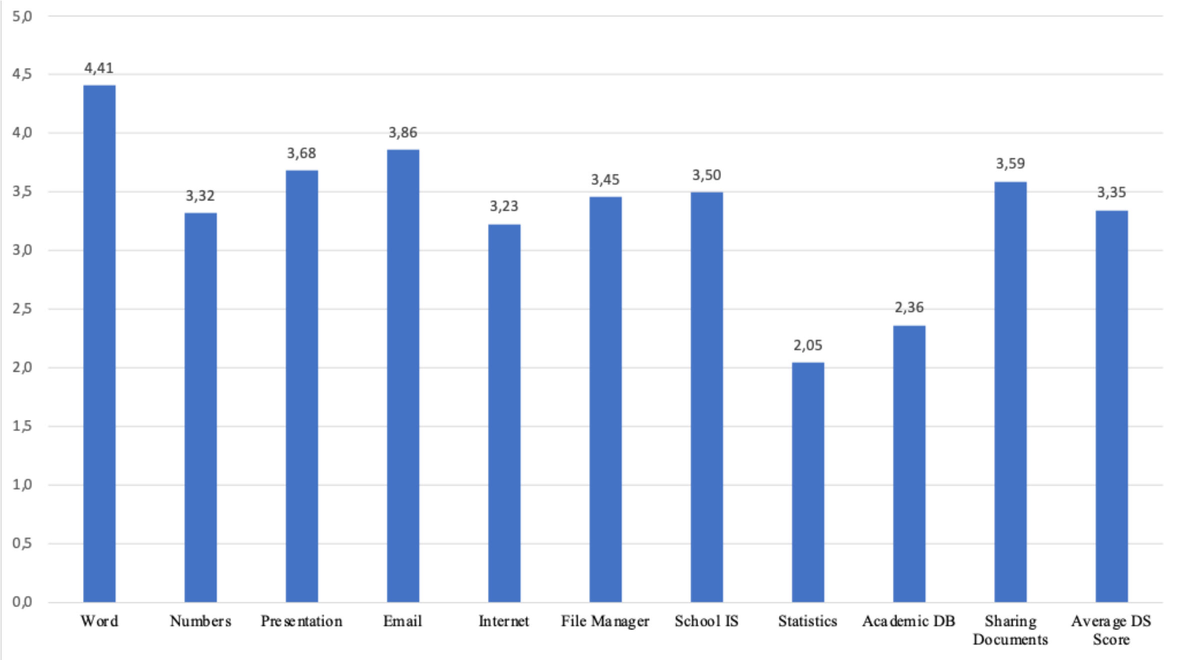

Figure 6. Self-reported digital skills per application's area of functionality

As per Table 8 figures, only the Word processor and Email communication skills were statistically significant for Course 1 assignments and exams, with a medium to strong positive relationship at significance level $p<0.05$, which may indicate communication was essential for students in being able to clarify requirements, take notes, and express their understanding in order to receive a good grade. Additionally, Email communication and School IS were also statistically significant for the exam score in Course 3, with medium-strong positive relationships at a significance level $p<0.05$, also suggesting that the ability to identify the study materials, information about class activities, and being able to submit one's assignments according to requirements and on time, along with the ability to communicate with your teachers and peers for class purposes may be essential for their academic performance in this course.

There were no significant correlational relationships between self-reported digital skills and course performance found for Course 2.

Table 8. Significant correlations between self-reported digital skills and course performance

Correlation relationship	Course 1				Course 3			
	Pearson Correlation (N=16)	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper
Word processor - Assignment score	.72***	.001	.349	.896				
Word processor - Exam score	.549**	.028	.073	.821				
Email - Assignment score	.587*	.017	.129	.839				
Email - Exam score	.658**	.006	.241	.840	.738**	.006	.248	.922
School IS - Exam score					.585*	.046	.017	.868
Sharing documents - Exam score					.742**	.006	.292	.923

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Linear regressions models were performed for all courses (Appendix - Section 13.3). The linear regression model with all self-reported digital skills as impacting variables on assignments and exams showed that only for Course 1 solely Word processor skills were a significant predictor of the assignment score with t=2.75, *p=.04*, while the entire set of digital skills did not significantly predict the assignment score with F(5,10) = 2.383, *p*=.175. For Course 2 and Course 3 there was no significant predictor of neither the assignment nor the exam score of this specific linear regression model.

Linear regressions of the first five highest ranked self-reported digital skills as impacting variables on assignments and exams showed that for Course 1 Word processor and Email skills were significant predictors of the assignment score with t=4.02 and *p*=.002 and, respectively, t=2.45 and *p*=.034, while the entire set of digital skills significantly predicted 77% of the assignment score with F(5,10) = 6.708, *p*=.005.

Similarly, for Course 1 Word processor and Email skills were significant predictors of the exam score with t=2.54 and *p*=.029 and, respectively, t=2.65 and *p*=.044, while the entire set of digital skills significantly predicted 70% of the exam score with F(5,10) = 4.854, *p*=.016.

Other regression models with different combinations of digital skills were found to be statistically significant predictors to a lesser extent for both the assignment and the exam score, while Word processor and Email skills remain the main significant predictors in these other investigated models.

In a linear regression model with Word processor, Presentation, School IS, Academic DB, and Email skills, all variables except Word processor were significant predictors of the exam score for Course 2, while the entire set of digital skills significantly predicted 92% of the exam score with F(5,5) = 11.546, *p*=.009, with Presentations and Academic DB contributing negatively to the exam score.

A three-variable linear regression model for Course 2 showed that Word processor, Presentation and School IS are all significant predictors of the exam score with $F(3,7) = 5.976$, $p=.024$, with Presentations contributing negatively to the exam score, while the set of variables explaining 71.9% of the exam score.

A four-variable linear regression model for Course 2 showed that Word processor, Presentation, Academic DB, and School IS are all significant predictors of the exam score with $F(4,6) = 10.384$, $p=.007$, with Presentations and Academic DB contributing negatively to the exam score, while the set of variables explaining 87.4% of the exam score.

For the assignment score of Course 2, in a three-variable linear regression model, all three variables, Word processor, Presentation, and School IS skills, were significant predictors in the model, while the entire set of three digital skills significantly predicted 69% of the assignment score with $F(3,7) = 5.186$, $p=.034$, with Presentations contributing negatively to the assignment score.

Other regression models, with different combinations of digital skills, were not found to be statistically significant predictors for neither the assignment nor the exam score.

In a linear regression model with only Word processor, Presentation, Email and School IS skills, all four variables were significant predictors of the exam score for Course 3, while the entire set of four digital skills significantly predicted 84.9% of the exam score with $F(4,7) = 9.875$, $p=.005$. Interestingly, Presentation skills also negatively predicted the exam score for Course 3 as for Course 2, with $t=(-3.194)$ and $p=.015$. For the assignment score of Course 3, only Word processor and Presentation skills were significant predictors in the model with $t=3.207$ and $p=.015$ and, respectively, $t=(-2.406)$ and $p=.047$, while the entire set was not a significant predictor, with $F(4,7) = 3.093$, $p=.092$. Similar to Course 2, Presentation was a negative predictor of the assignment score $t=(-2.406)$ and $p=.047$.

Other regression models were not found to be statistically significant predictors for neither the assignment nor the exam score.

The digital skills-digital competences relationship was investigated only using correlational analysis. Table 9 shows for Course 1 the analysis found strong significant correlations between Word processor on one side, and Research and Information Fluency, and Critical Thinking on the other side. Similarly, there were found medium significant correlations between Word processor, Communication and Collaboration, Digital Citizenship, and Technology and Operational Concepts.

Number processor skills were found to have a medium significant correlational relationship with Technology and Operational Concepts for Course 1, and a strong significant correlational relationship with Technology and Operational Concepts for Course 3.
Email skills were found to have a medium significant correlational relationship with Creativity and Innovation, Communication and Collaboration, and Critical Thinking for Course 1.
School IS skills were found to have a medium significant correlational relationship with Creativity and Innovation for Course 3, though the confidence intervals marginally disprove the significance of this relationship.
There was no significant correlation found between self-reported digital skills and assessed digital competences for Course 2.

Table 9. Correlation coefficients between self-reported digital skills and assessed digital competences

Correlation relationship	Course 1 (N=16)				Course 3 (N=12)			
	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper
Word processor - Communication and Collabotation	.635**	.008	.183	.885				
Word processor - Reasearch and Information Fluency	.726***	.001	.339	.894				
Word processor - Critical Thinking	.855***	<.001	.697	.946				
Word processor - Digital Citizenship	.615*	.011	.152	.845				
Word processor - Technology Operations and Concepts	.576*	.019	.094	.828				
Number processor - Technology Operations and Concepts	.549*	.028	.055	.815	.701**	.011	.182	.903
Email - Creativity and Innovation	.528*	.036	.026	.805				
Email - Communication and Collaboration	.563*	.023	.075	.822				
Email - Critical Thinking	.658**	.006	.220	.865				
School IS - Creativity and Innovation					.619*	.042	(-.001)	.882

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

For RQ2 several statistical tests were performed, such as comparing means, linear regressions, and bivariate correlations between the ICTE-MM areas, and assignment and exam scores.

Course assignments were evaluated independently by a second teacher from the English program. The Cohen's Kappa computations for each section are in Table 10.

The criteria for each domain of the ICTE-MM used in assignments evaluation were agreed upon by the two coders before handing over the assignments to the second coder. An example assignment was used to work out the application of the criteria for the coder's evaluations. Certain criteria were excluded from the coders' agreement computation due to the impossibility for Coder 2 to evaluate them. Communication criterium was excluded because in Coder 1's evaluation was included also the oral presentation of the information, at which Coder 2 was not present. Plan and Conduct Research and Manage Projects were excluded because in Coder 1's evaluations of these factors were included the timeframe of assignment submission and the student's level of comprehension of assignment's requirements in the context of the provided information in class, aspects to which Coder 2 was not privy to the needed extent to compare the evaluations.

Coders agreed to evaluate the ratings of the field where Cohen's Kappa is lower than .7, indicating a threshold between medium and strong agreement. A review was not needed, as the lowest rating was .707 in Creative thinking.

Table 10. Coder agreement computations for seminar assignments.

	N	Cohen's Kappa	Sig. *p*	SE	Weighted Cohen's Kappa	Sig. *p*	SE	CI interval
Creative thinking	53	.707	<.001	.079	.794	.000	.060	.676-.911
Acquire knolwedge	53	.853	<.001	.064	.878	.000	.048	.784-.972
Develop innovative products	53	.817	<.001	.064	.878	.000	.044	.792-.964
Support individual learning	53	.816	<.001	.071	.850	.000	.058	.736-.964
Contribute to others' learning	53	.716	<.001	.076	.817	.000	.051	.717-.918
Gather information	53	.759	<.001	.071	.835	.000	.048	.741-.930
Evaluate information	53	.738	<.001	.075	.819	.000	.055	.712-.926
Use information	53	.840	<.001	.061	.887	.000	.044	.801-.973
Understand social ICT issues	53	.898	<.001	.048	.935	.000	.030	.876-.994
Practice legal and ethical behaviour	53	.894	<.001	.050	.934	.000	.033	.869-.999
Understand technological concepts	53	.861	<.001	.060	.898	.000	.045	.809-987
Understand technological systems	53	.923	<.001	.043	.949	.000	.029	.891-1.007
Understand technological operations	53	.946	<.001	.038	.964	.000	.025	.915-1.014

The mean of digital competences measured in course assignments per each measured domain, and the exam scores in each course are presented in Figure 7, showing that in Course 1 students' assignments were assessed at higher levels of digital competences in all ICTE-MM fields compared to the other two courses, indicating that the students assignment scores in Course 1, which included a wider variety of ICT and non-ICT teaching tools, benefited from this diversity of teaching tools more compared to Course 2, where students had to rely mostly on the data sites provided in class and invest effort into further independent search for statistical data to produce a good assignment. Digital skills in the functional area "Statistics" were also reported as the least performant by the students themselves, which the figures indicate that it negatively informed their abilities to produce an assignment for Course 2 that would have been rated highly, because it was largely reliant on Statistics skills area. Similarly, scores in Course 3 were superior to those in Course 2, as in Course 3 independent search was needed aside from the course information, but it required less statistical data and more policy-based information than in Course 2, which are easier to evaluate and use at this educational level than statistical data. These differences in the competences used for the assignments may also explain the lower means of Digital Citizenship and Technology Operations and Concepts scores and the higher mean of Research and Information Fluency score in Course 2, compared to the other courses. The findings may also suggest that students do not have an objective self-reference standards when completing the self-reports on digital skills for domains they don't use in their daily non-academic and academic activities, such as academic DB search or statistical analysis.

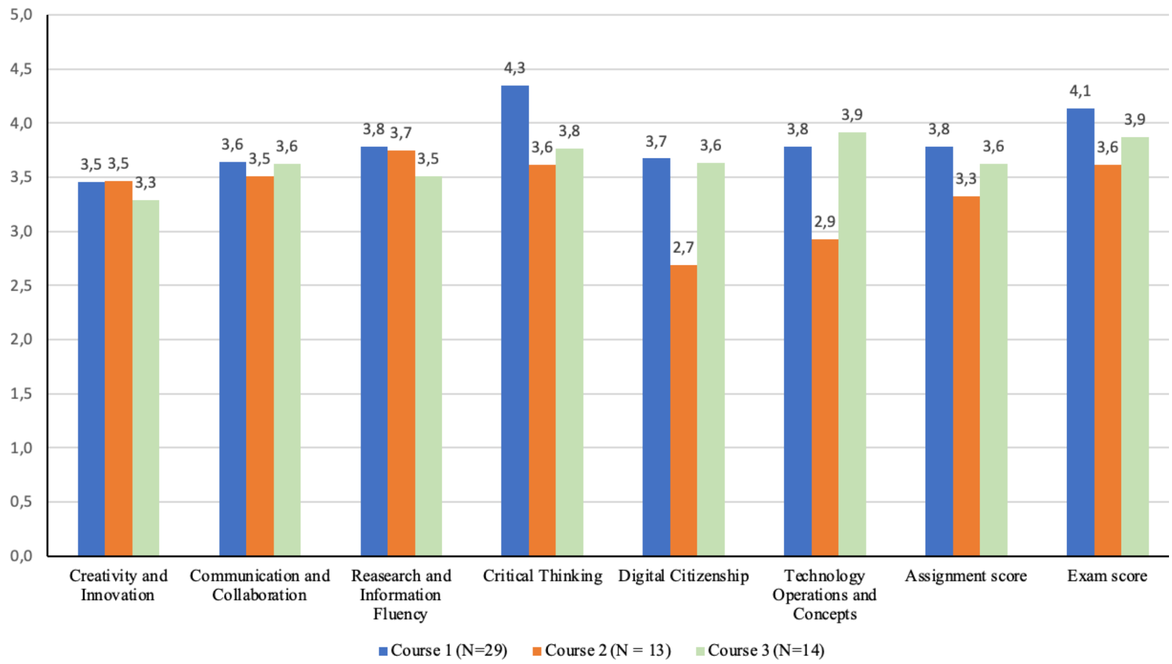

Figure 7. ICTE-MM Digital competences measured in course assignments and exam scores per course

Table 11 presents the statistically significant correlational relationships between the exam score, assignment scores, the perceived DM of the class and of the HEI, and specific KDA measured in seminar assignments. The exam in Course 1 is medium to strongly correlated at a .001 significance level with all ICTE-MM KDAs, but only four out of six are significant for Course 3, and only three for Course 2. The common domains statistically significant for the exam score for all three courses are: Communication and Collaboration, Research and Information Fluency, and Critical Thinking. The assignment score-exam score correlation is statistically significant only for Course 1 and 3, suggesting that the assignment in these courses were more representative for the ICTE-MM KDAs used also to prepare for the exam.

The digital maturity of the class is medium to strongly negatively correlated with the assignment score and the Research and Information Fluency score in Course 1 and Course 3, and with Communication and Collaboration in Course 1 (Table 11). These correlation relations are based on a small sample, with N-10 for Course 1, and with N = 5 for Course 3, which reduces the relevance of the correlations, however, the fact that systematically students rated the author's classes with a higher digital maturity (DMC) that that of other classes or the institution (DMHEI) as a whole is indicative of the fact that the pedagogical interventions performed in these three classes (compared to the institution's norms or practices on the use of ICT tools in teaching) were valued positively, and that they positively impacted the students' course performance. In the semi-structured interviews questions 8-9 asked the interviewees to evaluate the DMHEI and DMC from a scale from 1 to 5, 1 being the smallest rating. The average DMC was 4.36 (Std. dev. = .5) while the average DMHEI was 3.64 (Std. dev. = .71), indicated the author's classes used more and/or more effectively ICT tools in teaching compared to other teachers from the HEI considered by students in their evaluations.

Table 11. Significant correlation coefficients between ICTE-MM criteria, exam scores and reported digital maturity score of the HE institution and of the class

Correlation relationship	Course 1				Course 2				Course 3			
	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper			Lower	Upper
Digital Maturity HEI - Digital Maturity Class	.824** (N=11)	.002	.444	.953	.824** (N=11)	.002	.444	.953	.824** (N=11)	.002	.444	.953
Digital Maturity HEI - Reasearch and Information Fluency	(-.689)* (N=10)	.028	-.920	-.105								
Digital Maturity Class - Communication and Collaboration	(-.673)* (N=10)	.033	-.915	-.075								
Digital Maturity Class - Reasearch and Information Fluency	(-.636)* (N=10)	.048	-.904	-.010					(-.917)* (N=5)	.029	-.995	-.179
Digital Maturity Class - Assignment Score	(-.664)* (N=10)	.036	-.912	-.059					(-.915)* (N=5)	.029	-.994	-.173
Creativity and Innovation - Exam Score	.729***	<.001	.495	.865					.498*	.049	.003	.797
Communication and Collaboration - Exam Score	.777***	<.001	.574	.890	.664*	.013	.178	.889	.592*	.016	.137	.841
Reasearch and Information Fluency - Exam Score	.713***	<.001	.469	.856	.615*	.025	.096	.871	.630*	.009	.195	.858
Critical Thinking - Exam Score	.811***	<.001	.633	.908	.614*	.026	.095	.870	.620*	.010	.179	.853
Digital Citizenship - Exam Score	.649***	<.001	.370	.820								
Technology Operations and Concepts - Exam Score	.428*	.021	.073	.687								

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Linear regressions of all ICTE-MM criteria as impacting variables on exams (Appendix – Section 13.3.) showed that for Course 1 Critical Thinking was a significant predictor of the exam score ($t = 2.5$ $p = .02$) with $F(6,22) = 12.455$, $p<.001$, while all digital skills criteria explain 77% of the exam score.

Linear regressions of all ICTE-MM criteria as impacting variables on exams showed that for Course 2 Digital Citizenship was a significant predictor of the exam score ($t = 2.95$ $p = .03$) with $F(6,6) = 5.842$, $p=.025$, while all digital skills criteria explain 85% of the exam score.

There was no statistically significant result for linear regression tests between ICTE-MM criteria and exam scores for Course 3, in various models.

The quantitative figures were meaningful for certain areas, as shown above. However, the meaning for the teaching exercise involving ICT-tools was more detailed when we looked at the qualitative data for more in-depth explanations.

Using the content of the course feedback given after the oral examination by each examined student, the frequency of occurrence of the methods used in teaching was recorded using content analysis method.

Figure 8 shows the split between ICT and non-ICT tools used in teaching that were mentioned in the course feedback by students.

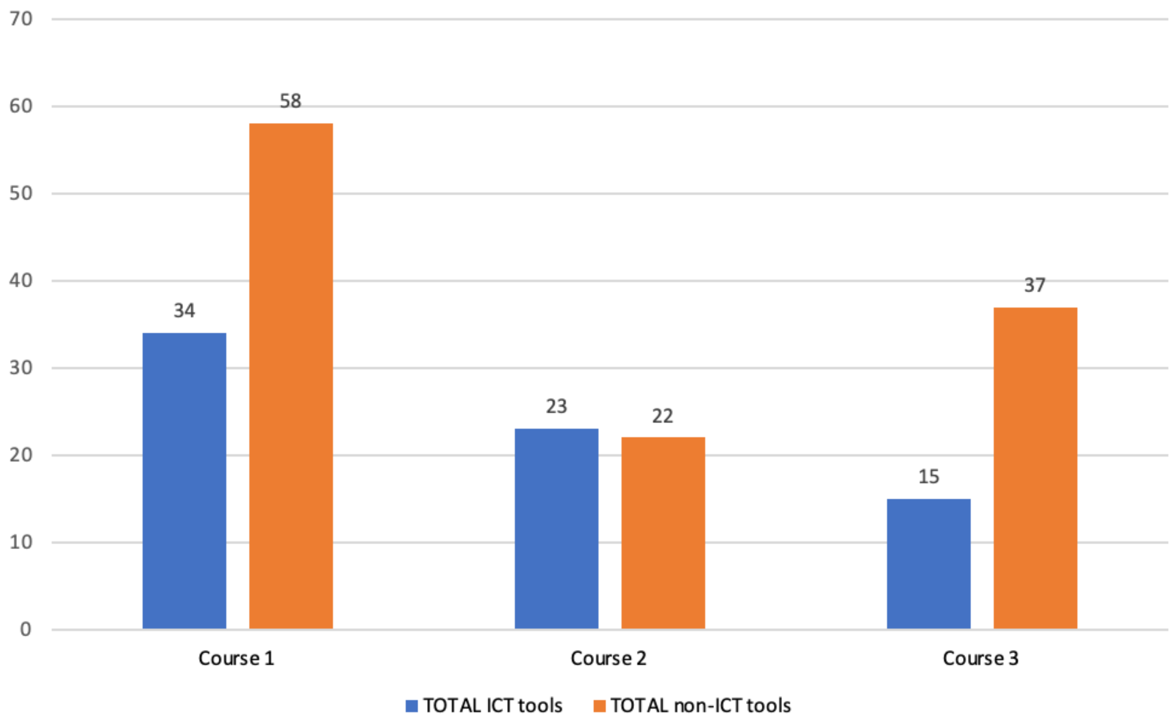

Figure 8. Frequency of occurrence of teaching tool type in course feedback per course

Figure 8 and Table 12 show the frequency of occurrence of specific items, split per each course.

In Course 1 students mentioned 70% more non-ICT tools than ICT tools as being helpful in their learning, by large the most memorable for students were the debates, presentations, and the negotiation/voting simulation, which made use of ICT tools (voting application) but it was counted as non-ICT practical method.
In Course 2 the difference between the two types was insignificant, with the most mentions gathered by site links and debates and other non-ICT.
In Course 3 the non-ICT tools mentioned were 147% more in number compared to the ICT tools, with the most mentioned received by Other non-ICT group, followed by debates.

Table 12. Frequency of occurrence of ICT and non-ICT tools/methods in teaching per course in exam feedbacks

Teaching tool type	Course 1 (N=28, F=18, M=10)	Course 2 (N=13, F=7, M=6)	Course 3 (N=14, F=7, M=7)
Presentations (by teacher/as assignments)	14	6	7
Handouts/slides	5	2	1
Links	8	2	4
Videos	1	2	1
Sites (institutions, databases)	4	10	2
Debates	17	10	14
Simulation	14		
Field trips	7	2	5
Other non-ICT (class dynamic, interactivity, teacher' skills, engagement, different perspectives, freedom to ask and express, diversity of presenters and opinions, developped skills)	20	10	18
Other ICT (individual research, use of digital tools)	2	1	0
TOTAL ICT tools	34	23	15
TOTAL non-ICT tools	58	22	37

The relationship between the exam and assignment scores for all three courses was analysed using correlational analysis. In Table 13 figures show that the assignment score for Course 3 is positively and medium-to-strongly correlated with the exam and assignment scores in both Course 1 and Course 2. The exam score for Course 1 is positively and strongly correlated with the assignment score in Course 1 and exam scores for Course 2 and 3, and positively and medium correlated with the assignment in Course 3. The exam score for Course 3 is positively and strongly correlated with the exam and assignment score for Course 1 and the exam score for Course 2. The exam score for Course 2 is positively and strongly correlated only with the exam score for Course 1, while the assignment score for Course 2 is not significantly correlated with any other recorded score. These figures can shed light on the impact of preparedness and assignment task type contribute to the students' academic performance.

Table 13. Correlational relationship between exam and assignment scores for all courses

Variables	1	2	3	4	5
1. Exam Course 1	1				
2. Assignment Course 1	.822***	1			
3. Exam Course 2	.878**	.653	1		
4. Assignment Course 2	.516	.658	.538	1	
5. Exam Course 3	.932***	.796**	.804**	.444	1
6. Assignment Course 3	.618*	.727**	.604*	.699*	.541*

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Figure 9 shows the path analysis of the correlational relationship between exam and assignment scores, while Figures 10-12 capture the complex relationship between digital skills, digital competences, exam score, and assignment score for each course, with the statistically significant correlational relationships and the coefficient of determination of specific statistically significant linear regression models.

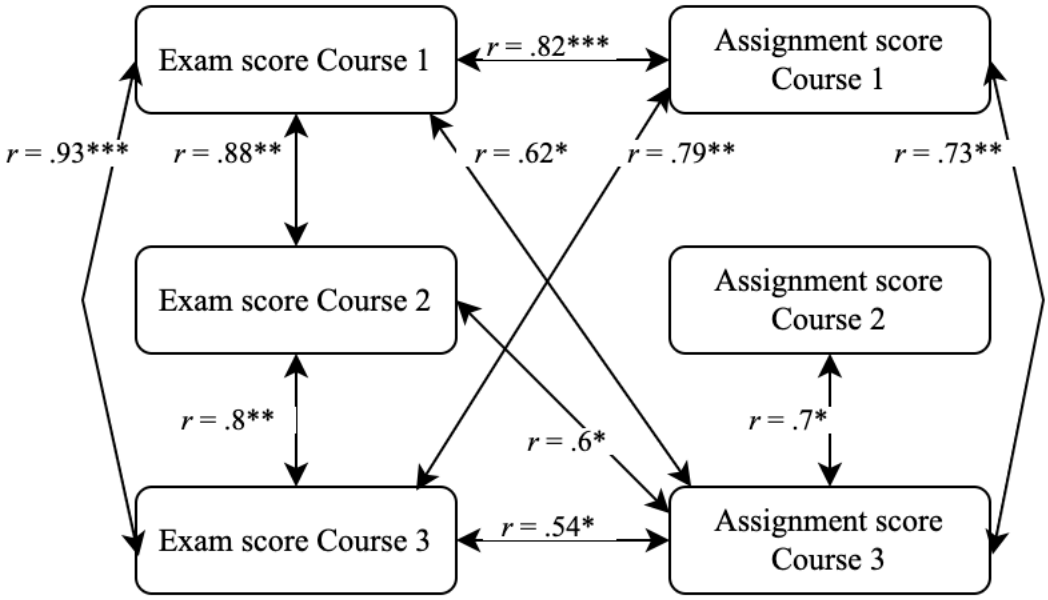

Figure 9. Correlational relationships between exam and assignment scores

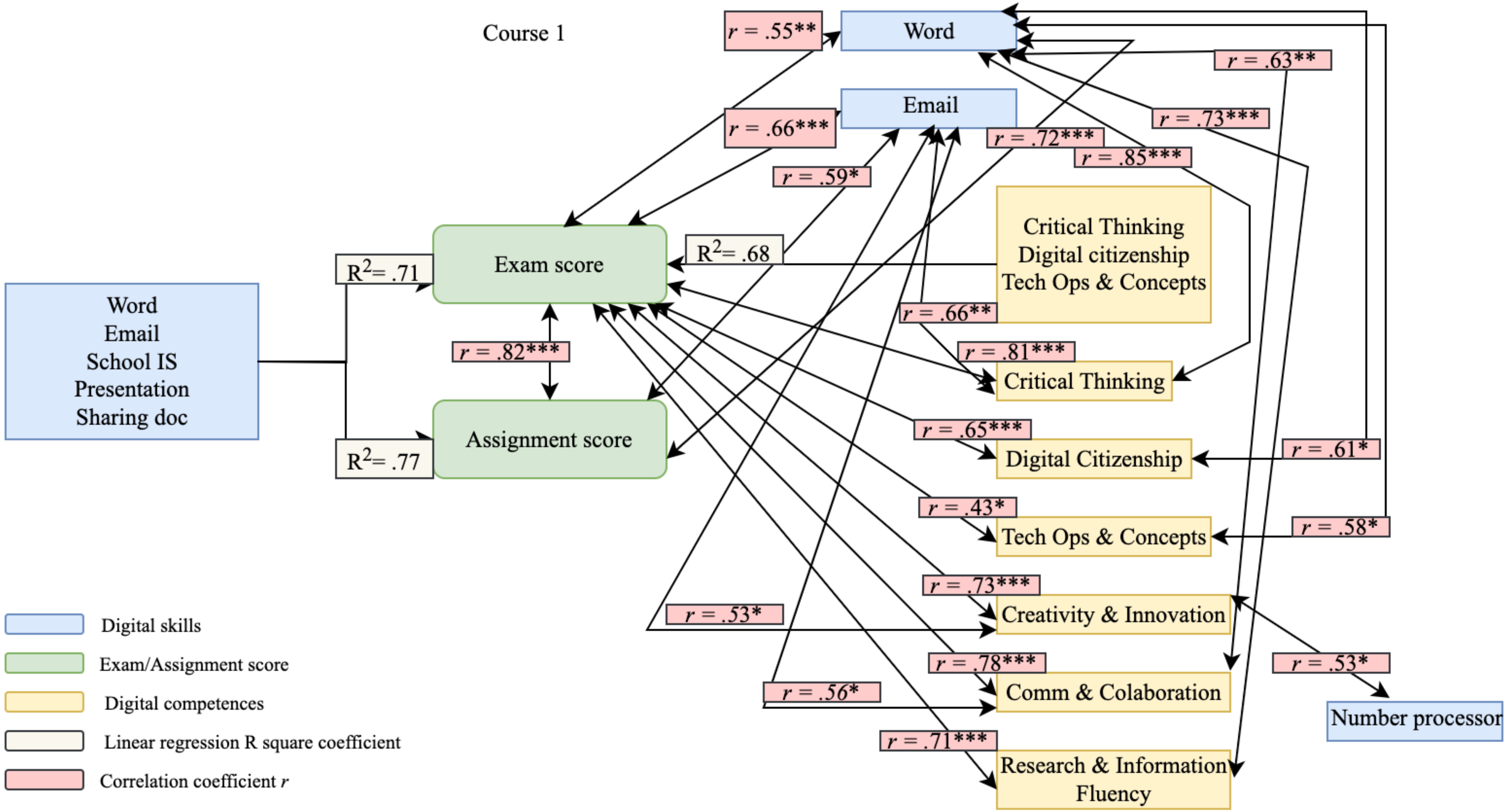

Figure 10. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 1

Course 2

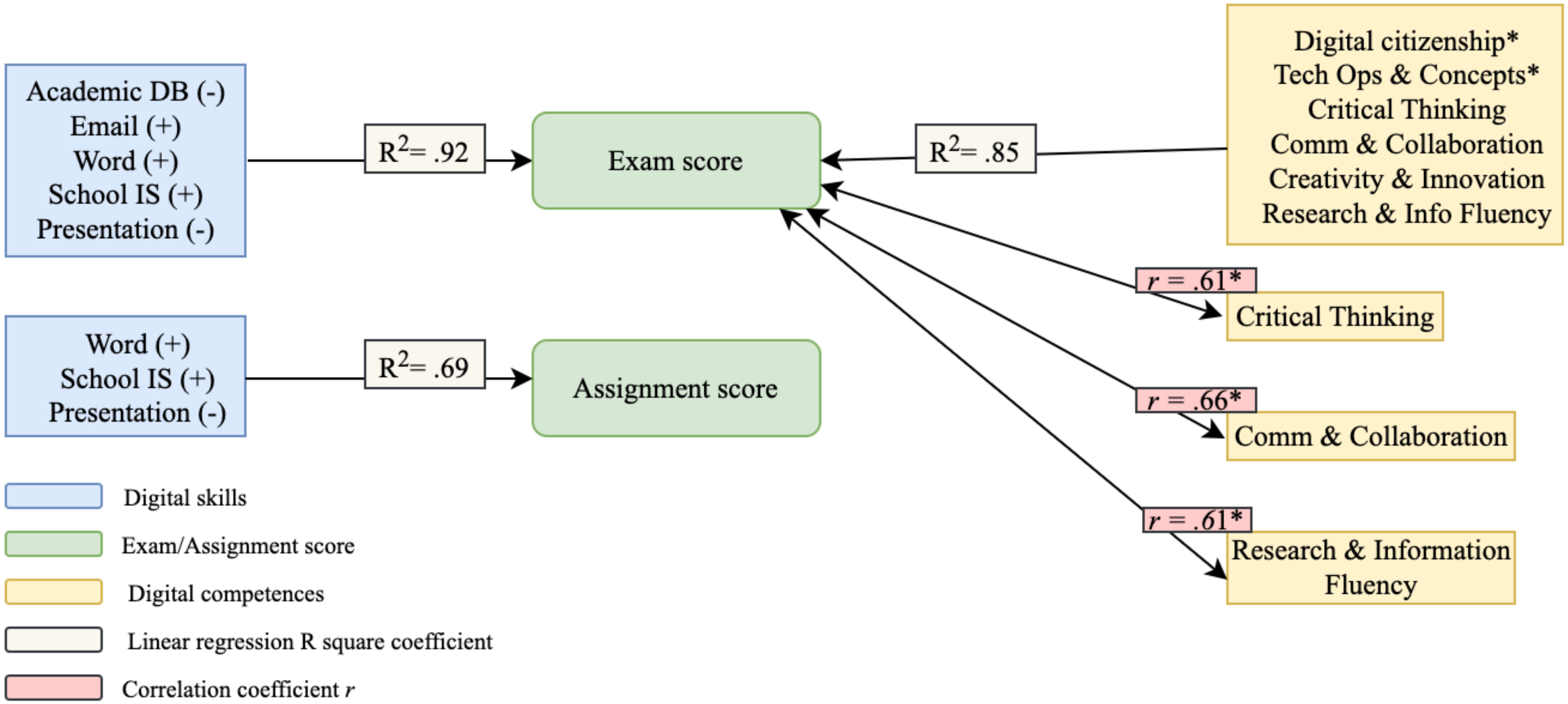

Figure 11. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 2

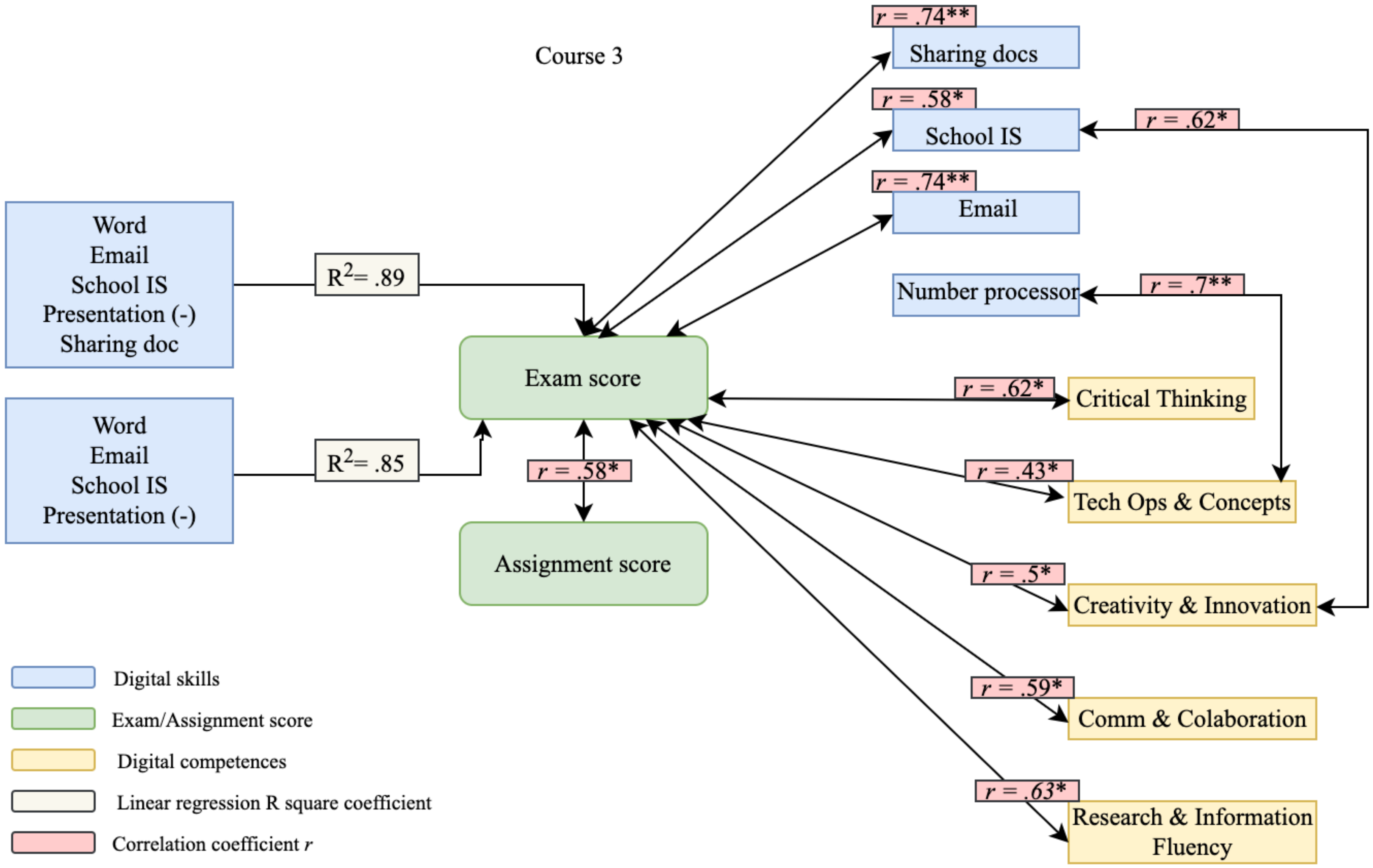

Figure 12. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 3

4.1.8. Limitations

The limitations of this study refer to the use of self-reports in extracting ratings about the use of ICT in the HEI's activities. While triangulation of data in some areas offsets some of these limitations, another limitation is the small number of participants, due to the small size of the analysed HEI, which limits the findings to similar profiles of HEIs, size and field-wise.

4.2. Study 2 – Semi-structured interviews

4.2.1. Design

More information about the effective use of digital tools in teaching, learning, and communication at the investigated HEI, from the students' perspective, was captured in the semi-structured interviews with 11 students, 5 female and 6 male students, average age 22.7 years (22.4 years for female students, 23 years for male students). Thematic analysis was used to extract the main themes referring to the use of digital tools at this HE institution.

The interviews included 11 questions (Figure 13, Appendix – Section 13.2.). The total recorded time was of 258 minutes with the average duration of interviews of 23.5 minutes (range [11.7-42.1] minutes). Participants were given code names and the school name was removed from the questions in order to maintain their anonymity.

Questions 8-9 asked them to rate the DMHEI and DMC, figures used and reported in the Study 1. Question 10 asked them to evaluate themselves in terms of preparedness to use digital tools for searching, filtering, and evaluating information after the classes together. Based on a preliminary analysis of the data, results show that 9 respondents answered they were definitely more prepared for these digital activities for resources useable for our classes and 8 also answered they are more prepared in general. Two respondents answered they were already well prepared, one mentioning they learned some new data and information sources.

1. How would you describe the use of ICT/digital tools in teaching at <school name>?

2. How would you describe the use of ICT/digital tool in communication at <school name>? (communication with the teachers, classmates, administration, library, etc)

3. How would you evaluate the use of ICT in your classes at <school name> for the purpose of understanding the subject matter, assimilating concepts, and acquiring new perspectives on the topic, or for any other purposes?

4. Overall, what digital tools were more useful for you to understand the taught topic?

5. What other teaching strategies and/or communication channels, and/or evaluation methods helped you in class?

6. How would you evaluate the teaching strategies in the classes taught by me and other teachers who use digital tools in their teaching, compared to classes in which such tools are not used or are less used?

7. Would you say the ICT helps or doesn't help students in their learning, and in developing certain skills?

8. On a scale from 1 to 5 how would you rate the digital maturity of <school name>?

9. On a scale from 1 to 5 how would you rate our classes in terms of digital tools used, considering that the topic cannot be taught in a fully digitalised form?

10. Would you say you are better equipped to search for, filter, evaluate and use digital tools to learn about a subject matter of our classes, and in general?

11. Do you have anything else you want to add?

Figure 13. The question list used in the semi-structured interviews (N=11)

4.2.2. Research Procedure

The students were invited to participate via school email, and selected to represent high, medium, and low academic performant students. The students who accepted the invitation were explained the purpose of the study both in the email and in the beginning of the interview. 8 interviews were conducted in-person in the HEI teacher’s office, while three were conducted online via school MS Teams account. The interviews were recorded, with the in-person interviews recording being only audio using AlonDictaphone mobile application on the researcher’s mobile phone, and the online interviews both audio and video using MS Teams recording function. The students were explained their rights as participants and signed an informed consent for the participation in the interview and the use of the data for the study. Their wellbeing was preserved at all times.

The audio data was transcribed using Sonix.io online application and checked manually for errors.

The text was analysed using thematic analysis to answer RQ4: What is the perceived role of ICT in teaching from the perspective of the students.

4.2.3. Research Sample

The participants were 11 students, 5 female and 6 male students, average age 22.7 years (22.4 years for female students, 23 years for male students). The nationalities of the students were as much as possible representative for the entire group of students included in the study, with 2 Czech nationals (2 males), 3 Spaniards (3 females), 1 American (male), 1 Czech-American (female) 1 French-Canadian (male), 1 Swedish (male), 1 Romanian (female), 1 Indian (male).

4 students had attended all three courses included in the study (2 females, 2 males), 5 had attended only Course 1 (2 females, 3 males), 1 female had attended Courses 1 and 2, and 1 male had attended Courses 2 and 3.

4.2.4. Research Instruments

The questions were formulated by the author of this study, to obtain in-depth information about the usefulness of ICT tools in teaching and learning at the HEI. The data was stored on the researcher’s notebook, and the thematic analysis was processed using traditional pen-paper methods and the findings stored on the researcher’s notebook.

4.2.5. Study 2 results

Three main third-level themes were identified in relation to RQ4.

Theme 1: ***The Good, the Bad, and the Ugly of ICT in teaching***

Based on answers to questions 2-7, the emerging opinions were that ICT-tools in teaching are generally beneficial, but their use is perceived not only in terms of their immediate positive and negative effects on student's learning and academic performance, both also in terms of individual and social long-term effects. Female respondents also pointed out the benefits of ICT in communication with positive effects on learning.

Overall, *"most teachers use slides... we saw videos, so we used YouTube… or any website that could provide videos. But... ,I think that the only one used wise[ly] was with the slides… the capacity of these tools are not fully exploited by al teachers. ..a lot of students before the exams are trying to understand something from the slides which are not really comprehensive. And so, in that matter it can be... problematic."* (Lancelot, 19-28).

Looking at the impact of digital tools in teaching from primary school onwards, students identify the benefits of classical tools, pen and paper, paper textbooks, and class activities. In comparison, for tertiary education ICT is essential in teaching and learning, but it can become distractive without discipline.

"...from a primary school level, I would say still that the classical way is better because you learn a bit more easily [..] to build foundations of topics you can stand upon to then advance up to a more digital medium and use the IoT to further your own research, like looking up articles on Google and news articles and scientific papers.. I think it's important maybe to combine both of them especially because I know many people that are not that structured. They ended up surfing on the internet instead of using the digital tools for teaching or listening to the teacher and working on assignments.[…] It could be for many people quite a distracting device. […] [ICT a.n] was an invaluable tool to get my own sources for the assignments." (Charming, 251-270).

"...the presentations are the most useful for me... and also [...] the email for writing the teachers and ask them questions…" (Ruby, 63-64)

"I think they help, but it's true that also are very distracting. […] having a laptop in class, it helps because you can write in Word the things you want. But also, it's so easy to start looking for something that is not about the class." (Ruby, 99-102)

When considering the future, students recognize that digital tools are part of our life and our future, be it in our studies or work. Humans need to accept them and adapt to them to benefit from the advantages they offer.

"...nowadays it's essential to work with new technologies and get used to them because it's the future and you're going to use them in the future in your job... and the sooner you get used to them the sooner different ones [appear a.n.]" (Mulan, 88-93)

Theme 2: ***ICT tools are new learning tools used along conservative ones, not replacing them***

In answers to questions 4-7 ICT tools are recognized as useful, especially when used in and interactive mode with the teacher, peers or other content which gives the student a more authentic, not monotone experience, which the sole lecture with or without slides can be. Field trips, discussions, research assignments, teacher's pedagogical skills, and students' own motivation to learn were all integrated in the learning experience.

[ICT interactive tools are useful in learning] "I would say it helps to memorize the information when you can interact with it. Like it's different than just reading a book or slides... ...and then you can kind of play with it, maybe sometimes see the numbers when you change numbers, like what happens. ..we used only in your class, it was the interactive map with the ships around the world. We did the field trip and saw how the National Bank works and shows everything [using digital tools a.n.], I was kind of impressed." (Merlin, 84-94)

"I think that the classes [of teachers that use more digital tools] are more engaging". (Merlin, 129)

Many respondents mentioned the open and respectful class discussions as offering different perspectives on matters that their own background, studies, and exposure to information cannot offer. In addition, communicating with teachers and peers, and watching their peers' presentations gives them further ideas about the digital tools they can use in their assignments.

"PowerPoints with videos and photos... that's a really good tool to learn and see not only writing, information [on the slides or in books]. […]

About useful methods in teaching*, " Going to visits [field trips]... Discussions in class, presentations... not only presentations... the work behind the group work, the communication, the emails..."* (Anna, 42-62)

Several respondents mentioned the students' motivation as an important factor in the learning experience, while others put more responsibility on the teacher's skills to motivate students. The interaction between independent and social learning, using both conservative and digital tools seems to be the answer to a better performance in class.

"It depends because the students have to first want to learn in the first place... some digital tools can help people learn. […] some websites can show graphically some problems, it's more interactive. So, yeah, I think these digital tools can like, like online websites can help the

students… to spark some interest in some topics. But I think also the main thing [motivating] the students to want to learn is probably still the teacher." (Hook, 109-116).

Theme 3*: Being social beings in a digital world*

Answers to questions 5-7 revealed that students still seek to learn from social interaction, mentioning the positive effect of interactive ICT tools, but also how ICT-tools are used to influence the quality of our communication. At the HEI from this case study, there were several aspects mentioned as impacting communication in class, and thus, the learning exercise and the student's experience. In their evaluation, respondents appreciated positively the effects of digital tools introduced in our courses together, especially in Course 1 where ICT-tools were used more intensively, and also in practical exercises (negotiation and voting).

"I really enjoy classes where I'm being asked questions and giving an answer so I can gain a better understanding of the material... that ensures that I actually understand and paying attention... so, yeah, I enjoy the most... the more interactive the class, the better..." (Nemo, 104-111)

The digital tools used in Course 1 generated a positive emergent property: a bridge between reality and academic information, which engaged students and offered them a new perspective on the course content.

"But with you […] it was quite clear and the communication compared to other classes... […] your classes were a bit more balanced when it came to literature and requirements compared to other teachers, and that we used more digital tools like the Digital Atlas website, for example... […] That was a very big difference, you provided the EU websites and applications to give an opportunity to understand more about the EU... We had no such integration between reality and the academic part in the other classes... it was quite interesting and refreshing… […] more engaging.".(Charming, 219-238)

As social beings we need to practice social skills. Digital tools are still only tools that we use in our human society, for good or bad. It is not only the tools or the teacher that create the learning environment, but how these items come together in the class dynamic, and the result can nurture or hinder the learning process for individual students.

"...for the practical parts, voting or in the negotiation class, you really need to be active as a person. I don't think tools can help you practice your soft skills because here you really need to communicate between two people so here you can have this." (Grethel, 211-220)

"We had some websites like Our World in Data and like traffic in the sea, traffic in the air. Like we observe all those things and see how the world is going... and those are very useful. […]

But the attitude of the students is what shapes the emotion of any individual, the collective understanding or acceptance of the classroom, the environment." (Arthur, 81-93)
"...you used most of the digital tools than the rest of the teachers. The difference would be like when I am in your class, I see myself not just learning something, but rather as observing things that would be true because of the use of digital tools in your class." (Arthur, 170-174).
"...you can have online classes, but it's not interactive. There is no teacher, it's videos. The benefits of having a teacher are that you can interact with them, you can ask questions, and even if you don't interact on purpose the teacher can see if you understand and can adapt to the students. A good teacher is better than a crash course, but a bad one might not be." (Lancelot, 190-199)

4.3. Discussion

4.3.1. Digital skills and competences, ICT in teaching, and student's performance in social sciences

One aspect worth mentioning is that despite having a plethora of terms outlining various digital skills, competencies and literacies (Eshet, 2004; Ferrari, 2012; Ala-Mutka, 2011; Martin & Grudziecky, 2006; Helpser $ Eyon, 2014; van Deursen & van Dijk, 2008), if we research the use of digital tool in education, we can efficiently design studies centred on the ICTE-MM digital competences, and use this taxonomy as baseline in further research, until new technologies will the need to develop new skills, requiring from researchers the adaptation of this model. These frameworks of digital skills themselves evolved in time, and some proved to be difficult to operationalise and were abandoned (DigLitEU, DIGCOMP). ICTE-MM was found to include in a different structure most of the analysed digital competences from older frameworks, and added the dimensions needed to discuss the results using an ecological system theory, such as the administration, teacher, IT and management layers. Its version presented in Solar et al. (2013) was found to be the easiest to operationalise for the purpose of the included studies.
The discussion will present further the interpretation of the quantitative results aided by the findings from the qualitative research.
Supporting existing research (Park & Weng, 2020; Rahman & Rahman, 2015; Lim et al., 2013; Hsin et al., 2014), the results from the self-reported digital skills questionnaires and the students' performance in the three courses show that the self-perceived digital skills (in most cases) and the use of ICT tools in teaching are positively linked to student's performance in certain areas (Word processors, Email, and School IS). Additionally, the differences between

the courses' content were reflected in the type of assignments received and the information students needed to master in the oral exam for each of these courses. Therefore, with the same level of DS, as a group average, students handled these requirements best in Course 1 where ICT was most used, and it was used in more activities, followed by Course 3 in which their strengths (Word processors, Email, Presentations, School IS) weighed more in the assignment and exam, compared to Course 2 where their gaps in skills (Statistical analysis and Academic DB search) weighted more for the course performance.

It was, however, surprising that Presentation skills were a negative predictor of exam score in Course 2 and 3, and of the assignment score in Course 2. Academic DB search skills were also a negative predictor of Course 2 exam score, which can be interpreted by the gap between the self-reported skill and the actual skill required to search for relevant and helpful material for both the assignment and the exam. A halo effect bias can influence the students' self-reports of certain skills (Davis et al., 2023). As such, regarding Academic DB skills, being less aware of the extent of the skill required for a good academic performance, while extrapolating from the ability to search on the Internet of Things (IoT) for non-academic purposes to the skill of the academic search in academic DBs, can lead to overestimating one's own skills and competences. Similarly, Presentation digital skills self-reports can be overestimated by the transferred digital skills of presenting oneself on social media platforms, without properly identifying the differences between the requirements for these two purposes. The interpretation of these findings is supported by existing research which shows that students from IT, Mathematics, and Social Sciences tend to overestimate their digital skills (Černochová et al., 2020).

Such phenomena of overestimation of own skills and competences may also affect the teaching staff. As such, the current findings of self-reports in questionnaires compared with class observations and interviews-based data show that the teachers underestimated their own ICT competences, and those of their students. This interpretation can be explained by the teachers' use of ICT in their teaching, which informs their choice of material and assessment tasks and methods to be more or less ICT-based/dependent. As such, being less proficient in using ICT in teaching, the teacher's assessment of own students will be based on more conservative methods, and their skills and competences would be less visible to the teacher. This interpretation of the current findings is supported by Hatlevik (2016), who found that the use of ICT in teaching is predicted by the teachers' digital competences, and their self-efficacy in online collaboration, while their digital competences level is predicted by the self-efficacy in ICT and the used strategies to evaluate information. Hatlevik (2016) goes further to proposing the implementation of national and school programs to instruct teachers in the use of ICT in teaching to increase their digital competences.

Furthermore, the use of ICT in teaching and assessment tasks, is shown to positively influence learning, measured by the ICT-based seminar assessment and exam score. The most used digital skills by students, which are Word processor skills, were found to be significant predictors of all three exams scores, and also for the seminar assignment in Course 1 and Course 2. Other digital skills were also found to be significant predictors in several courses, such as Email, or School IS, and they were also found to be correlated with digital competences, but differently for each course. These findings show that the foundation of digital skills, text editing, remains the most important skill for students to help with their learning activities, which are results supported by the Czech National Statistics Bureau (, 2021).

Moreover, the linear regressions models for digital competences found only two significant predictors, Critical Thinking for Course 1, and Digital Citizenship for Course 3, while Critical thinking was positively correlated with Word processor and Email digital skills for Course 1. The lack of more significant correlations between digital skills and digital competences for all courses indicates that not all the competences make use of the same digital skills and to the same extent for each course task and subject matter. The teacher is guiding the use of materials and methods in class, while driving the independent work through the seminar work requirements. The pedagogical intervention of how ICT was used in each class, affected the relationship between digital skills and competences of students in each course. Moreover, considering the fact that the self-reports were collected at the beginning of the semester, while the course assessments were performed at the end, it is also possible that the students' digital skills at the end of the semester progressed.

The medium-strong positive correlations between communication-based DS proficiency and assignment and/or exam scores in Course 1 and Course 3 suggests communication was essential for students' understanding, such as being able to take notes and use them effectively later, clarify requirements with teachers and peers, and express their understanding. It may also suggest that the ability to locate study materials, information about class activities, and being able to submit one's assignments according to requirements and on time, along with the ability to communicate with your teachers and peers for class purposes are similarly essential for their class performance. Students can effectively use these skills also if the institutional and class environment allows it, as part of the systemic influence of ICT tools effect on learning (Stensaker et al., 2007; Gibson et al., 2018). As reported by interviewees, being able to pay attention to the teacher in class makes it less likely for them to get distracted by the digital tools used to take notes during class, which they can transfer in digital form at home. At the same time, effective use of digital communication benefits the students by being able to clarify information with teachers and peers quickly to absorb the material while still fresh. Having Wi-Fi connection in the school and on their devices, as well as a course online streaming platform, allow them also to search information on the spot, connect to classes remotely and not miss as much as they would in the absence of those. Communication in person with the teacher was also mentioned as being refreshing in the school, which is a result of being a small-size HEI. In larger HEI classes, teachers are reported as "always on the move" (Charming, 196-197), which hinders the effective personal teacher-student communication. A more effective and personal teacher-student communication style can make the students more receptive to the taught information. These factors are indicative of the positive effect of the synchronous social interaction with a teacher (Vygotsky, 1962, Kim et al., 2013; Hernandez, 2017), and of role of exo and meso-system factors in the student's performance, supporting the use of Bronfenbrenner's ecological system theory when analysing the complex role of ICT in education (Rosa & Tudge, 2013).

Furthermore, as previously suggested by Stensaker et al. (2007) and Kim et al. (2013) the study showed that the more intense use of ICT alone does not necessarily improve class performance. These finding support also Ackerman & Goldsmith (2011) and Singer & Alexander (2016) which found that reading from paper increases learning, compared to reading materials in electronic form. However, in this study an improvement in class performance is observed if ICT is used in diverse activities, including practical exercises, which make use of the students' DS strengths. Course 2 and 3 had the same range of ICT-tools used in class and that were required in seminar assignments, yet the differences in the type of DS used made the difference between the scores they received in seminar assignments. Moreover, the ICT-tools used in class in Course 2 additional to the students' own DS seem to have impacted their Digital Citizenship score making it a reliable predictor for the exam score. In Course 1 though Critical Thinking was found to be a reliable predictor for the exam score, indicating that perhaps the larger range of ICT and non-ICT tools used in teaching increased the student's ability to effectively evaluate and integrate information and perform better in the exam. Using pedagogical methods (ICT or non-ICT) that develop critical thinking, communication, and digital citizenship can help with the transference of the acquired knowledge and skills across domains and activities, which the isolated use of certain ICT tools cannot provide (Simons et al., 2016; Souders et al., 2017).

For each course different ICTE-MM competences were found for correlate strongly and positively with the exam score, indicating that the assignments and the exams required more from the students than memorizing facts and figures, such as critical thinking, communication skills, and research fluency. Also, they may suggest that the more, and more diverse, ICT and non-ICT tools were used in class, the more of those ICTE-MM areas were used by students in class and exam, supporting the research that showed positive effects between ICT in teaching and student's developed abilities (Lim et al., 2013; Hsin et al., 2014). Additionally, more non-ICT tools were mentioned in Course 1 and 3 and overall as being useful in their learning. Furthermore, students evaluated positively the class dynamic, teachers' approach to communication, therefore we can extract from all the data that ICT-tools can develop skills and increase class performance in students, but only in corroboration with good teacher-student communication (ICT-mediated or in-person) and pedagogical skills.

While the studies measured quantitatively the academic performance of students in exam and assignment scores, it was in the interviews that other factors, apart from the use of ICT tools and teacher's skills, can influence this performance. One such factor can be inferred from the relationship between the scores in exam and assignments in all three courses. In Table 13 figures indicate that the students who prepared well or bad for the assignment in Course 3 were likely to earn a similar grade for their assignment and exams in all the other courses. Similarly, a good/bad preparation for exam in Course 1 is associated with a strong likelihood of earning a grade in a similar range for the assignments in Course 1 and 3, exams in Course 2 and 3. Moreover, a good/bad grade at the exam for Course 3 is associated with a high likelihood to ears a grade in a similar range at exams for Course 1 and 2 and for the assignment in Course 1. These figures show how the student's motivation (or lack of) to learn can spill over into other classes, diminishing the role of factors such as the use of ICT tools, digital maturity of the institution, and/or teachers' skills. This inference from the studies' findings is supported by Vansteenkiste et al. (2006), who state intrinsic motivation produces deep learning of the material, more profound understanding of course concepts, and greater persistence of tasks effect, compared to the opposite effect of extrinsic motivation. In fact, Everaert et al., (2017) found that intrinsic motivation is positively correlated with deep learning, which is positively correlated with academic performance in accounting. On the other hand, intrinsic motivation is negaitvely correlated with surface learning, which is itself negatively correlated with academic performance. Motivation, intrinsic or extrinsic, positively predicted most of the deep learning approach to learning in students, while intrinsic motivation negatively predicted surface approach, and extrinsic motivation positively predicted surface approach to learning in students (Everaert et al., 2017). Essentially, the figures from the thesis, additional to existing literature, show the interaction between the micro-system and exo-system factors, giving rise to the meso-system phenomena.

Additionally, the path analysis diagrams in Figures 9-12 (Appendix – Section 13.2.) and the correlations from Table 11, indicate that there are differences in how the students' skills and competences are used in the course assignments, because for the same set of digital skills and competences of students who participated in all three courses, or in any pair of two courses, if a core set of skills and competences can influence the student's performance regardless of the type of skills and competences needed for the course assignment, it would create strong correlational relationships among all seminar and exam scores, which the current figures do not exhibit. These findings can be interpreted as the result of the task type tapping into specific digital skills and competences, tailored to the course content by the teacher. To be able to foster the students' academic performance, the school should ensure all needed digital skills and competences for a large range of subjects are sufficiently developed in all students.

4.3.2. Digital maturity of a HEI in social sciences

A more unusual finding was the negative strong correlation between the DMC and ICTE-MM competencies in Course 1 and Course 3. While it is difficult to reliably interpret these findings not knowing if students understand well the concept of digital maturity, they may roughly suggest that a better DMC rating corroborated with the student's met expectations of the use of ICT in class and an accurate evaluation of one own's gaps in DS, was reflected in the student's assignments scores, and their Research and information fluency and Communication and collaboration competencies (only for Course 1). Similarly, a lower DMC rating corroborated with the student's unmet expectations of the use of ICT in class and an accurate evaluation of one own's strengths in DS, was also reflected in their assignment scores, and the Research and information fluency and Communication and collaboration competencies (only for Course 1). The subjectivity of the student's experience is highly influential for this rating, and the interviewed students represented only a small sample, hence this indicator should be taken with reservations, as also should its interpretation in this paper.

The institutional measure of digital maturity using questionnaires, class observations and interviews indicated that the HEI employees overestimated the digital capability of all included KDAs in all domains except STU. The difference in the STU category can be explained by the more intense use of ICT tools in the included classes, which helped nurture the digital abilities of the students, alongside other teaching methods employed. The field of the HEI is important for the range of ICT tools that can be employed to convey the subject matter to students, and, similarly, to attract teaching and non-teaching staff that are capable to innovate the school's activity by incorporating more ICT tools. The mathematical universe hypothesis (Tegmark, 2007) proposes that the further we go towards social sciences, the more interpretative language we use to explain the field's subject matter, as opposed to objective mathematical structures (Figure 16). Thus, the range of ICT tools used in education for natural science fields (drill and practice programs, tutoring system, intelligent tutoring systems, simulations, hypermedia systems (Hillmayr et al., 2020) is broader than for social sciences, where teachers can generally aim at most to use ICT to engage students in social and civic activities discussed and critically debated in-person or using ICT for information search (Ferreira & Bombardelli, 2016). As a consequence, in social sciences, a HEI's the range of ICT tools in teaching is reduced mostly to digitally stored interpretative content (e.g. hypermedia systems, presentations, videos, pictures, etc), and has less available algorithm-based data/information (e.g. interactive graphs, live maps, simulations, etc.). Thus, these differences in the DM ratings also suggest that the HEI size and its non-technical field constitute influential factors in formally and consistently adopting (or delaying the adoption) of ICT in teaching, infrastructure, and school administration, which supports the findings of Langan et al. (2016).

Related to this thesis' research aim 7, in an integrative manner, again using the ecological system theory, we can interpret the findings from all the included sources as the interaction between the students' micro system and the teacher's micro system through their own digital skills and competences, communication skills, and pedagogical skills (only teacher), within the meso and macro system offered by the infrastructure and processes established at the HEI level. For example, as long as the way of presenting the subject matter of a course, the seminar assignment(s) and the exams do not all make use of the KDAs students need to develop and master, these will not be (easily) reflected in their class and exam performance. It is the interplay between stimulating these capabilities in students in teaching and offering them sources to investigate the subject matter further independently that ensure the level of their capabilities can develop. In addition, other micro-system factors may come into play as indicated by the qualitative study and inferred from quantitative data, such as the student's own motivation to learn (Afzal et al., 2010), time spent on preparing the assignments, and exam preparation, even if these factors were not specifically measured quantitatively in these studies. At the same time, the teacher is to a great extent limited or supported by the processes set by the HEI, such as the infrastructure available to them, the trainings offered to learn how to better create and deliver the subject matter, and the access to materials they can use in class. In a nutshell, these interactions between the factors of each system level give rise to the proximal processes which can nurture or hinder the student's learning activity and their academic performance (Rosa & Tudge, 2013). Thus, evaluating only the ICT tools used in teaching cannot offer an accurate image of what influences students' performance (Gibson et al., 2018; Begicevic Redjep et al., 2021), and should include a multi-layered framework that takes into account more than the isolated use of ICT in education.

Using the ecological system theory, in an integrative manner Figure 14 captures graphically the multitude of factors measured using quantitative research methods and identified using qualitative research methods using the ecological system theory, that have at its centre the effect of ICT tools on students' class performance in the investigated HEI. Similarly, Figure 15 captures the measured factors of influence on student's class performance per type of context, institutional and class.

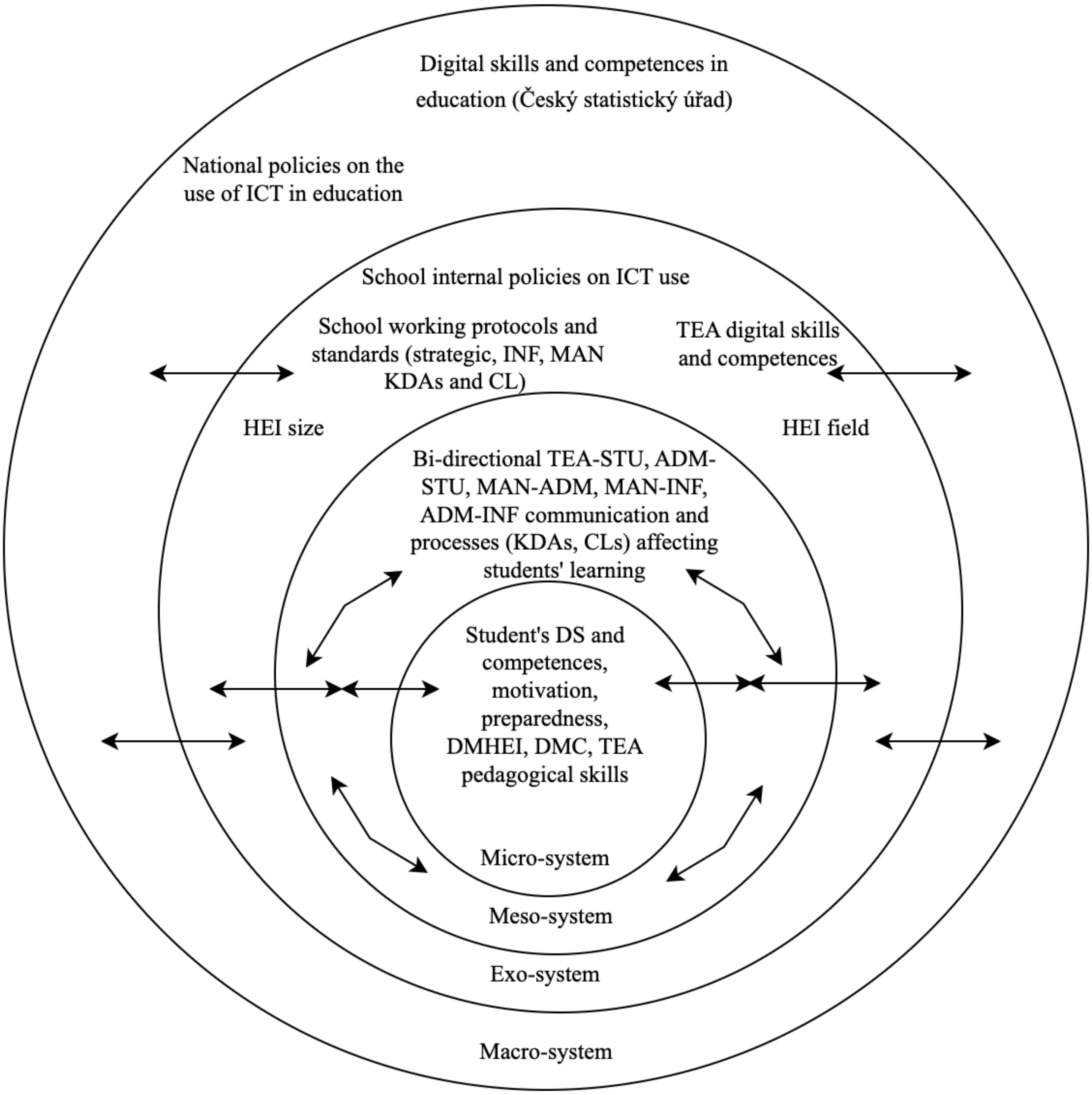

Figure 14. Factors of influence on the use of ICT in education per ecological system

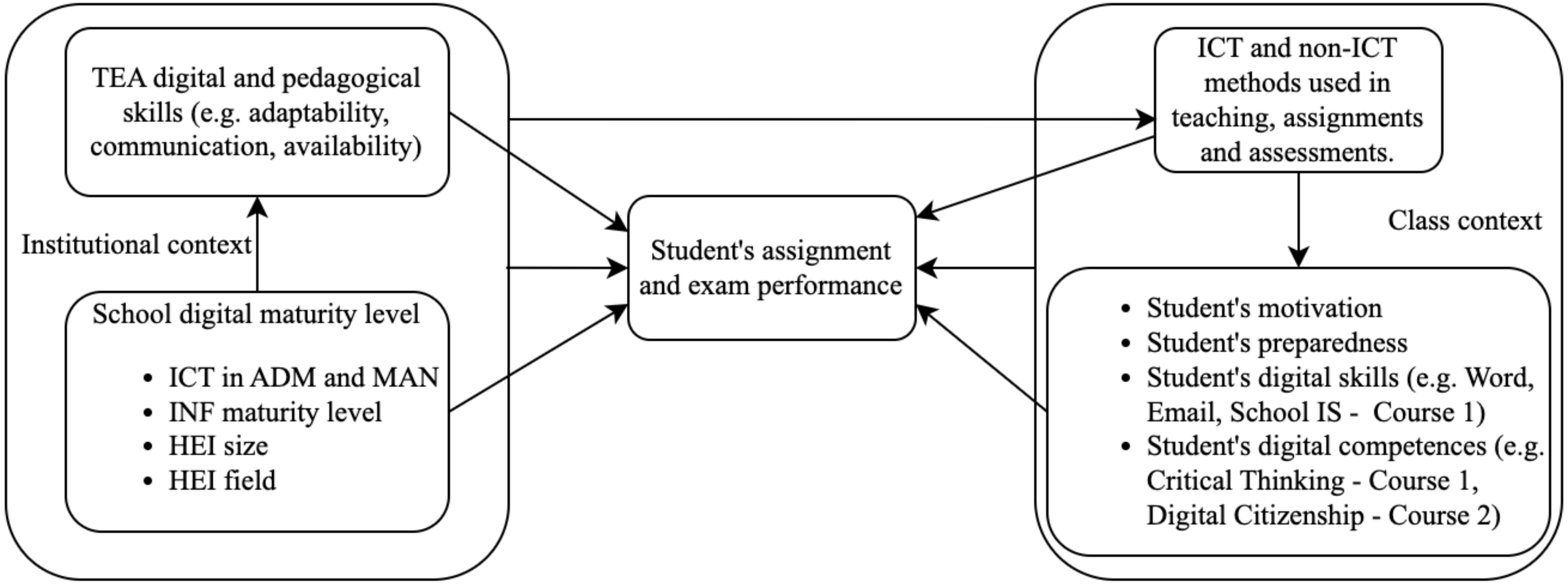

Figure 15. Relationships between ICT-dependent factors and student's course performance per context type

4.4. Limitations

The study's limitations are related to the sample size used for the class intervention, of only 34 students, though the number represents 75% of registered students, and using self-report as a data collection. The author attempted to overcome with the triangulation of data on students' performance and DS and included multiple measured on overlapping groups of students. Future research should use a larger student sample, at a HEI of a larger size, include more courses as data sources and compare the students' performance with that of control groups of students in classes taught by teachers using only conservative teaching methods. A subsequent project should also include more class observations to assess the digital skills of the teachers in the HEI, and triangulation of data captured in administration. It would be also useful to include practical evaluation of students' digital skills, to compare them with the self-reported levels, while also taken repeated measures of the digital skills of students in the beginning and at the end of the semester.

The current study revealed new and interesting aspects of the effectiveness of ICT tools used in teaching in tertiary education in the field of social sciences, yet it is only one institution included in the study and this aspect demands further work to be done in this field. Replicating the study, with as many corrections of the design limitations as can be included, in a different social sciences HEI, would bring additional information as to what is the role of the HEI's digital maturity, the student's digital skills, the teacher's digital abilities, and the subject matter ability to be expressed and exercised using available ICT tools, in the students' academic performance.

4.5. Recommendations for the HEI

The studies presented in this paper are completed, the data has been analysed and interpreted. The last research aim of this thesis is to provide a set of recommendation for the analysed HEI, based on the available models and literature and the results of the included studies, summarised in the results and discussion sections. The recommendations will be structured per each domain from the ICTE-MM model (Solar et al., 2013). The ADM, INF, TEA, and STU domain recommendations depend on the ability of the school management to implement the recommendation for the MAN domain.

4.5.1. MAN - Management domain

1. Conduct a thorough evaluation of the to-day status of technology-based tools used in teaching, administration, and infrastructure using a standardised model. There are several such models available (ISTE, ICTE-MM, ICDL, ECDL, NETS, NCCA), and the recommendation is to use one that allows the comparison of the findings with other similar HEIs for both the student's (client) informed decision and the school's accurate situatedness on the educational service market. ICTE-MM (Solar et al, 2013) has the benefit of assessing all the relevant domains in a school, not just the digital competences of students and teachers, at different levels of development, and using a framework to evaluate and plan the introduction of technologies in education is beneficial for the teaching staff (Liu & Kleinsasser, 2015).
2. Based on the findings from this thesis, the management should create a role that is well-trained in the role of ICT in education, to create, maintain, and update the plans for the use of ICT in the HEI's activities, as well as to create training sessions for the HEI employees when new technology is included in the school's activities. Given the small size of the HEI, the role could be assigned to an IT employee, or an administrative one.
3. Using the model adopted at point 1, the person assigned to the role from point 2 should create a road map for the digital maturity of the HEI which should be aligned with the management's strategic plans for the school. The person assigned to this role should be focused on both continuous assessment of how ICT is used in school activities and on communicating with the school staff and management about the status, and needed changes in the IT infrastructure, ICT tools used for communication, management, and teaching.
4. As part of the management strategy, the management team must ensure the person(s) performing this role are regularly attending specialised trainings to improve their knowledge and skills needed for the role (Bozkuş, 2019; Svendsen, 2017; Unger & Tracey, 2013).
5. Based on the findings about the benefit of a mix of ICT and non-ICT teaching methods, the management team should include in their strategic plan for the teaching staff's development that they have the tools and flexibility to combine ICT-based (e.g. online applications, mobile applications, online quizzes, virtual labs, videos, etc.) and non-ICT teaching methods (e.g. field trips, simulation of course-related exercises, etc.) to enhance the transfer of the subject-matter they teach.

4.5.2. INF - Infrastructure domain

1. Solely based on the studies' findings, the school should ensure the IT infrastructure used in teaching and administration is set up consistently on all HEI's PCs and notebooks used for teaching and administrative activities.
2. The classrooms hardware should be functional and set up to ensure the teacher can easily use ICT materials and tools during classes, as well as for the communication with the students, assessments, and grading.
3. For each ICT tool used in class for teaching, communication, and administration (School IS, MS Teams, Moodle, academic DB etc.) IT should issue a manual guide and training material for all employees to be able to learn how to effectively use them. These materials should be made available to all employees before the start of the academic year, and in-person training sessions should be organised for new employees, and for all employees when they the material is updated and there are changes in the functionalities of the ICT tools.
4. For each ICT tool used by students for learning and for communicating with teachers and administration (School IS, MS Teams, Moodle, academic DB etc.) IT should issue a manual guide and training material for all students to be able to learn how to effectively use them. These materials should be made available to all students before the start of the academic year, and they should be updated every time there are changes in the functionalities of the ICT tools.

4.5.3. ADM - Administration domain

1. Based on the findings from the studies included in this thesis, the administrative staff should be part of the chosen managerial model recommended in the Management domain.
2. The administrative staff must be trained in using the ICT tools made available for their activities, but also be able to assist teachers with their teaching activities.
3. The administrative staff should have designated tools and processes to use for the communication with students (e.g. announcements on class organisation change, general announcements about the school year and exam dates, confirmation of completion of courses/degrees, etc), teachers, and the general public.
4. Administrative staff should be in charge of verifying and notifying responsible people of any inconsistencies or gaps affecting the teaching and assessment processes (e.g.

missing learning material, exam dates, course syllabus, individual/group access to academic DBs, etc.).

5. Being responsible for the maintenance, changes to, and communication of school's organisational charts, employees' availability, and designated location for communication with the public (including students), the administrative staff should have access to and maintain the repository with employees' contact details and employment status (including vacation days reserved), from which reports can be issued on request, based on set templates for the request type.
6. The administrative staff should maintain a list of attended trainings for the ICT tools used in school, as well as a list of accounts granted access to educational resources used by the teaching staff, and, in cooperation with the IT department, recommend when such trainings and accounts should be renewed, based on the ICTE-MM model.

4.5.4. TEA - Teachers domain

1. For the communication with students, the teachers should be assigned clear guidance on the ICT tools to be used, and when/if administrative/managerial/IT employees should be included in the communication.
2. Teaching staff should be trained, using in-house training sessions or online courses, to use the ICT equipment in classrooms and offices and be given clear instructions before the academic year starts on where manual guides and responsible people can be found.
3. Teachers should be made aware of the school's strategic plan on the use of ICT in teaching, to be able to effectively incorporate them in their classes, as well as to include other ICT-based teaching tools and methods they deem suitable for the taught subject, that depend on the IT infrastructure provided by the school.
4. Teachers should be provided with access to academic DB to be able to use up-to-date teaching materials in their classes.
5. Teachers should be supported in their practice to include also non-ICT teaching methods appropriate for the subject matter they teach, as the current studies showed a mix of teaching methods increase the transfer of information.

4.5.5. STU - Students domain

1. For the communication with teachers and school administration, students must be assigned clear guidance on the ICT tools to be used, and when/if administrative/managerial/IT/academic employees should be included in the communication.
2. Students should be trained, using in-house training sessions or online courses, to use the ICT equipment in classrooms and student rooms (if made available in the school) and be given clear instructions before the academic year starts on where manual guides and responsible people can be found.
3. Students should be provided with access to academic DB to be able to use up-to-date learning materials for their class assignments, independent research, and exam preparation.
4. Students should be offered training sessions and access to computer rooms to gain, improve, and train their digital skills and competences that they need in their learning and class-related academic research.

4.6. Research aims summary

The dissertation project included two studies designed to meet eight research aims.

1. For the assessment of the digital skills and competences of the students participating in the study, which constituted the research aim 1, the research methods and results (Tables 5-6, Figures 4-7) of the quantitative study provide clear and sufficient information to consider the research aim 1 met. The figures offer descriptive information of the tools used for the measurement, as well as the results and their interpretation of the measurements of digital skills and competences of students at a small private HEI in the field of social sciences.
2. The statistical analysis using SPSS and path analysis on the significant relationships between the students' digital skills and competences and their performance in class, reported in Tables 8-11, and 13, and Figures 9-12, provide the data which, together with the interpretation in the discussion section, to consider the research aim 2 met.
3. For the evaluation of whether varying the use of ICT-based teaching methods in class changes the students' performance in class, and for the measurement of the found relationships, SPSS correlational analysis, linear regression analysis and path analysis were used. The results reported in Tables 7-9, and 11-13, and Figures 5, 7, 8 -12, and

their interpretation from the discussion section, offer consistently information to consider the research aim 3 met.

4. The measurements of the DMHEI and DMC, and the maturity levels of the HEI based on ICTE-maturity model reported in Tables 4-6 and 11, and Figures 5, 10-12, 14, and 15, as well as their interpretation from the discussion section, offer consistently information to consider the research aims 4 and 5 met.
5. The qualitative study using the interview questions listed in Figure 13, which found three themes using thematic analysis, as well as the results of the content analysis of course feedback reported in Table 12 and Figure 8, provide the necessary information to consider the research aim 6 met.
6. The discussion section offers an integrative interpretation of the collected and reported data and their analysis, using the ecological system theory. Figures 9-12 and, especially, Figures 14-15 offer the graphic interpretation of the statistical results using the ecological system theory, with a focus on the impactful ICT-based factors on the students' course performance in the analysed HEI, which reflect the way research aim 7 was answered and met.
7. The analysis was followed by a series of recommendation specific for the analysed HEI, to improve their approach on how ICT is used in the school academic and administrative activities, which can improve the students' academic performance in this field where the adoption of ICT in teaching, at least, lags behind other academic fields. This list of recommendation from section 4.5., together with the input data found in Tables 4-6 and Figures 9-14, offer the required information to consider the research aim 8 met.

5. CONCLUSIONS

In an integrative manner, using the ecological system theory, we can interpret the findings from all the included sources as the interaction between the students' micro system and the teacher's micro system through their own DS, communication skills, and pedagogical skills (only teacher), within the meso and macro system offered by the infrastructure and processes established at the HEI level. For example, as long as the way of presenting the subject matter of a course, the seminar assignment(s) and the exams do not all make use of the KDAs students need to develop and master, these will not be (easily) reflected in their class and exam performance. It is the interplay between stimulating these capabilities in students in teaching and offering them sources to investigate the subject matter further independently that ensure the level of their capabilities can develop. In addition, other micro-system factors may come into play, such as the student's own motivation to learn (Everaert et al., 2017; Vansteenkiste et al., 2006; Afzal et al., 2010), but this was not measured in these studies. At the same time, the teacher is to some extent limited to or supported by the processes set by the HEI, such as the infrastructure available to them, the trainings offered to learn how to better create and deliver the subject matter, and the access to materials they can use in class. In a nutshell, these interactions between the factors of each system level give rise to the proximal processes which can nurture or hinder the student's learning activity and their academic performance (Rosa & Tudge, 2013). Thus, evaluating only the ICT tools used in teaching cannot offer an accurate image of what influences students' performance (Gibson et al., 2018; Begicevic Redjep et al., 2021), and should include a multi-layered framework that takes into account more than the isolated use of ICT in education.

The findings of the presented studies indicate that the use of ICT in teaching in social sciences classes in a HEI at least partially predicted the students' performance in course assignments and exams. At the same time, the teacher's traditional role of guiding, communicating, and adapting the content to the learner's abilities is also recognized as an important factor influencing the acquisition of knowledge and skills by students themselves. Using a complex methodology of quantitative and qualitative research methods to identify micro, meso, exo and macro factors in the educational environment, this study supports the view of prior research (Gibson et al., 2018; Solar et al., 2013; Begicevic Redjep et al., 2021) that there is a need for a more consolidated and standardized, yet flexible, research framework in the field of ICT in education for collecting and measuring the data, but also for their interpretation to properly evaluate the role of ICT in education, and the effect of ICT-based education in our society.

6. REFERENCES

Ackerman, R., & Goldsmith, M. (2011). Metacognitive regulation of text learning: On screen versus on paper. *Journal of Experimental Psychology: Applied*, *17*(1), 18-32. doi:10.1037/a0022086

Afzal, H., Ali, I., Aslam Khan, M., & Hamid, K. (2010). A study of University students' motivation and its relationship with their academic performance. *International Journal of Business and Management*, *5*(4). https://doi.org/10.5539/ijbm.v5n4p80

Ahmed, S., & Parsons, D. (2013). undefined. *Computers & Education*, *63*, 62-72. https://doi.org/10.1016/j.compedu.2012.11.017

AL-Ali, M., & Marks, A. (2021). A digital maturity model for the education enterprise. *Perspectives: Policy and Practice in Higher Education*, *26*(2), 47-58. https://doi.org/10.1080/13603108.2021.1978578

Ala-Mutka, K. (2011). *Mapping Digital Competence: Towards a Conceptual Understanding* (JRC67075-201). Retrieved from European Commission website: ftp://s-jrcsvqpx102p.jrc.es/pub/EURdoc/JRC67075_TN.pdf

Alter, A. (2023, April 20). *Book bans rising rapidly in the U.S., free speech groups find.* The New York Times. https://www.nytimes.com/2023/04/20/books/book-bans-united-states-free-speech.html

Aslanova, I., & Kulichkina, A. (2020). Digital maturity: Definition and model. *Proceedings of the 2nd International Scientific and Practical Conference "Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth" (MTDE 2020)*. https://doi.org/10.2991/aebmr.k.200502.073

Aviram, A., & Eshet-Alkalai, Y. (2006). Towards a Theory of Digital Literacy: Three Scenarios for the Next Steps. *European Journal of Open, Distance and eLearning*, *1*, 1-11. Retrieved from http://www.eurodl.org/index.php?p=archives&year=2006&halfyear=1

Armstrong, K. (2023, July 5). *Netherlands: Phone ban announced to stop school disruptions*. BBC News. https://www.bbc.com/news/world-europe-66107027

BBC News. (2023, July 5). *Netherlands: Phone ban announced to stop school disruptions*. https://www.bbc.com/news/world-europe-66107027

Begicevic Redjep, N., Balaban, I., & Zugec, B. (2021). *Assessing digital maturity of schools: Framework and instrument.* Technology, Pedagogy and Education, *30*(15), 643-658. https://doi.org/10.1080/1475939x.2021.1944291

Bozkuş, K. (2019). The application of the dynamic teacher professional development through experimental action research. *lnternational Electronic Journal of Elementary Education*, *11*(4), 335-352. https://doi.org/10.26822/iejee.2019450792

Bronfenbrenner, U., & Evans, G. W. (2000). *Developmental science in the 21 St century: Emerging questions, theoretical models, research designs and empirical findings.* Social Development, *9*(1), 115-125. https://doi.org/10.1111/1467-9507.00114

Davis, K. A., Grote, D., Mahmoudi, H., Perry, L., Ghaffarzadegan, N., Grohs, J., Hosseinichimeh, N., Knight, D. B., & Triantis, K. (2023). Comparing self-report assessments and scenario-based assessments of systems thinking competence. *Journal of Science Education and Technology*, *32*(6), 793-813. https://doi.org/10.1007/s10956-023-10027-2

Durek, V., Kadoic, N., & Begicevic Rediep, N. (2018). Assessing the digital maturity level of higher education institutions. *2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*. https://doi.org/10.23919/mipro.2018.8400126

The Earth Institute, Columbia University, & Ericsson. (2016). ICT and Education. *Sustainable Development Solutions Network*. http://www.jstor.org/stable/resrep15879.11

ECDL. (n.d.). International certification of digital literacy. *European / International Certification of Digital Literacy and Digital Skills*. Retrieved February 2023, from https://ecdl.cz/o_projektu.php

Edwards, S., Henderson, M., Gronn, D., Scott, A., & Mirkhil, M. (2016). Digital disconnect or digital difference? A socio-ecological perspective on young children's technology use in the home and the early childhood centre. *Technology, Pedagogy and Education*, *26*(1), 1-17. https://doi.org/10.1080/1475939x.2016.1152291

Eshet, Y. (2004). Digital Literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*, *13*(1), 93-106. Retrieved from https://www.learntechlib.org/primary/p/4793/

Eshet-Alkalai, Y., & Chajut, E. (2009). Changes Over Time in Digital Literacy. *CyberPsychology & Behavior*, *12*(6), 713-715. doi:10.1089/cpb.2008.0264

European Parliament and Council. (2008). *Recommendation of the European Parliament and of the Council on the establishment of the European Qualifications Framework for lifelong learning* (C111/111). Retrieved from Official Journal of the European Union website: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008H0506%2801%29

Everaert, P., Opdecam, E., & Maussen, S. (2017). The relationship between motivation, learning approaches, academic performance and time spent. *Accounting Education*, *26*(1), 78-107. https://doi.org/10.1080/09639284.2016.1274911

Eynon, R., & Geniets, A. (2015). The digital skills paradox: how do digitally excluded youth develop skills to use the internet? *Learning, Media and Technology*, *41*(3), 463-479. doi:10.1080/17439884.2014.1002845

Ferrari, A. (2012). *Digital Competence in Practice: An Analysis of Frameworks* (Report EUR 25351EN). Retrieved from European Commission website: ftp://s-jrcsvqpx102p.jrc.es/pub/EURdoc/JRC67075_TN.pdf

Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe* (EUR 26035). Retrieved from European Commission website: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83167/lb-na-26035-enn.pdf

Ferrari, A., Punie, Y., & Redecker, C. (2012). Understanding Digital Competence in the 21st Century: An Analysis of Current Frameworks. *Lecture Notes in Computer Science*, 79-92. doi:10.1007/978-3-642-33263-0_7

Ferreira, P. D., & Bombardelli, O. (2016). Editorial: Digital Tools and Social Science Education. *Journal of Social Science Education*, *15*(1), 1-4. https://doi.org/10.4119/UNIBI/jsse-v15-i1-1522

Garnham, N. (2000). *Information society theory as ideology: A critique.* Loisir et Société / Society and Leisure, *21*(1), 97-120. https://doi.org/10.1080/07053436.1998.10715565

Gibson, D., Broadley, T., Downie, J., & Wallet, P. (2018). *Evolving learning paradigms: re-setting baselines and collection methods of Information and Communication Technology in education statistics.* Journal of Educational Technology & Society, *21*(2), 62-73. https://www.jstor.org/stable/10.2307/26388379. Published by: International Forum of Educational Technology & Society

Hargittai, E. (2005). Survey measures of web-oriented digital literacy. *Social Science Computer Review*, *23*(3), 371-379. https://doi.org/10.1177/0894439305275911

Hatlevik, O. E. (2016). Examining the relationship between teachers' self-efficacy, their digital competence, strategies to evaluate information, and use of ICT at school. *Scandinavian Journal of Educational Research*, *61*(5), 555-567. https://doi.org/10.1080/00313831.2016.1172501

Helsper, E. J., & Eynon, R. (2013). Distinct skill pathways to digital engagement. *European Journal of Communication*, *28*(6), 696-713. doi:10.1177/0267323113499113

Hernandez, R. M. (2017). *Impact of ICT on Education: Challenges and Perspectives.* Propósitos y Representaciones, *5*(1), 325-347. https://doi.org/10.20511/pyr2017.v5n1.149

Hilbert, M., & López, P. (2011). *The world's technological capacity to store,communicate, and compute information.* Science, *332*(6025), 60-65. https://doi.org/10.1126/science.1200970

Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers & Education*, *153*, 103897. https://doi.org/10.1016/j.compedu.2020.103897

Hsin, C. T., Li, M. C., & Tsai, C. C. (2014). *The Influence of Young Children's Use of Technology on Their Learning: A Review.* Journal of Educational Technology & Society, *17*(4), 85-99. https://www.jstor.org/stable/10.2307/jeductechsoci.17.4.85
Review Articles in Educational Technology (October 2014), Published by: International Forum of Educational Technology & Society

ISTE. (n.d.). ISTE Standards. Retrieved August 2022, from https://www.iste.org/iste-standards

ITU. (2022). Measuring digital development. Facts and figures 2022. *International Telecommunication Union*. https://www.itu.int/itu-d/reports/statistics/facts-figures-2022/ ISBN 978-92-61-37011-5

Kim, S., Chung, K., & Yu, H. (2013). *Enhancing digital fluency through a training program for creative problem solving using computer programming.* The Journal of Creative Behavior, *47*(3), 171-199. https://doi.org/10.1002/jocb.30

Kline, R. R. (2006). *Cybernetics, management science, and technology policy: The emergence of "Information Technology" as a keyword, 1948-1985.* Technology and Culture, *47*(3), 513-535. https://doi.org/10.1353/tech.2006.0184

Langan, D., Schott, N., Wykes, T., Szeto, J., Kolpin, S., Lopez, C., & Smith, N. (2016). Students' use of personal technologies in the university classroom: Analysing the perceptions of the digital generation. *Technology, Pedagogy and Education*, *25*(1), 101-117. https://doi.org/10.1080/1475939x.2015.1120684

Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S., & Tsai, C. C. (2013). *Bridging the Gap: Technology Trends and Use of Technology in Schools.* Journal of Educational Technology & Society, *16*(2), 59-68. https://www.jstor.org/stable/10.2307/jeductechsoci.16.2.59
Grand Challenges and Research Directions in e-Learning of the 21th Century (April 2013), Published by: International Forum of Educational Technology & Society

Liu, M. H., & Kleinsasser, R. C. (2015). Exploring EFL teachers' CALL knowledge and competencies: In-service program perspectives. *Language Learning & Technology*, *19*(1), 119-138. https://api.semanticscholar.org/CorpusID:146472318

Livingstone, S. (2004). Media literacy and the challenge of new information and communication technologies. *The Communication Review*, *7*(1), 3-14. https://doi.org/10.1080/10714420490280152

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford Review of Education*, *38*(1), 9-24. https://doi.org/10.1080/03054985.2011.577938

Livingstone, S., & Helsper, E. (2009). Balancing opportunities and risks in teenagers' use of the internet: the role of online skills and internet self-efficacy. *New Media & Society*, *12*(2), 309-329. doi:10.1177/1461444809342697

Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and Tools for Digital LiteracyDevelopment. *Innovation in Teaching and Learning in Information and Computer Sciences*, *5*(4), 249-267. Retrieved from DOI: 10.11120/ital.2006.05040249

Misuraca, G., Codagnone, C., & Rossel, P. (2013). *From practice to theory and back to practice: Reflexivity in measurement and evaluation for evidence-based policy making in the information society.* Government Information Quarterly, *30*, S68-S82. https://doi.org/10.1016/j.giq.2012.07.011

Park, S., & Weng, W. (2020). *The relationship between ICT-related factors and student academic achievement and the moderating effect of country economic indexes across 39 countries: using multilevel structural equation modelling.* Educational Technology & Society, *23*(3), 1-15. https://www.jstor.org/stable/10.2307/26926422

Prestridge, S., Tondeur, J., & Ottenbreit-Leftwich, A. T. (2019). Insights from ICT-expert teachers about the design of educational practice: The learning opportunities of social media. *Technology, Pedagogy and Education*, *28*(2), 157-172. https://doi.org/10.1080/1475939x.2019.1578685

Rahman, A., & Rahman, F. M. (2015). *Knowledge, attitude and practice of ICT use in teaching and learning: In the context of Bangladeshi tertiary education.* International Journal of Science and Research (IJSR), *4*(12), 755-760. https://doi.org/10.21275/v4i12.nov152006

Rosa, E. M., & Tudge, J. (2013). *Urie Bronfenbrenner's theory of human development: Its evolution from ecology to bioecology.* Journal of Family Theory & Review, *5*(4), 243-258. https://doi.org/10.1111/jftr.12022

Shelton, C. (2016). Giving up technology and social media: Why university lecturers stop using technology in teaching. *Technology, Pedagogy and Education*, *26*(3), 303-321. https://doi.org/10.1080/1475939x.2016.1217269

Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. (2016). Do “brain-training” programs work? *Psychological Science in the Public Interest*, *17*(3), 103-186. https://doi.org/10.1177/1529100616661983

Singer, L. M., & Alexander, P. A. (2016). Reading Across Mediums: Effects of Reading Digital and Print Texts on Comprehension and Calibration. *The Journal of Experimental Education*, *85*(1), 155-172. doi:10.1080/00220973.2016.1143794

Solar, M., Sabattin, J., & Parada, V. (2013). *A Maturity Model for Assessing the Use of ICT in School Education.* Journal of Educational Technology & Society, *16*(1), 206-218. http://www.jstor.org/stable/jeductechsoci.16.1.206

Souders, D. J., Boot, W. R., Blocker, K., Vitale, T., Roque, N. A., & Charness, N. (2017). Evidence for narrow transfer after short-term cognitive training in older adults. *Frontiers in Aging Neuroscience*, *9*. https://doi.org/10.3389/fnagi.2017.00041

Spariosu, M. I. (2006). ‘Information and Communication Technology for Human Development: An Intercultural Perspective.’ In *Remapping knowledge: Intercultural studies for a global age*, 95-142. Berghahn Books. https://www.jstor.org/stable/j.ctv3znztw.6

Stensaker, B., Maassen, P., Borgan, M., Oftebro, M., & Karseth, B. (2007). *Use, updating and integration of ICT in higher education: Linking purpose, people and pedagogy.* Higher Education, *54*(3), 417-433. https://doi.org/10.1007/s10734-006-9004-x

Svendsen, B. (2016). Teachers’ experience from a school-based collaborative teacher professional development programme: Reported impact on professional development. *Teacher Development*, *20*(3), 313-328. https://doi.org/10.1080/13664530.2016.1149512

Tegmark, M. (2007). The mathematical universe. *Foundations of Physics*, *38*, 101-150. https://doi.org/10.1007/s10701-007-9186-9

Therrien, A. (2018, September 27). *Limiting children's screen time linked to better cognition*. BBC News. https://www.bbc.com/news/health-45651725

Tsatsou, P. (2011). Digital divides revisited: what is new about divides and their research? *Media, Culture & Society*, *33*(2), 317-331. doi:10.1177/0163443710393865

Unger, K. L., & Tracey, M. W. (2013). Examining the factors of a technology professional development intervention. *Journal of Computing in Higher Education*, *25*(3), 123-146. https://doi.org/10.1007/s12528-013-9070-x

Van Deursen, A. J., & Helsper, E. J. (2015). The Third-Level Digital Divide: Who Benefits Most from Being Online? *Communication and Information Technologies Annual*, 29-52. doi:10.1108/s2050-206020150000010002

Van Deursen, A. J., & Mossberger, K. (2018). Any Thing for Anyone? A New Digital Divide in Internet-of-Things Skills. *Policy & Internet*, *10*(2), 122-140. doi:10.1002/poi3.171

Van Deursen, A., & Van Dijk, J. (2008, May). *Measuring digital skills*. Paper presented at 58th Conference of the International Communication Association, Montreal, Canada. Retrieved from https://www.utwente.nl/nl/bms/com/bestanden/ICA2008.pdf

Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, *72*, 577-588. doi:10.1016/j.chb.2017.03.010

Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2018). 21st-century digital skills instrument aimed at working professionals: Conceptual development and empirical validation. *Telematics and Informatics*, *35*(8), 2184-2200. doi:10.1016/j.tele.2018.08.006

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educational Psychologist*, *41*(1), 19-31. https://doi.org/10.1207/s15326985ep4101_4

Volungevičienė, A., Brown, M., Greenspon, R., Gaebel, M., & Morrisroe, A. (2021). Developing a high performance digital education ecosystem. Institutional self-assessment instruments. *European University Association absl.* https://eua.eu/downloads/publications/digi-he%20desk%20research%20report.pdf

Vavoula, G., Sharples, M., Rudman, P., Meek, J., & Lonsdale, P. (2009). Myartspace: Design and evaluation of support for learning with multimedia phones between classrooms and museums. *Computers & Education*, *53*(2), 286 299. https://doi.org/10.1016/j.compedu.2009.02.007

Waite, B. M., Lindberg, R., Ernst, B., Bowman, L. L., & Levine, L. E. (2018). Off-task multitasking, note-taking and lower- and higher-order classroom learning. *Computers & Education*, *120*, 98-111. https://doi.org/10.1016/j.compedu.2018.01.007

Walsh, J. J., Barnes, J. D., Cameron, J. D., Goldfield, G. S., Chaput, J., Gunnell, K. E., Ledoux, A., Zemek, R. L., & Tremblay, M. S. (2018). Associations between 24 hour movement behaviours and global cognition in US children: A cross-sectional observational study. *The Lancet Child & Adolescent Health*, *2*(11), 783-791.

https://doi.org/10.1016/s2352-4642(18)30278-5

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., & Monseur, C. (2013). *The use of ICT in education: A survey of schools in Europe.* European Journal of Education, *48*(1), 11-27. https://doi.org/10.1111/ejed.12020

Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers & Education*, *58*(1), 365-374. https://doi.org/10.1016/j.compedu.2011.08.029

Černochová, M., Voňková, H., Štípek, J., & Černá, P. (2020). How do learners perceive and evaluate their digital skills? In I. Management Association (Ed.), *Learning and Performance Assessment: Concepts, Methodologies, Tools, and Applications* (pp. 1453-1464). IGI Global. https://doi.org/10.4018/978-1-7998-0420-8.ch0

Český statistický úřad. (2022, April 27). *Počítačové dovednosti v EU*. Český statistický úřad | ČSÚ. https://www.czso.cz/

Český statistický úřad. (2022, March 7). *Počítačové dovednosti v ČR*. Český statistický úřad | ČSÚ. https://www.czso.cz/

7. PUBLICATION LIST

Moldoveanu, M., Milkova, E. (2024). *The influence of students' personality traits and their parents' parenting style on Romanian student's performance in science subjects at secondary and university level.* Journal of Contemporary Central and Eastern Europe (publication decision received in August 2023)

Moldoveanu, M. (2022). *Developing Logical Thinking of Computer Science Students – Modelling the Curriculum and Teaching Environment*. In *DIVAI 2022 14th International Scientific Conference on Distance Learning in Applied Informatics* (pp. 257-266). Wolters Kluwer. https://www.divai.sk/assets/divai2022.pdf

Moldoveanu, M. (2022). Challenges and limitations of using an online survey in social sciences: Recruiting qualified respondents to investigate the job satisfaction and intention to leave of millennial employees. In *SAGE Research Methods: Doing Research Online*. SAGE Publications, Ltd., https://doi.org/10.4135/9781529600919

Moldoveanu, M., & Cirklova, J. (2022). Challenges and limitations of using an online survey in social sciences: Measuring beliefs and intentions related to the consumption of organic cotton clothing. In *SAGE Research Methods: Doing Research Online*. SAGE Publications, Ltd., https://doi.org/10.4135/9781529600926

Sevcikova, A., Milkova, E., Moldoveanu, M., & Konvicka, M. (2023). Graph theory: Enhancing understanding of mathematical proofs using visual tools. *Sustainability*, *15*(13), 10536. https://doi.org/10.3390/su151310536

8. CONFERENCE PARTICIPATION

Participant at the international conference ILIS2023 – Prague, International Lab for Innovative Social Research with the paper "The role of ICT in teaching social sciences in tertiary education" Prague, June 2023.

Participant at the international workshop "Trends in Digital Education" at the Western Czech University in Pilsen Pilsen, June 2022.

Participant at DIVAI2022 – Sturovo, Slovakia, with the paper "*Developing Logical Thinking of Computer Science Students – Modelling the Curriculum and Teaching Environment*." Sturovo, May 2022.

Participant at the International Conferences of Young Scholars, University of Economics in Prague Prague, 2004.

Participant at the International Conferences of Young Scholars, University of Economics in Prague Prague 2003.

Participant at the National Student Conference "End of State – Globalisation and Regionalism" Cluj Napoca, Romania, 2000.

9. LIST OF TABLES

10. LIST OF FIGURES

11. LIST OF LINEAR REGRESSION MODELS

12. LIST OF RELEVANT T-TESTS RESULTS

13. APPENDIX

13.1. Tables

Table 1. Teaching teachniques used in the courses included in the study

Teaching techniques	Course 1	Course 2	Course 3
ICT-based	Links to data and news	Links to data and news	Links to data and news
ICT-based	Videos	Videos	Videos
ICT-based	Presentation	Presentation	Presentation
ICT-based	Handouts	Handouts	Handouts
ICT-based	Reading materials	Reading materials	Reading materials
ICT-based	Projector	Projector	Projector
ICT-based	MS Teams	MS Teams	MS Teams
ICT-based	IS	IS	IS
ICT-based	Email	Email	Email
ICT-based	Facebook	Facebook	Facebook
ICT-based	Links to institutional data/instructions/legislation	Links to institutional data	Links to legislation
ICT-based	Mobile applications		
ICT-based	Live streaming of EU communications		
ICT-based Practical	Activity simulation (negotiation and voting)		
Practical	Field trip - exhibition 18.10 https://matterof.art/2022 https://www.ghmp.cz/en/exhibitions/biennale-matter-of-art-2022/	Field trip 8.12 https://www.ghmp.cz/en/exhibitions/john-wehrheim-paradise-lost/	Field trip - CNB 3.11 23.11 https://www.dox.cz/en/visit-us
Practical	Discussions	Discussions	Discussions
Conservative	Lecture	Lecture	Lecture

Table 2. The ICTE-MM domains, KDAs and CVs used in this study, per Solar et al. (2013)

Domain D_1 – Management (MAN)	MAN-KDA_1 – School management	CV_1 – Action plan for ICT use in school administration CV_2 – Technology plan in school administration CV_3 – Monitoring and evaluation plan for the use of ICT in school administration CV_4 – Verification of individual use of ICT use in school administration CV_5 – The use of ICT for report cards, registration, qualifications CV_6 – the use of ICT for follow-ups procedure for teacher-student cases
	MAN-KDA_2 – Vision, strategies, and policies	CV_1 – The existence of an alignment strategy with best practices in the industry for the use of ICT resources for the school's vision, strategy, and priorities CV_2 – Commitment of senior management toward aligning with best practices for using ICT in school management CV_3 – Communication with school community using ICT CV_4 – Policy regarding the use of internet resources in school CV_5 – Policy regarding the acquisition and technological resources to meet the school's needs
	MAN-KDA_3 – Organisation and ICT management	CV_1 – Planning guidance for the IT infrastructure CV_2 – IT infrastructure planning CV_3 – IT process map CV_4 – The use of ICT for the definition of organisational structure
Domain D_2 – Infrastructure (INF)	INF-KDA_1 – Software	CV_1 – Operating system CV_2 – Educational software CV_3 – Administrative software
	INF-KDA_2 – Networks	CV_1 – Internet CV_2 – Wi-fi CV_3 – Intranet

	INF-KDA$_3$ – Hardware	CV$_1$ – Access to computer room CV$_2$ – Quality for technological equipment for educational use
	INF-KDA$_4$ – Maintenance plan	CV$_1$ – Maintenance of equipment CV$_2$ – Operational maintenance supplies CV$_3$ – Existence of a maintenance plan
Domain D$_3$ – Administration (ADM)	ADM-KDA$_1$ – Leadership and vision	"Educational leaders inspire a shared vision for comprehensive integration of ICT and foster an environment and culture conducive to the realisation of that vision." (Solar et al., 2013, p. 212)
	ADM-KDA$_2$ – Learning and teaching	"Educational leaders ensure that curricular design, instructional strategies, and learning environments integrate appropriate ICT to maximise learning and teaching." (Solar et al., 2013, p. 212)
	ADM-KDA$_3$ – Productivity and professional practice	"Educational leaders apply ICT to enhance their professional practice and increase their own productivity and that of others." (Solar et al., 2013, p. 212)
	ADM-KDA$_4$ – Support, management and operations	"Educational leaders ensure the integration of ICT to support productive systems for learning and administration." (Solar et al., 2013, p. 212)
	ADM-KDA$_5$ – Assessment and evaluation	"Educational leaders use ICT to plan and implement comprehensive systems of effective assessment and evaluation." (Solar et al., 2013, p. 212)
	ADM-KDA$_6$ – Social, legal, and ethical issues	"Educational leaders understand the social, legal, and ethical issues related to ICT and model responsible decision-making related to these issues." (Solar et al., 2013, p. 212)
Domain D$_4$ – Teachers (TEA)	TEA-KDA$_1$ – Student learning and creativity	"Teachers use their knowledge of the subject matter, teaching and learning practices, and ICT to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments." (Solar et al., 2013, p. 212)
	TEA- KDA$_2$ – Digital-age learning	"Teacher design, develop, and evaluate authentic learning experiences and assessments, incorporating contemporary tools and resources

	experiences and assessment	to maximise content learning in context and to develop knowledge, skills, and personal attitudes." (Solar et al., 2013, p. 212)
	TEA-KDA$_3$ – Digital-age work and learning	"Teacher exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society." (Solar et al., 2013, p. 212)
	TEA-KDA$_4$ – Digital citizenship and responsibility	"Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behaviour in their professional practices." (Solar et al., 2013, p. 212)
	TEA-KDA$_5$ – Professional growth and leadership	"Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources." (Solar et al., 2013, p. 212)
Domain D$_5$ – Students (STU)	STU-KDA$_1$ – Creativity and innovation using ICT	CV$_1$ – Students demonstrate creative thinking using ICT CV$_2$ – Students acquire knowledge using ICT CV$_3$ – Students develop innovating products using ICT
	STU- KDA$_2$ – Communication and collaboration using ICT	CV$_1$ – Students communicate using ICT CV$_2$ – Students work collaboratively using ICT CV$_3$ – Students support individual learning using ICT CV$_4$ – Students contribute to the learning of others using ICT
	STU-KDA$_3$ – Research and information fluency	CV$_1$ – Students use digital tools to gather information CV$_2$ – Students use digital tools to evaluate information CV$_3$ – Students use digital tools to use information
	STU-KDA$_4$ – Critical thinking, problem solving, and decision-making	CV$_1$ – Students use critical thinking to plan and conduct research using appropriate digital tools and resources CV$_2$ – Students manage projects using appropriate digital tools and resources

		CV_3 – Students solve problems using appropriate digital tools and resources CV_4 – Students make informed decisions using appropriate digital tools and resources
	STU-KDA$_5$ – Digital citizenship	CV_1 – Students understand human, cultural, and societal issues related to ICT CV_2 – Students practice legal and ethical behaviour
	STU-KDA$_6$ – Technology, operations and concepts	CV_1 – Students demonstrate a sound understanding of technological concepts CV_2 – Students demonstrate a sound understanding of technological systems CV_3 – Students demonstrate a sound understanding of technological operations

Table 3. Examples of answering scales per included domain (Solar et al., 2013).

Domain	Examples of answering scales
Domain D_1 – Management (MAN)	1. There is no plan 2. There is an informal plan 3. There is a formal plan 4. There is a formal and standardised plan 5. There is a plan, and it is annually reviewed 1. There is no plan 2. There is an informal plan 3. There is a formal plan 4. There is a formal and standardised plan 5. There is a plan based on the best practices 1. There is no verification 2. There is an informal verification 3. There is a formal verification procedure 4. There is a formal and standardised verification procedure 5. There is a verification procedure based on the best practices 1. There are no reports automatically generated 2. There are no formal procedures 3. There are formal procedures 4. There is a standardised way to generate reports

	5. All reports are using ICT and best practices 1. There is no IT infrastructure planning 2. There is an informal IT infrastructure planning 3. There is a formal IT infrastructure plan 4. There is a standardised IT infrastructure plan 5. There is an IT infrastructure plan based on the best practices
Domain D_2 – Infrastructure (INF)	1. There is no plan to upgrade the technological equipment for educational use in the school 2. There is an informal plan to upgrade the technological equipment for educational use in the school 3. There is a formal plan to upgrade the technological equipment for educational use in the school 4. There is a formal and standardised procedure for upgrading of the technological equipment for educational use in the school 5. There is a formal and standardised procedure for upgrading of the technological equipment for educational use in the school, and it is annually reviewed 1. There is no maintenance of the equipment 2. There is an informal maintenance activity, based on incidence occurrence 3. There is a formal maintenance of the equipment, based on warranty requirements, 4. There is a formal and standardised maintenance procedure for the equipment decided by the technical department 5. There is a formal and standardised maintenance procedure of the equipment, and it is annually reviewed to fit best practices 1. There is no plan for the acquisition of operational maintenance supplies 2. There is an informal plan for the acquisition of operational maintenance supplies 3. There is a formal plan for the acquisition of operational maintenance supplies

	4. There is a formal and standardised acquisition plan for operational maintenance supplies 5. There is a formal and standardised acquisition plan for operational maintenance supplies, and it is annually reviewed to fit best practices
Domain D_3 – Administration (ADM)	1. Not at all applicable in our school 2. Not much applicable in our school 3. Somewhat applicable in our school 4. Mostly applicable in our school 5. Very much applicable in our school
Domain D_4 – Teachers (TEA)	1. Not at all applicable to me/our school 2. Not much applicable to me/our school 3. Somewhat applicable to me/our school 4. Mostly applicable to me/our school 5. Very much applicable to me/our school
Domain D_5 – Students (STU)	1. Very low performance 2. Low performance 3. Average performance 4. High performance 5. Very high performance

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
Management (N=3)	School Management	2,44	2	2	Based on the manual data collection with the school's rector formal plans had not been drafted, so ML was assessed as 2. There were only 3 individuals listed under managerial staff, one of which was an external collaborator. Some of the administrative employees had partial
	Vision, strategies and Policies	2,67	3	2	
	Organisation & ICT Management	2,58	3	2	
Infrastructure (N=3)	Software	2,00	2	2	OS-Closer to expiration, or there is an upgrade planned, there is a preparation for the upgrade. Upgrade is done at every two versions, or more. Authority lies with IT, IT prepares a budget a year prior to the upgrade. The management needs to approve the budget. Some differences between the required and approved budget can happen - nomber of licenses, etc. Meeting ad hoc with the management about the needs of the school. Long-term plan for the basic SW, MS Office, MS Tems - basic, MS 360. Licenses for the number of devices. For students only the browser version is bought, not the installed application. IS - full functions - guidance from MUNI, Upgrade and invoices every 6 months.
	Network	2,00	2	2	Network of T-Mobile, if the provider offers an upgrade, the approval is requested by IT for the additional budget. Max 2 months needed for approval if HW upgrade is needed. Wi-fi is supplied by a different supplier O2 - is more overloaded, and it is separate from the internal network. Firewall is only on the internal network, it's planned to extend it to Wifi. Certain pages and applications are blocked.
	Hardware	2,00	2	2	Upgrade serveru after 7 years, migration is gradual, refresh is done ever 5-7 years. DR site - basic data is saved. Security is set per user (management, administrative, IT, students, teachers) for oneDrive and Intranet. Standard procedure for the computers in classrooms. Individual login credentials for each individual. Students and teachers can use the classroom computer with a generic ID or own ID. Generic ID and password and instruction for login are available next to every notebook in each class. Notebook, projector, cameras, presenter are basic. Additional HW is requested and evaluated on merits.
	Maintenance Plan	2,33	2	2	Lifecycle maintenance - servers Notebook, cameras, projector - issues addressed on incidence-basis There was no device maintained on a regular formal plan There are some spare parts or new devices in storage - are used on incidence occurence - there is no immediate purchase to have a minimum number of items in storage. Spare parts and projectors are replaced immediately, not to affect the teaching process. Servers, notebooks, are not immediately replaced. There is a formal plan for the DR site storage, archive of email communication. - outsourced - communication ad hoc, every quarter.

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
	Security	Outsourced	1	1	Servers are protected by network's provider's security protocols. Only internal connections are set-up internaly: Wi-fi, computers in offices. IT can access them remotely, users have individual logins and one generic is used by all. Wi-fi password is visible to everyone, internal or external, not changed. No firewall for the Wi-fi network. Before the end of the second semester a security attack on the management's personal accounts occured, providing additional information abour the security level of the infrastructure under local management. Access to the building is not done always via ID student/employee card - security incidents occur when stranger enter the building and can remove digital HW from classrooms. Notebooks have a tracking chip which triggers a security alarm to local IT team.
Administration (N=3)	Leadership and Vision	3,33	3	2	Based on the information provided by students in interviews, the communication of the author with the admnistrative staff, and feeback from the academic staff in the author's department the ML was assessed as 2. There are only 7 administrative employees listed officially, two of which perform managerial activites as well. For example, several administrative (and some academic) employees replyed to the author's request to complete the questionnaire stating that they could not understand the questions, which indicates that they lacked the basic terminology to understand what the question required. There was no information provdided to the author as a new lecturer about the means and platforms of communication with the students, colleagues, management, or administrative staff. There was no organisational chart provided or processes to understand the ways to process any specific request. There was no process described in any format about the agreed ways to access, distribute and store study material. There was no documentation provided, or training scheduled, to ensure the teachers follow formal procedures and tools (ICT or conservative) for communication, teaching, assessment, evaluation, creation of teaching material, and evaluating students' work for legal and ethical practice. However, essentially, there was no objective data collection to triangulate the answers of the administrative staff. There were, however, informal discussions in the department about practices in teaching, usually prompted by specific events, and exchanges of ideas for the individual alignment of used tools in teaching based on this common understanding of best practices in teaching.
	Learning and Teaching	3,33	3	2	
	Productivity and Professional Practice	3,00	3	2	
	Support Management and Operations	3,67	4	2	
	Assessment and Evaluations	3,67	4	2	
	Social, Legal and Ethical issues	3,00	3	2	

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
Teachers (N=43)	Student Learning and Creativity	2,88	3	2	Observed class 1 - F 48y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to images and videos; videos on YouTube used as example for the topic, search engine used to find targeted information. Used digital information sources for approximately 40 minutes (video included). Topic discussed: resilience and resilient thinking in a changing global economy Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, evaluation of oppinions and facts, key takeaway, summary. Observed class 2 - M 65y ICT tools: none Topic discussed: financial institutions Teaching methods: conservative lecturing, flipchart for key concepts notes. Observed class 3 - F 35y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with bulletpoints content, links to sources (two links briefly accessed in class - 2min), static map - image embbedd on slide. Used digital information sources for approximately 30 minutes (presentation passively displayed in the background). Topic discussed: Security aspects of globalisation Teaching methods: presentation (using dispaly of presentation and conservative), discussion, questions and exchange of viewpoints on the topic, comparisson with other similar scenarios/topics. 30 minutes allocated for open discussion, no presentation displaoyed, no use of presentation content. Observed class 4 - M 55y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with bulletpoints content, graphs and tables to present information. Used digital information sources for approximately 30 minutes (presentation passively displayed in the background). Topic discussed: Financial institutions Teaching methods: presentation (using dispaly of pptx presentation and conservative), mainly conservative lecturing with the aid of the digital format to display content, calculations and graph drawing on flip chart. Observed class 5 - F 47y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to images and videos; videos on YouTube used as example for the topic. Used digital information sources for approximately 40 minutes (videos included). Topic discussed: The role of community practices and values in decision-making Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, evaluation of oppinions and facts, summary, reflexive exercise to apply concepts on own experience.
	Digital-Age Learning Experiences and Assessments	2,76	3	2	
	Digital-Age Work and Learning	2,68	3	2	
	Digital Citizenship and Responsibility	3,30	3	2	
	Professional Growth and Leadership	2,79	3	2	

Table 4. Capability levels of each KDA per questionnaires, observations, interviews, and seminar assessments

Domain	KDA	Mean score	CL (questionnaire)	CL (teacher assessments, interviews, class observations)	Data collected from class observations, interviews with the Head of IT Department, and discussions at department level
					Observed class 6 - F 62y ICT tools: class HW (projector, notebook), MS Teams for online streaming, pptx presentation with embedded images, links to sites for more infromation. Topic discussed: Covid-19 catalyst. Irish Catholic survival, resistance and identity. Teaching methods: presentation (using ICT and conservative), discussion, questions and feedbacks, inquisitive storytelling to connect the topic with the audience's emotions and knowledge, open discussion to evaluate the presented facts as a group, summary. Observed class 7 - M 54y ICT tools: class HW (projector, notebook), MS TEams for online streaming, ptx presentation with mostly text, a few pictures, and graphs as content. Assistance needed to handle equipment. Topic discussed: CZ and Turkyie economy - using AI in financial activities Teaching methods: presentation as support for content, classic lecturing, brief Q&A at the end of the lecture.
Students (N=28)	Creativity and Innovation	2,85	3	3	Average score rounded to the closest integer based on the seminar assignments from all three courses.
	Communication and Collaboration	3,70	4	4	
	Research and Information Fluency	3,71	4	4	
	Critical Thinking, Problem Solving and Decision-making	2,77	3	4	
	Digital Citizenship and Responsibility	2,84	3	3	
	Technology Operations and Concepts	2,63	3	4	

Table 5. The assessed ML of the HEI based on the questionnaire, observations, interviews and seminar assessments.

Domain	ML (Questionnaires)	ML (teacher assessments, interviews, class observations)
Management (N=3)	3	2
Infrastructure (N=3)	2	2
Administration (N=3)	3	2
Teachers (N=43)	3	2
Students (N=28)	3	4

Table 6. The CL, per KDA for a secondary school as desired configuration for each ML

Table 6. The CL per KDA for a secondary school as a desired configuration for each ML level

Domain	KDA	CL 1	CL 2	CL 3	CL 4	CL 5
Management	School management		2	3	4	5
	Vision, strategies & policies				2	3
	Organisation & ICT Managemetn		2	3	4	5
Infrastructure	Software			2	3	3
	Network				2	3
	Hardware			3	3	3
	Maintenance Plan		2	2	3	4
	Security			3	3	3
Administration	Leadership & Vision			3	3	3
	Learning & Teaching			3	3	3
	Productivity & Professional Practice		2	3	4	5
	Support Management & Operations		2	3	4	5
	Asessment & Evaluations			2	3	4
	Social, Legal & Ethical Issues			3	3	3
Teachers	Student Learning and Creativity			2	3	4
	Digital-Age Learning Experiences and Assessments			3	3	3
	Digital-Age Work and Learning			3	4	5
	Digital Citizenship and Responsibility			3	3	3
	Professional Growth and Leadership		2	3	4	5
Students	Creativity and Innovation			2	3	4
	Communication and Collaboration		2	3	4	5
	Research and Information Fluency		2	3	4	5
	Critical Thinking, Problem Solving and Decision-making				2	3
	Digital Citizenship and Responsibility				3	3
	Technology Operations and Concepts			4	4	4

Table 7. Student participants in the study, per data source and gender

Study data	**N**	**Female**	**Male**
Total registered students	45	28	17
Only Course 1	17	11	6
Only Course 2	0	0	0
Only Course 3	1	1	0
Course 1-2	1	1	0
Course 1-3	4	3	1
Course 2-3	5	2	3
Course 1-2-3	7	4	3
Total Course 1	29	19	10
Total Course 2	13	7	6
Total Course 3	17	10	7
Total seminar assignments Course 1	29	19	10
Total seminar assignments Course 2	13	7	6
Total seminar assignments Course 3	14	7	7
Total exam feedbacks Course 1	28	18	10
Total exam feedbacks Course 2	13	7	6
Total exam feedbacks Course 3	14	7	7
Total semi-structured interviews	11	5	6
Total DS questionnaires	22	14	8

Table 8. Significant correlations between self-reported digital skills and course performance

Correlation relationship	Course 1				Course 3			
	Pearson Correlation (N=16)	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper
Word processor - Assignment score	.72***	.001	.349	.896				
Word processor - Exam score	.549**	.028	.073	.821				
Email - Assignment score	.587*	.017	.129	.839				
Email - Exam score	.658**	.006	.241	.840	.738**	.006	.248	.922
School IS - Exam score					.585*	.046	.017	.868
Sharing documents - Exam score					.742**	.006	.292	.923

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Table 9. Correlation coefficients between self-reported digital skills and assessed digital competences

Correlation relationship	Course 1 (N=16)				Course 3 (N=12)			
	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper
Word processor - Communication and Collabotation	.635**	.008	.183	.885				
Word processor - Reasearch and Information Fluency	.726***	.001	.339	.894				
Word processor - Critical Thinking	.855***	<.001	.697	.946				
Word processor - Digital Citizenship	.615*	.011	.152	.845				
Word processor - Technology Operations and Concepts	.576*	.019	.094	.828				
Number processor - Technology Operations and Concepts	.549*	.028	.055	.815	.701**	.011	.182	.903
Email - Creativity and Innovation	.528*	.036	.026	.805				
Email - Communication and Collaboration	.563*	.023	.075	.822				
Email - Critical Thinking	.658**	.006	.220	.865				
School IS - Creativity and Innovation					.619*	.042	(-.001)	.882

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Table 10. Coder agreement computations for seminar assignments.

	N	Cohen's Kappa	Sig. *p*	SE	Weighted Cohen's Kappa	Sig. *p*	SE	CI interval
Creative thinking	53	.707	<.001	.079	.794	.000	.060	.676-.911
Acquire knolwedge	53	.853	<.001	.064	.878	.000	.048	.784-.972
Develop innovative products	53	.817	<.001	.064	.878	.000	.044	.792-.964
Support individual learning	53	.816	<.001	.071	.850	.000	.058	.736-.964
Contribute to others' learning	53	.716	<.001	.076	.817	.000	.051	.717-.918
Gather information	53	.759	<.001	.071	.835	.000	.048	.741-.930
Evaluate information	53	.738	<.001	.075	.819	.000	.055	.712-.926
Use information	53	.840	<.001	.061	.887	.000	.044	.801-.973
Understand social ICT issues	53	.898	<.001	.048	.935	.000	.030	.876-.994
Practice legal and ethical behaviour	53	.894	<.001	.050	.934	.000	.033	.869-.999
Understand technological concepts	53	.861	<.001	.060	.898	.000	.045	.809-987
Understand technological systems	53	.923	<.001	.043	.949	.000	.029	.891-1.007
Understand technological operations	53	.946	<.001	.038	.964	.000	.025	.915-1.014

Table 11. Significant correlation coefficients between ICTE-MM criteria, exam scores and reported digital maturity score of the HE institution and of the class

Correlation relationship	**Course 1**				**Course 2**				**Course 3**			
	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals		Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
			Lower	Upper			Lower	Upper			Lower	Upper
Digital Maturity HEI - Digital Maturity Class	.824** (N=11)	.002	.444	.953	.824** (N=11)	.002	.444	.953	.824** (N=11)	.002	.444	.953
Digital Maturity HEI - Reasearch and Information Fluency	(-.689)* (N=10)	.028	-.920	-.105								
Digital Maturity Class - Communication and Collaboration	(-.673)* (N=10)	.033	-.915	-.075								
Digital Maturity Class - Reasearch and Information Fluency	(-.636)* (N=10)	.048	-.904	-.010					(-.917)* (N=5)	.029	-.995	-.179
Digital Maturity Class - Assignment Score	(-.664)* (N=10)	.036	-.912	-.059					(-.915)* (N=5)	.029	-.994	-.173
Creativity and Innovation - Exam Score	.729***	<.001	.495	.865					.498*	.049	.003	.797
Communication and Collaboration - Exam Score	.777***	<.001	.574	.890	.664*	.013	.178	.889	.592*	.016	.137	.841
Reasearch and Information Fluency - Exam Score	.713***	<.001	.469	.856	.615*	.025	.096	.871	.630*	.009	.195	.858
Critical Thinking - Exam Score	.811***	<.001	.633	.908	.614*	.026	.095	.870	.620*	.010	.179	.853
Digital Citizenship - Exam Score	.649***	<.001	.370	.820								
Technology Operations and Concepts - Exam Score	.428*	.021	.073	.687								

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

Table 12. Frequency of occurrence of ICT and non-ICT tools/methods in teaching per course in exam feedbacks

Teaching tool type	**Course 1 (N=28, F=18, M=10)**	**Course 2 (N=13, F=7, M=6)**	**Course 3 (N=14, F=7, M=7)**
Presentations (by teacher/as assignments)	14	6	7
Handouts/slides	5	2	1
Links	8	2	4
Videos	1	2	1
Sites (institutions, databases)	4	10	2
Debates	17	10	14
Simulation	14		
Field trips	7	2	5
Other non-ICT (class dynamic, interactivity, teacher' skills, engagement, different perspectives, freedom to ask and express, diversity of presenters and opinions, developped skills)	20	10	18
Other ICT (individual research, use of digital tools)	2	1	0
TOTAL ICT tools	34	23	15
TOTAL non-ICT tools	58	22	37

Table 13. Correlational relationship between exam and assignment scores for all courses

Variables	1	2	3	4	5
1. Exam Course 1	1				
2. Assignment Course 1	.822***	1			
3. Exam Course 2	.878**	.653	1		
4. Assignment Course 2	.516	.658	.538	1	
5. Exam Course 3	.932***	.796**	.804**	.444	1
6. Assignment Course 3	.618*	.727**	.604*	.699*	.541*

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed).

13.2. Figures

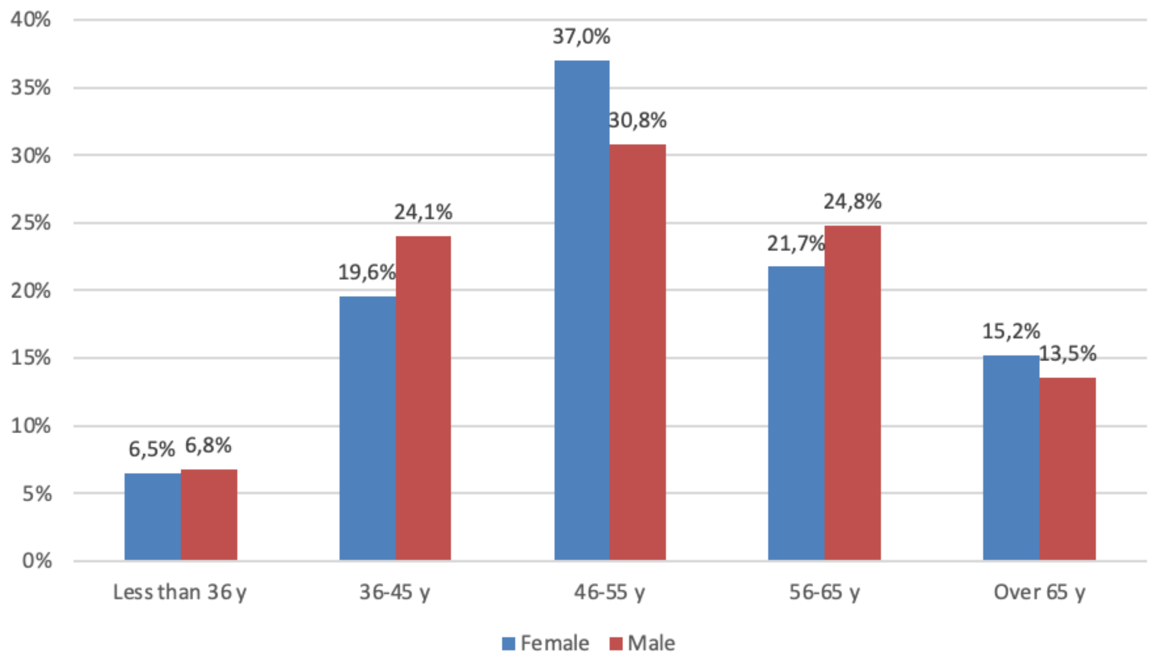

Figure 1. The distribution of teachers in the HEI per gender and age groups

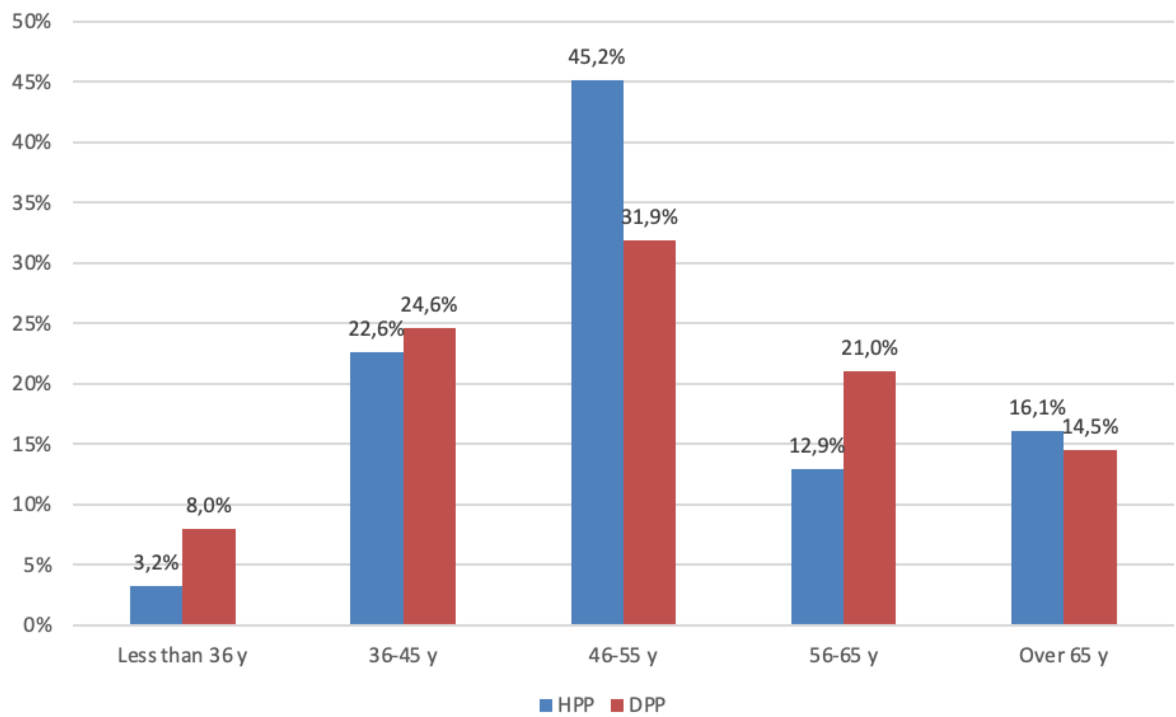

Figure 2. The distribution of teachers in the HEI per type of contract and age groups

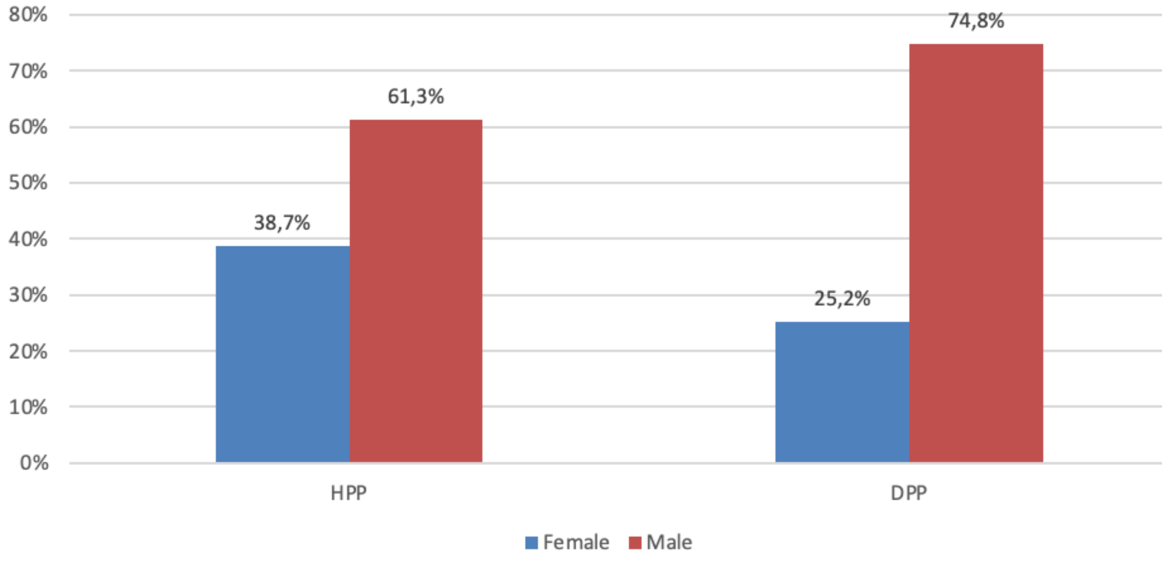

Figure 3. The distribution of teachers in the HEI per type of contract and gender groups

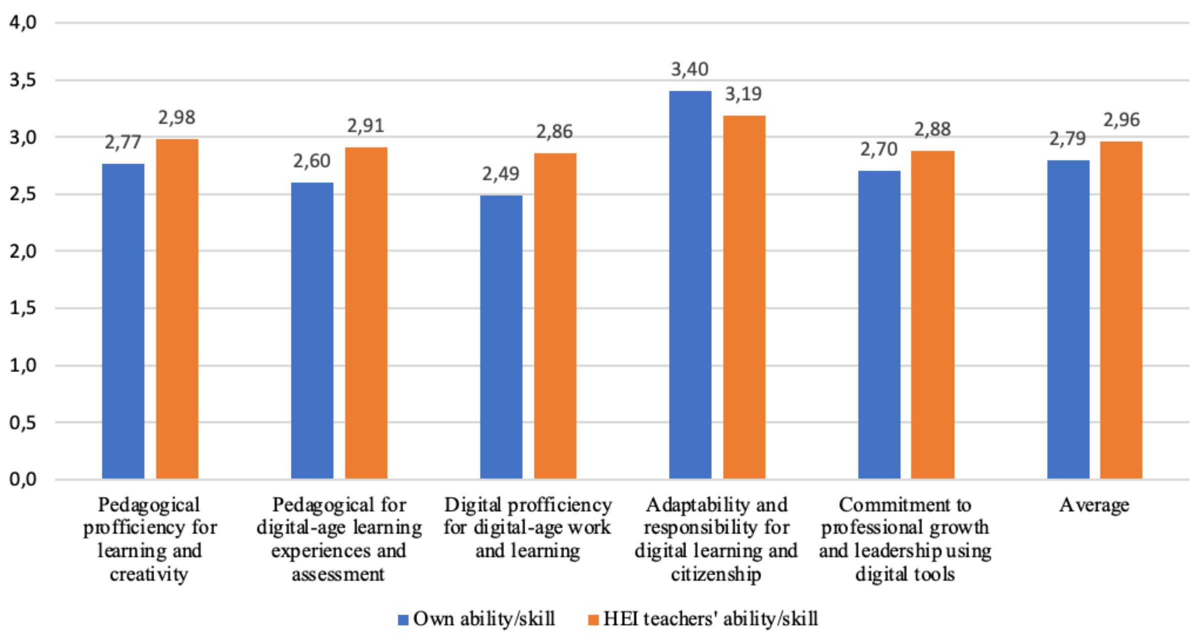

Figure 4. Mean estimate of own and other teachers' ICT-related abilities/skills

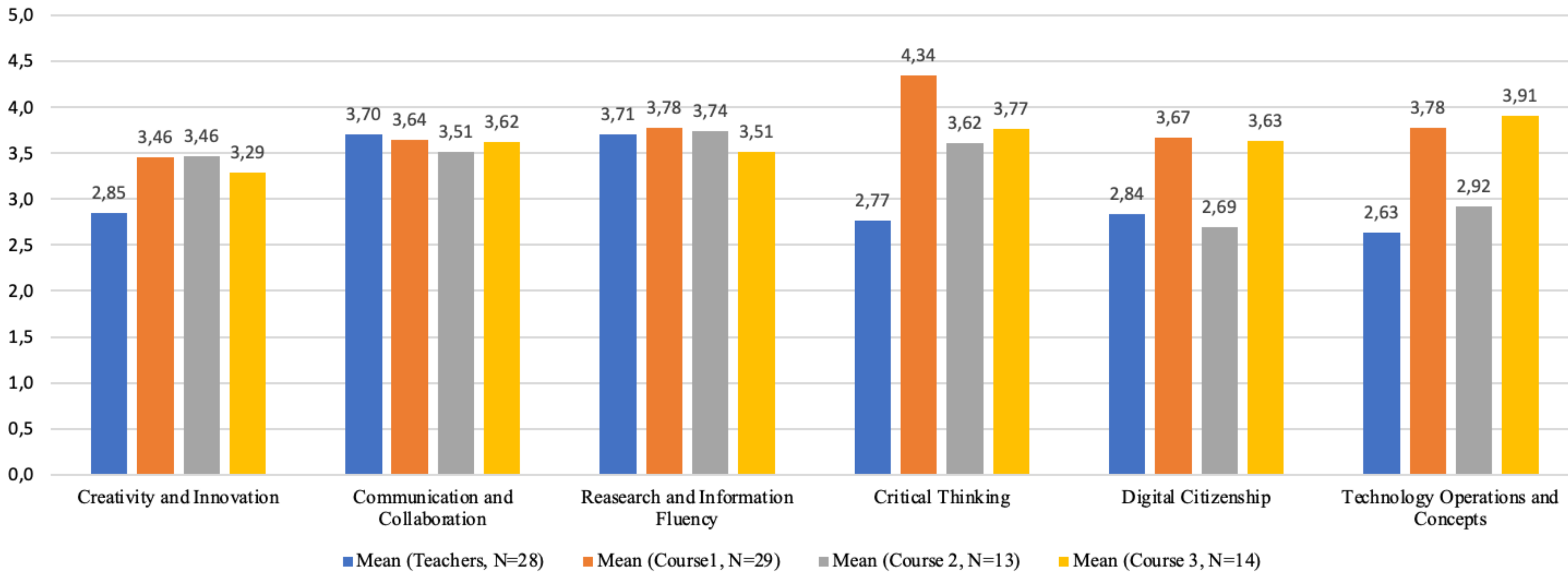

Figure 5. Evaluations of students' digital competences by HEI teachers compared to Courses 1-3 seminar evaluation scores

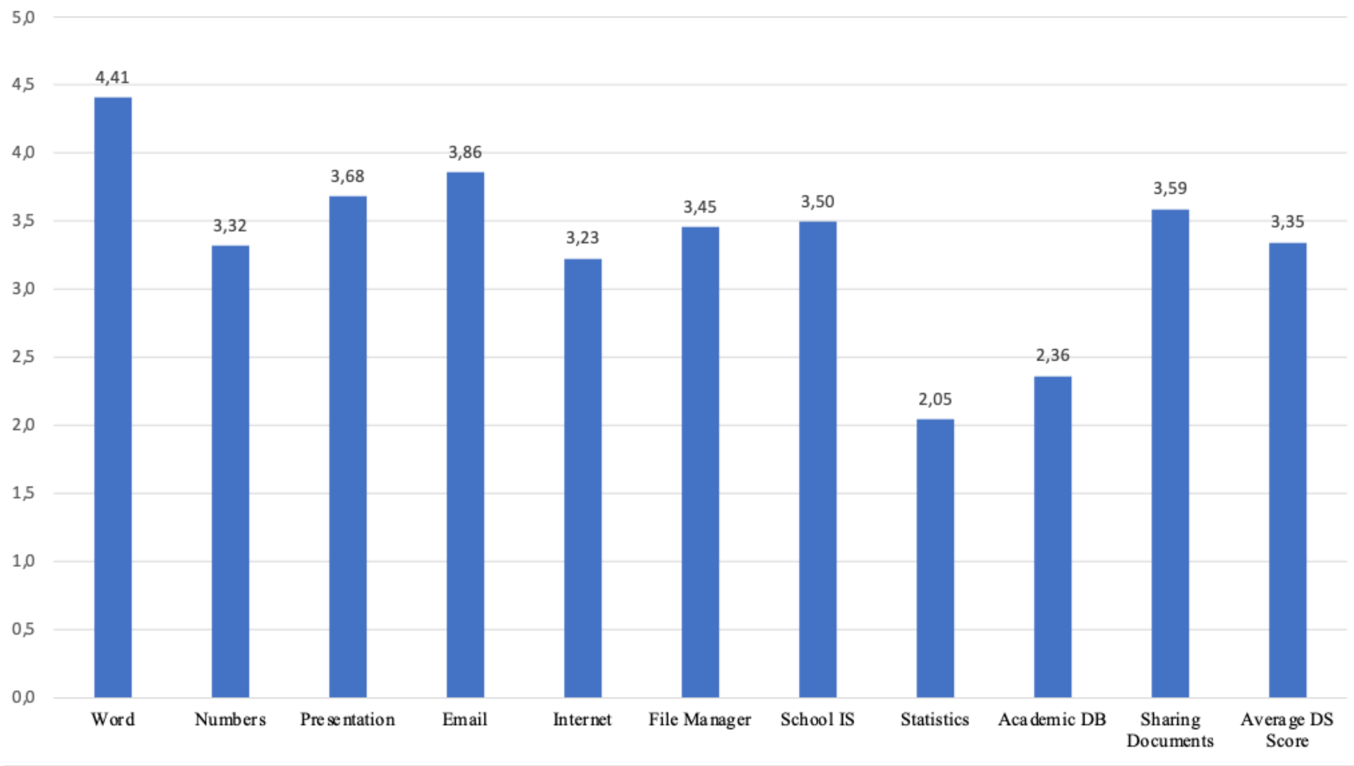

Figure 6. Self-reported digital skills per application's area of functionality

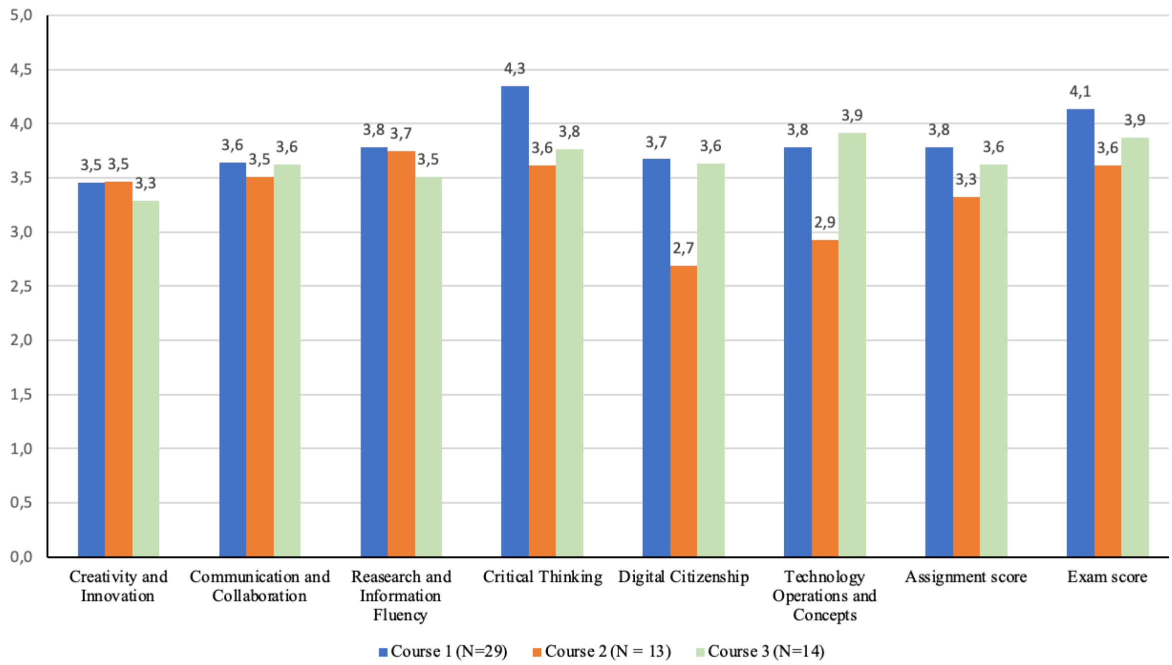

Figure 7. ICTE-MM Digital competences measured in course assignments and exam scores per course

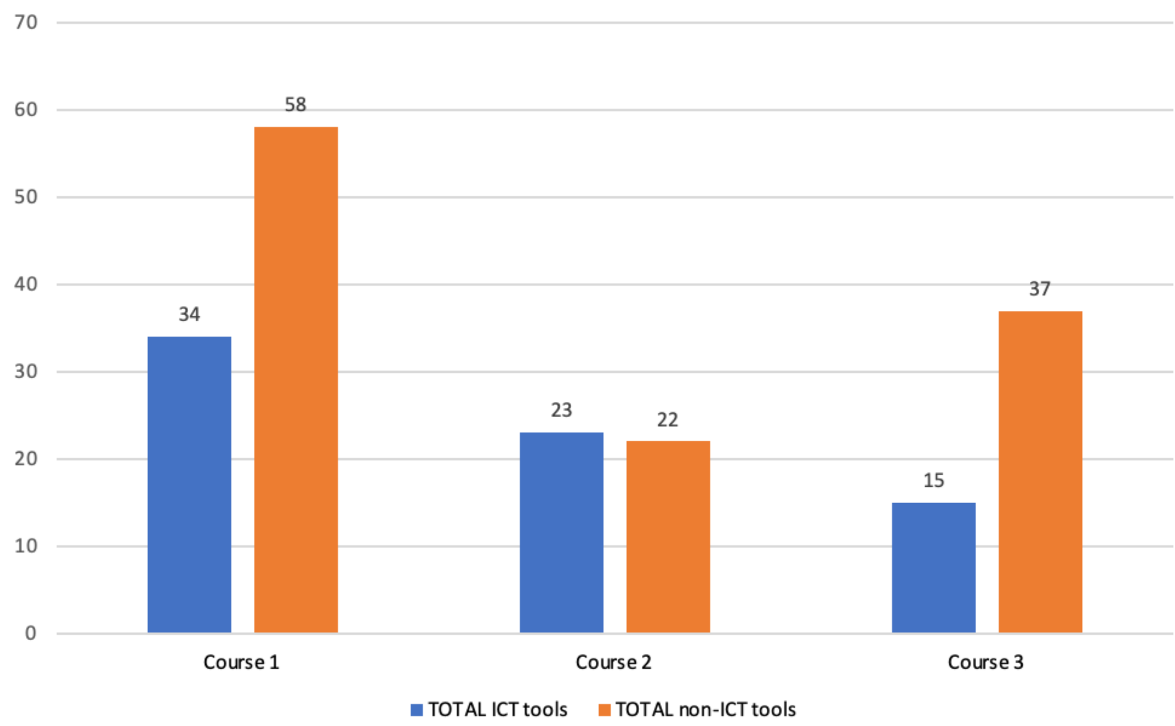

Figure 8. Frequency of occurrence of teaching tool type in course feedback per course

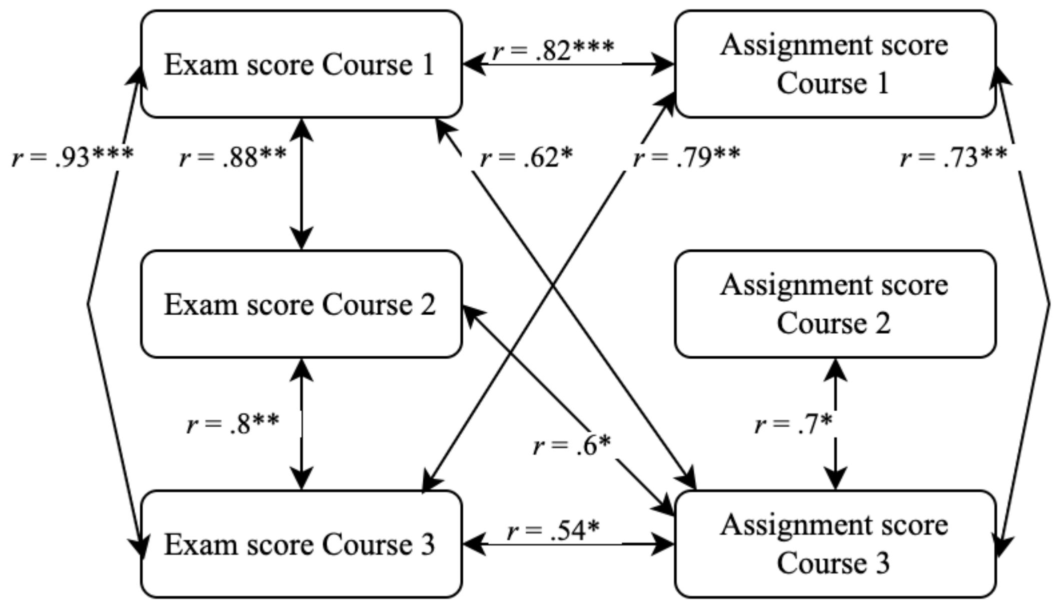

Figure 9. Correlational relationships between exam and assignment scores

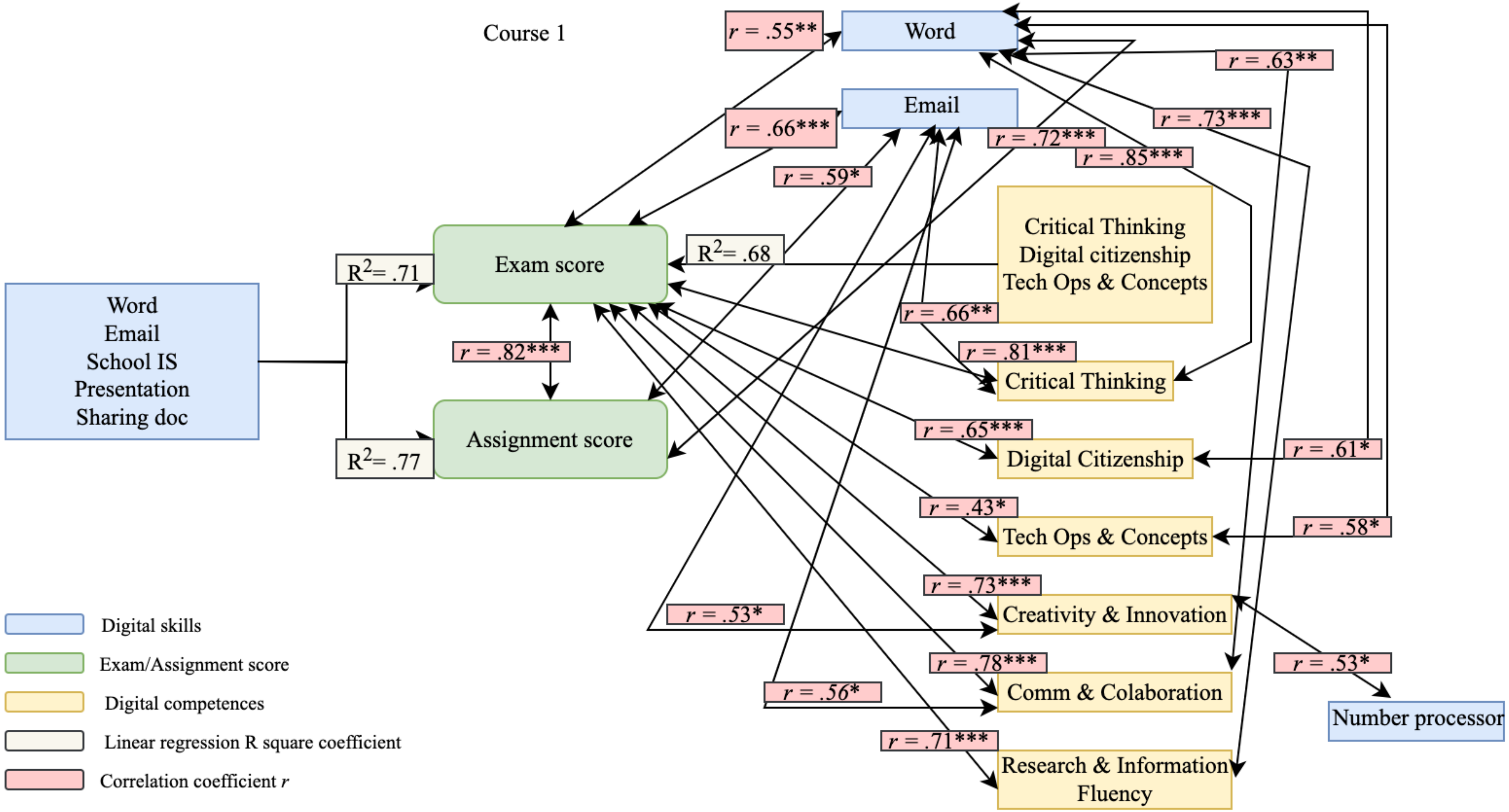

Figure 10. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 1

Course 2

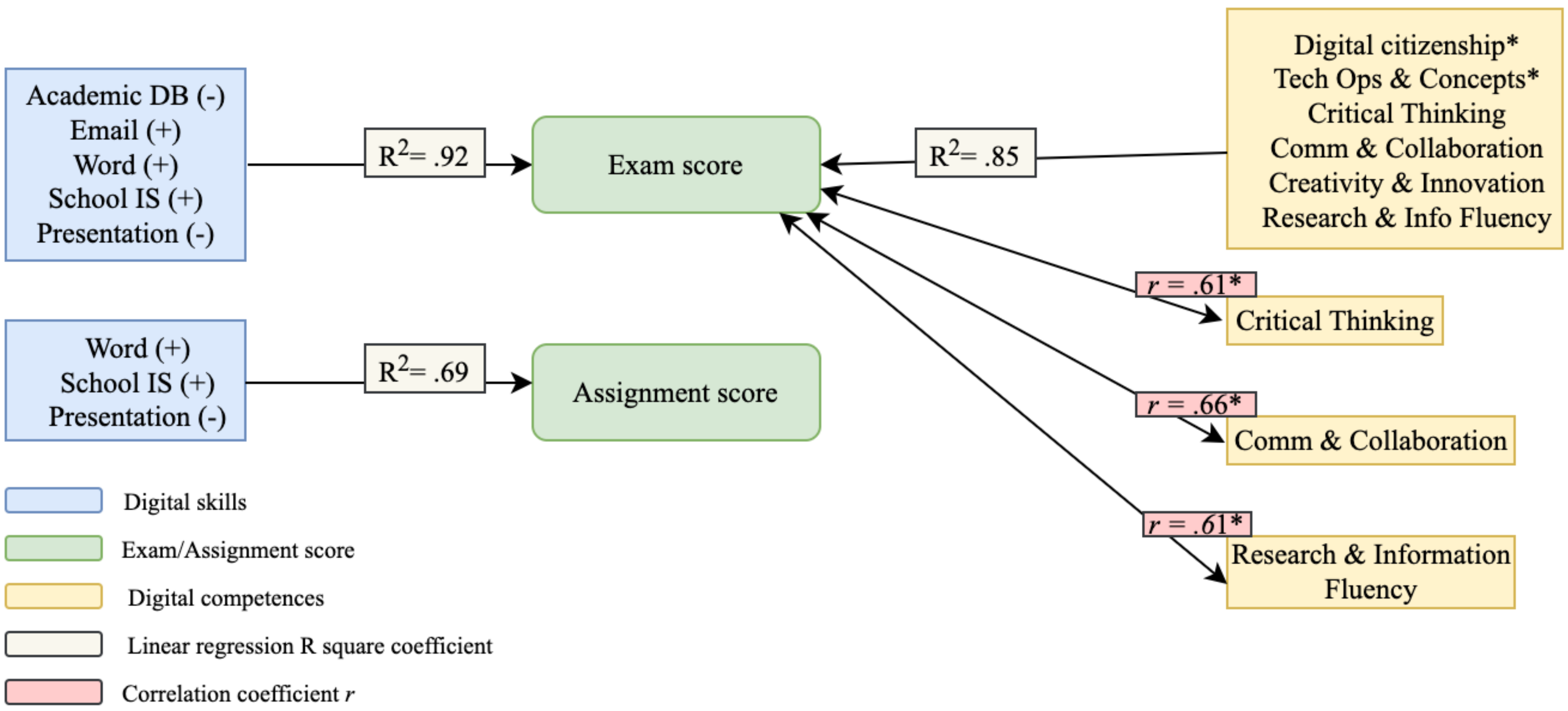

Figure 11. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 2

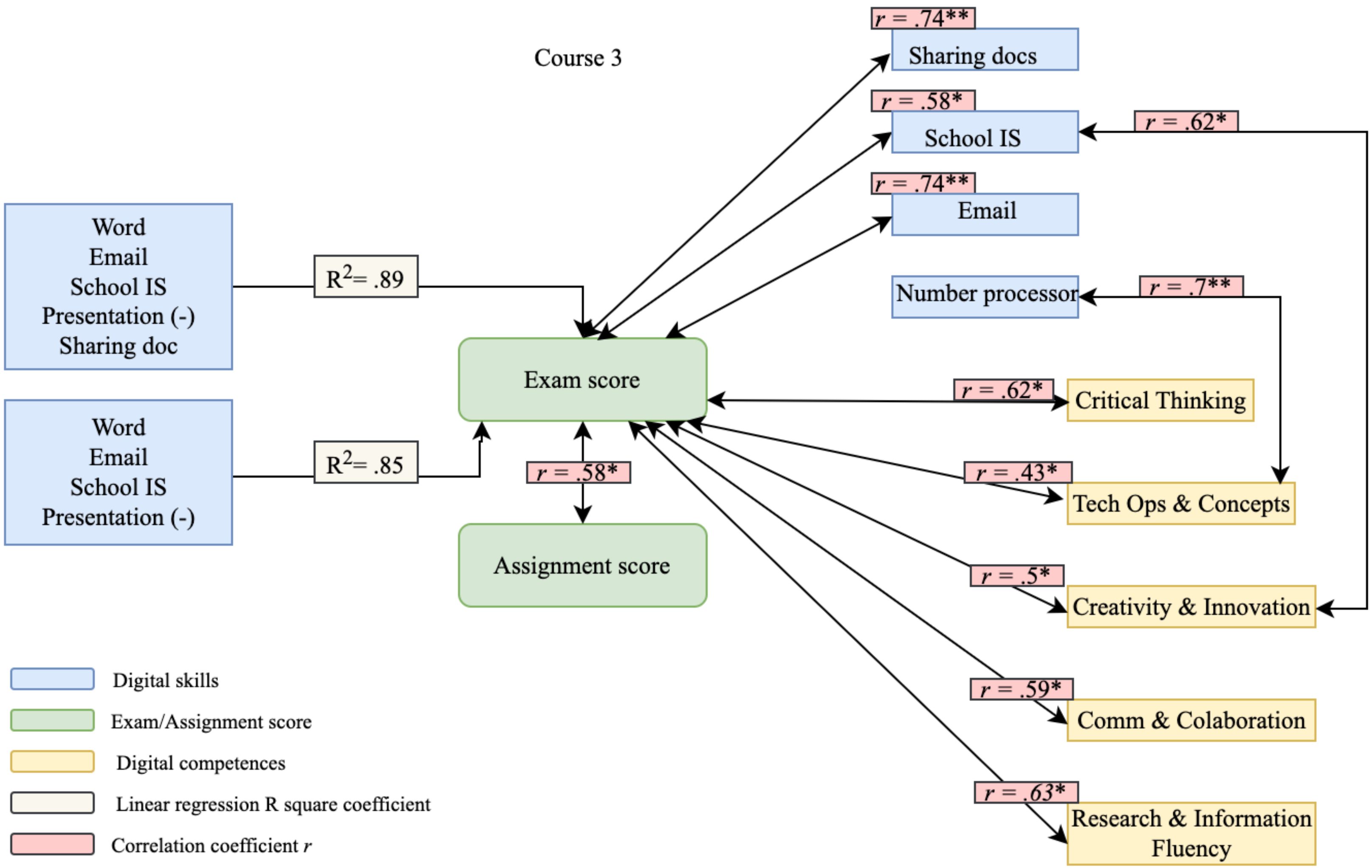

Figure 12. Correlational relationships and coefficients of determination between digital skills, digital competences, exam and assignment scores for Course 3

1. How would you describe the use of ICT/digital tools in teaching at <school name>?

2. How would you describe the use of ICT/digital tool in communication at <school name>? (communication with the teachers, classmates, administration, library, etc)

3. How would you evaluate the use of ICT in your classes at <school name> for the purpose of understanding the subject matter, assimilating concepts, and acquiring new perspectives on the topic, or for any other purposes?

4. Overall, what digital tools were more useful for you to understand the taught topic?

5. What other teaching strategies and/or communication channels, and/or evaluation methods helped you in class?

6. How would you evaluate the teaching strategies in the classes taught by me and other teachers who use digital tools in their teaching, compared to classes in which such tools are not used or are less used?

7. Would you say the ICT helps or doesn't help students in their learning, and in developing certain skills?

8. On a scale from 1 to 5 how would you rate the digital maturity of <school name>?

9. On a scale from 1 to 5 how would you rate our classes in terms of digital tools used, considering that the topic cannot be taught in a fully digitalised form?

10. Would you say you are better equipped to search for, filter, evaluate and use digital tools to learn about a subject matter of our classes, and in general?

11. Do you have anything else you want to add?

Figure 13. The question list used in the semi-structured interviews (N=11)

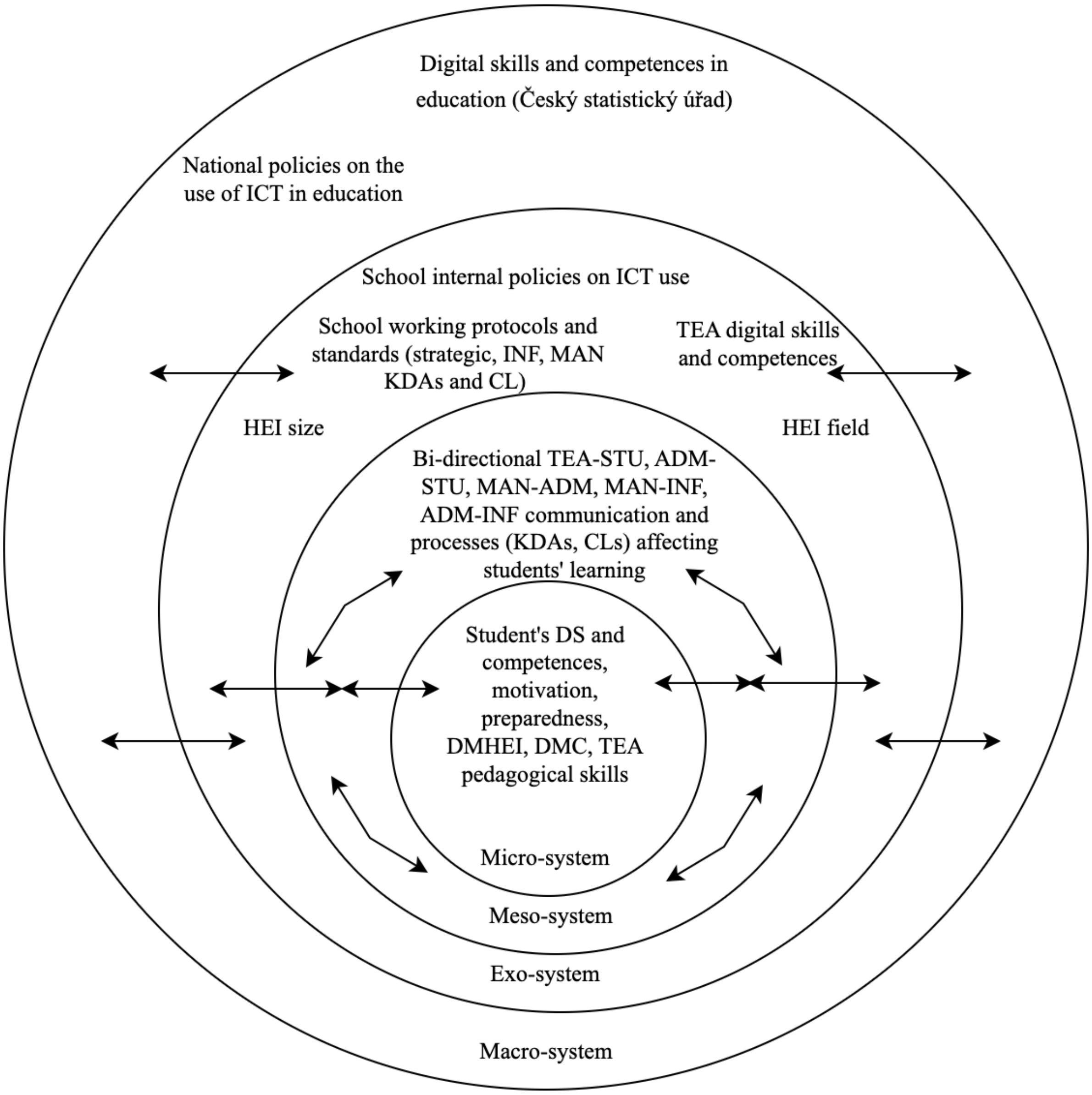

Figure 14. Factors of influence on the use of ICT in education per ecological system

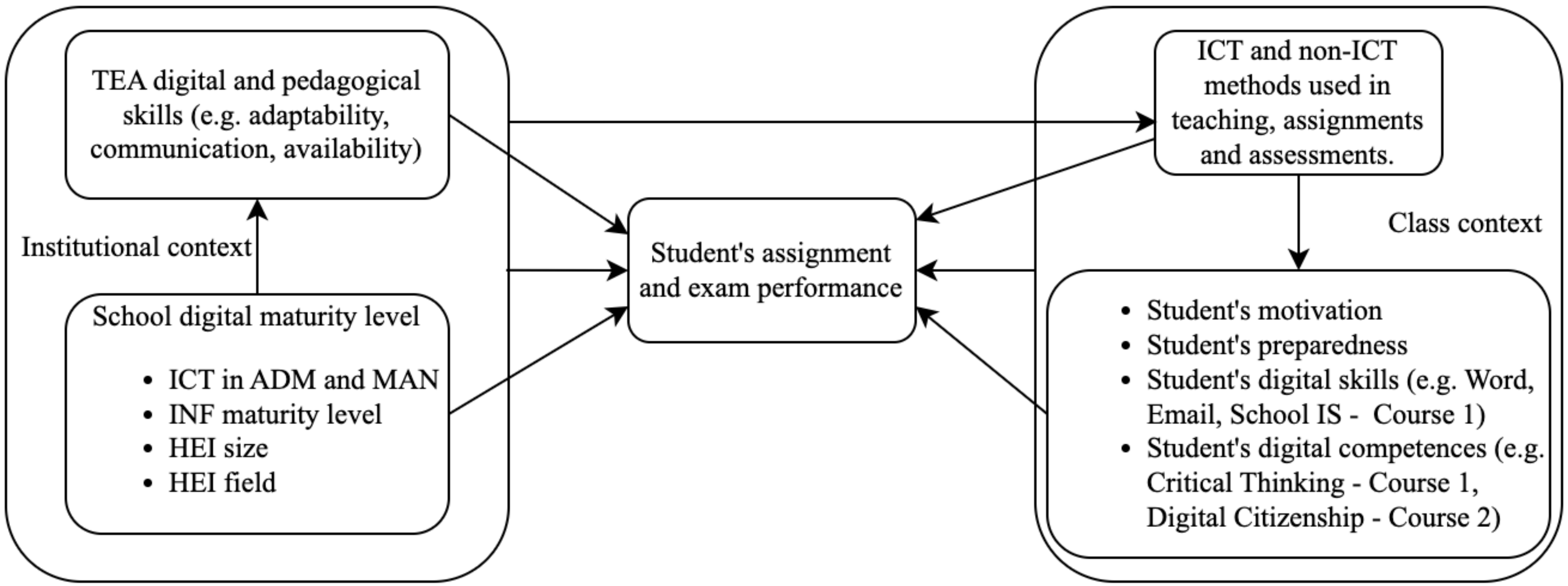

Figure 15. Relationships between ICT-dependent factors and student's course performance per context type

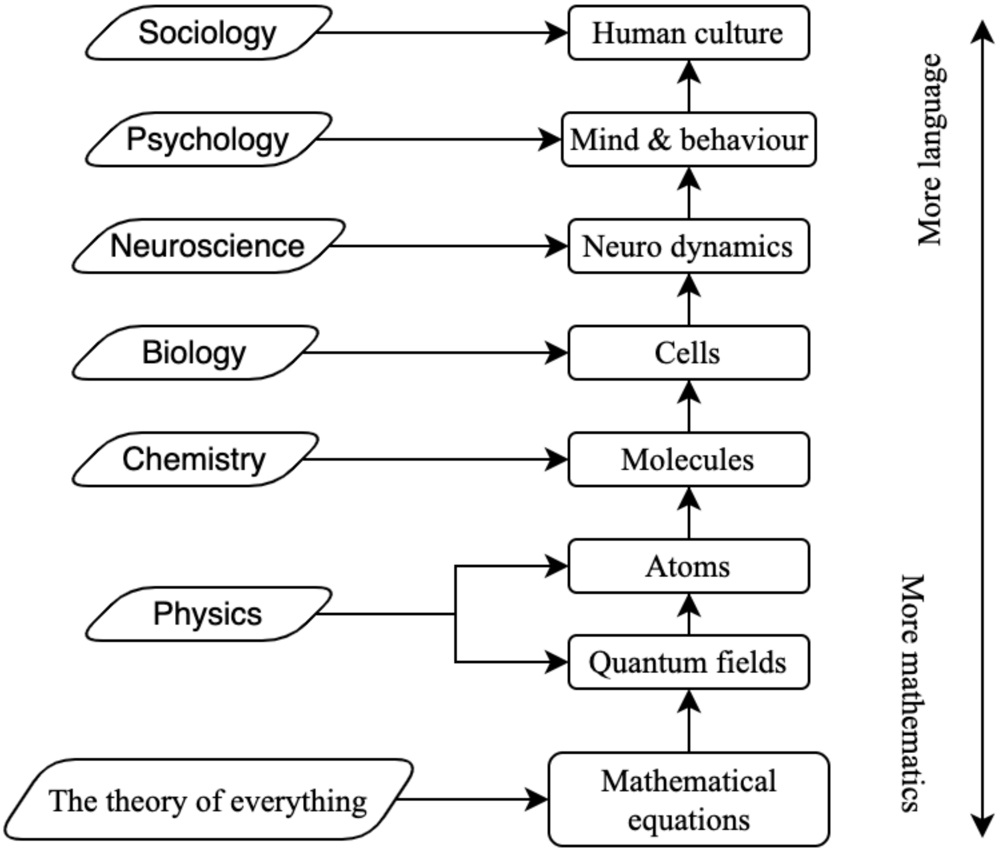

Figure 16. Mathematics/baggage ratio in theories of nature in the mathematical universe theory (Tegmark, 2007)

13.3. Linear regression models

Digital skills x Assignment/Exam Course 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.880[a]	.774	.623	.51243	.774	5.131	6	9	.015

a. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email, Mean Internet

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.084	6	1.347	5.131	.015[b]
	Residual	2.363	9	.263		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email, Mean Internet

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.550	1.498		-2.370	.042	-6.940	-.161			
	Mean Word processor	1.369	.370	.794	3.699	.005	.532	2.207	.720	.777	.586
	Mean Presentation	-.459	.270	-.374	-1.700	.123	-1.071	.152	.273	-.493	-.270
	Mean Email	.628	.269	.506	2.335	.044	.019	1.237	.587	.614	.370
	Mean Internet	.114	.308	.101	.372	.719	-.582	.811	.135	.123	.059
	Mean School IS	.152	.240	.142	.634	.542	-.391	.696	.293	.207	.101
	Mean Sharing documents	-.245	.220	-.265	-1.114	.294	-.742	.252	.180	-.348	-.177

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.878[a]	.770	.655	.48985	.770	6.708	5	10	.005

a. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.048	5	1.610	6.708	.005[b]
	Residual	2.400	10	.240		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part
1	(Constant)	-3.380	1.364		-2.478	.033	-6.420	-.341			
	Mean Word processor	1.318	.328	.764	4.017	.002	.587	2.049	.720	.786	.609
	Mean Presentation	-.428	.245	-.349	-1.744	.112	-.974	.119	.273	-.483	-.264
	Mean Email	.630	.257	.508	2.451	.034	.057	1.204	.587	.613	.372
	Mean School IS	.208	.180	.194	1.158	.274	-.192	.609	.293	.344	.175
	Mean Sharing documents	-.202	.179	-.219	-1.129	.285	-.600	.197	.180	-.336	-.171

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.842[a]	.708	.562	.74337	.708	4.854	5	10	.016

a. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.412	5	2.682	4.854	.016[b]
	Residual	5.526	10	.553		
	Total	18.938	15			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Sharing documents, Mean School IS, Mean Word processor, Mean Presentation, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-4.707	2.070		-2.274	.046	-9.320	-.094			
	Mean Word processor	1.267	.498	.545	2.545	.029	.158	2.376	.549	.627	.435
	Mean Presentation	-.619	.372	-.375	-1.664	.127	-1.448	.210	.214	-.466	-.284
	Mean Email	1.036	.390	.620	2.653	.024	.166	1.905	.658	.643	.453
	Mean School IS	.433	.273	.301	1.588	.143	-.175	1.041	.406	.449	.271
	Mean Sharing documents	-.227	.271	-.183	-.837	.422	-.832	.378	.222	-.256	-.143

a. Dependent Variable: Exam PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.861[a]	.741	.647	.49592	.741	7.870	4	11	.003

a. Predictors: (Constant), Mean Word processor, Mean School IS, Mean Email, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.742	4	1.935	7.870	.003[b]
	Residual	2.705	11	.246		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean Word processor, Mean School IS, Mean Email, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.456	1.379		-2.505	.029	-6.492	-.420			
	Mean Presentation	-.477	.244	-.389	-1.953	.077	-1.015	.061	.273	-.507	-.300
	Mean School IS	.247	.179	.230	1.380	.195	-.147	.640	.293	.384	.212
	Mean Email	.472	.218	.380	2.164	.053	-.008	.951	.587	.546	.332
	Mean Word processor	1.334	.332	.774	4.022	.002	.604	2.065	.720	.772	.617

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.838[a]	.702	.593	.53236	.702	6.466	4	11	.006

a. Predictors: (Constant), Mean Internet, Mean Word processor, Mean Email, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.330	4	1.832	6.466	.006[b]
	Residual	3.117	11	.283		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean Internet, Mean Word processor, Mean Email, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.140	1.536		-2.044	.066	-6.520	.241			
	Mean Presentation	-.441	.281	-.359	-1.571	.145	-1.058	.177	.273	-.428	-.259
	Mean Email	.494	.249	.398	1.984	.073	-.054	1.042	.587	.513	.327
	Mean Word processor	1.327	.379	.769	3.500	.005	.493	2.161	.720	.726	.577
	Mean Internet	.105	.235	.092	.447	.664	-.412	.621	.135	.133	.074

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.861[a]	.741	.647	.49592	.741	7.870	4	11	.003

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.742	4	1.935	7.870	.003[b]
	Residual	2.705	11	.246		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.456	1.379		-2.505	.029	-6.492	-.420			
	Mean Presentation	-.477	.244	-.389	-1.953	.077	-1.015	.061	.273	-.507	-.300
	Mean Email	.472	.218	.380	2.164	.053	-.008	.951	.587	.546	.332
	Mean Word processor	1.334	.332	.774	4.022	.002	.604	2.065	.720	.772	.617
	Mean School IS	.247	.179	.230	1.380	.195	-.147	.640	.293	.384	.212

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.807[a]	.651	.564	.55098	.651	7.471	3	12	.004

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.804	3	2.268	7.471	.004[b]
	Residual	3.643	12	.304		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.132	1.521		-2.059	.062	-6.447	.183			
	Mean Email	.400	.239	.322	1.677	.119	-.120	.920	.587	.436	.286
	Mean Word processor	1.007	.318	.584	3.166	.008	.314	1.700	.720	.675	.540
	Mean School IS	.153	.191	.142	.798	.440	-.264	.569	.293	.224	.136

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.831[a]	.690	.612	.51952	.690	8.903	3	12	.002

a. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.209	3	2.403	8.903	.002[b]
	Residual	3.239	12	.270		
	Total	10.447	15			

a. Dependent Variable: Assignment PEofEU

b. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-2.813	1.373		-2.049	.063	-5.804	.178			
	Mean Email	.667	.259	.537	2.577	.024	.103	1.230	.587	.597	.414
	Mean Word processor	1.027	.300	.595	3.418	.005	.372	1.681	.720	.702	.549
	Mean Sharing documents	-.275	.185	-.298	-1.488	.163	-.677	.128	.180	-.395	-.239

a. Dependent Variable: Assignment PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.767[a]	.589	.486	.80547	.589	5.730	3	12	.011

a. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.152	3	3.717	5.730	.011[b]
	Residual	7.785	12	.649		
	Total	18.938	15			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.582	2.128		-1.683	.118	-8.220	1.055			
	Mean Email	1.150	.401	.688	2.867	.014	.276	2.024	.658	.638	.531
	Mean Word processor	.842	.466	.363	1.809	.096	-.172	1.857	.549	.463	.335
	Mean Sharing documents	-.352	.286	-.283	-1.231	.242	-.976	.271	.222	-.335	-.228

a. Dependent Variable: Exam PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.772[a]	.595	.494	.79911	.595	5.885	3	12	.010

a. Predictors: (Constant), Mean Presentation, Mean Email, Mean Word processor

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.275	3	3.758	5.885	.010[b]
	Residual	7.663	12	.639		
	Total	18.938	15			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Presentation, Mean Email, Mean Word processor

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.651	2.113		-1.728	.110	-8.255	.953			
	Mean Email	.987	.342	.590	2.884	.014	.241	1.733	.658	.640	.530
	Mean Word processor	1.149	.528	.495	2.176	.050	-.001	2.300	.549	.532	.400
	Mean Presentation	-.499	.379	-.302	-1.316	.213	-1.325	.327	.214	-.355	-.242

a. Dependent Variable: Exam PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.772[a]	.595	.494	.79911	.595	5.885	3	12	.010

a. Predictors: (Constant), Mean Email, Mean Word processor, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.275	3	3.758	5.885	.010[b]
	Residual	7.663	12	.639		
	Total	18.938	15			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Email, Mean Word processor, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.651	2.113		-1.728	.110	-8.255	.953			
	Mean Word processor	1.149	.528	.495	2.176	.050	-.001	2.300	.549	.532	.400
	Mean Presentation	-.499	.379	-.302	-1.316	.213	-1.325	.327	.214	-.355	-.242
	Mean Email	.987	.342	.590	2.884	.014	.241	1.733	.658	.640	.530

a. Dependent Variable: Exam PEofEU

Digital skills x Assignment/Exam Course 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.866[a]	.750	.583	.42713	.750	4.501	4	6	.051

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.285	4	.821	4.501	.051[b]
	Residual	1.095	6	.182		
	Total	4.379	10			

a. Dependent Variable: Assignment GES

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Email, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-.772	1.417		-.545	.605	-4.241	2.696			
	Mean Word processor	1.712	.455	1.454	3.762	.009	.599	2.826	.363	.838	.768
	Mean Presentation	-.966	.336	-1.077	-2.877	.028	-1.788	-.145	.011	-.761	-.587
	Mean Email	-.486	.404	-.409	-1.204	.274	-1.473	.502	.078	-.441	-.246
	Mean School IS	.643	.202	.768	3.189	.019	.150	1.137	.346	.793	.651

a. Dependent Variable: Assignment GES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.830[a]	.690	.557	.44062	.690	5.186	3	7	.034

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.020	3	1.007	5.186	.034[b]
	Residual	1.359	7	.194		
	Total	4.379	10			

a. Dependent Variable: Assignment GES

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-1.207	1.414		-.853	.422	-4.550	2.137			
	Mean Word processor	1.441	.408	1.224	3.532	.010	.476	2.407	.363	.800	.744
	Mean Presentation	-1.067	.335	-1.189	-3.179	.016	-1.860	-.273	.011	-.769	-.669
	Mean School IS	.625	.207	.746	3.011	.020	.134	1.115	.346	.751	.634

a. Dependent Variable: Assignment GES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.848[a]	.719	.599	.86674	.719	5.976	3	7	.024

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.469	3	4.490	5.976	.024[b]
	Residual	5.259	7	.751		
	Total	18.727	10			

a. Dependent Variable: Exam GES

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-5.525	2.781		-1.986	.087	-12.102	1.052			
	Mean Word processor	2.894	.803	1.188	3.604	.009	.995	4.792	.272	.806	.722
	Mean Presentation	-2.348	.660	-1.266	-3.559	.009	-3.909	-.788	-.069	-.803	-.713
	Mean School IS	1.405	.408	.811	3.444	.011	.440	2.371	.381	.793	.690

a. Dependent Variable: Exam GES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.848[a]	.719	.599	.86674	.719	5.976	3	7	.024

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.469	3	4.490	5.976	.024[b]
	Residual	5.259	7	.751		
	Total	18.727	10			

a. Dependent Variable: Exam GES

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-5.525	2.781		-1.986	.087	-12.102	1.052			
	Mean Word processor	2.894	.803	1.188	3.604	.009	.995	4.792	.272	.806	.722
	Mean Presentation	-2.348	.660	-1.266	-3.559	.009	-3.909	-.788	-.069	-.803	-.713
	Mean School IS	1.405	.408	.811	3.444	.011	.440	2.371	.381	.793	.690

a. Dependent Variable: Exam GES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.959[a]	.920	.841	.54640	.920	11.546	5	5	.009

a. Predictors: (Constant), Mean Email, Mean School IS, Mean Academic DB, Mean Presentation, Mean Word processor

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.235	5	3.447	11.546	.009[b]
	Residual	1.493	5	.299		
	Total	18.727	10			

a. Dependent Variable: Exam GES

b. Predictors: (Constant), Mean Email, Mean School IS, Mean Academic DB, Mean Presentation, Mean Word processor

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-5.517	1.819		-3.034	.029	-10.192	-.842			
	Mean Word processor	1.214	.711	.498	1.708	.148	-.613	3.040	.272	.607	.216
	Mean Presentation	-1.667	.488	-.899	-3.413	.019	-2.922	-.411	-.069	-.836	-.431
	Mean School IS	.948	.288	.547	3.287	.022	.207	1.689	.381	.827	.415
	Mean Academic DB	-1.079	.317	-.733	-3.400	.019	-1.895	-.263	-.419	-.836	-.429
	Mean Email	2.194	.711	.893	3.084	.027	.365	4.022	.233	.810	.389

a. Dependent Variable: Exam GES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.935[a]	.874	.790	.62766	.874	10.384	4	6	.007

a. Predictors: (Constant), Mean Email, Mean School IS, Mean Academic DB, Mean Presentation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.364	4	4.091	10.384	.007[b]
	Residual	2.364	6	.394		
	Total	18.727	10			

a. Dependent Variable: Exam GES

b. Predictors: (Constant), Mean Email, Mean School IS, Mean Academic DB, Mean Presentation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-4.025	1.833		-2.197	.070	-8.509	.459			
	Mean Presentation	-1.111	.418	-.599	-2.655	.038	-2.135	-.087	-.069	-.735	-.385
	Mean School IS	.684	.280	.395	2.445	.050	.000	1.369	.381	.706	.355
	Mean Academic DB	-1.390	.299	-.944	-4.653	.003	-2.121	-.659	-.419	-.885	-.675
	Mean Email	3.030	.593	1.233	5.111	.002	1.579	4.480	.233	.902	.741

a. Dependent Variable: Exam GES

Digital skills x Assignment/Exam Course 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.945[a]	.894	.805	.50209	.894	10.105	5	6	.007

a. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Presentation, Mean School IS, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.737	5	2.547	10.105	.007[b]
	Residual	1.513	6	.252		
	Total	14.250	11			

a. Dependent Variable: Exam EP

b. Predictors: (Constant), Mean Sharing documents, Mean Word processor, Mean Presentation, Mean School IS, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-2.862	1.539		-1.860	.112	-6.627	.903			
	Mean Word processor	.978	.391	.455	2.504	.046	.022	1.935	.461	.715	.333
	Mean Presentation	-1.025	.270	-.706	-3.793	.009	-1.686	-.364	.139	-.840	-.504
	Mean Email	.372	.374	.237	.994	.359	-.544	1.288	.738	.376	.132
	Mean School IS	.566	.236	.469	2.392	.054	-.013	1.144	.585	.699	.318
	Mean Sharing documents	.594	.375	.450	1.584	.164	-.323	1.511	.742	.543	.211

a. Dependent Variable: Exam EP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.922[a]	.849	.724	.59786	.849	6.773	5	6	.019

a. Predictors: (Constant), Mean Internet, Mean Word processor, Mean School IS, Mean Presentation, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.105	5	2.421	6.773	.019[b]
	Residual	2.145	6	.357		
	Total	14.250	11			

a. Dependent Variable: Exam EP

b. Predictors: (Constant), Mean Internet, Mean Word processor, Mean School IS, Mean Presentation, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.704	1.896		-1.954	.099	-8.343	.935			
	Mean Word processor	1.083	.586	.503	1.847	.114	-.351	2.516	.461	.602	.293
	Mean Presentation	-.916	.393	-.631	-2.329	.059	-1.878	.046	.139	-.689	-.369
	Mean Email	.766	.484	.487	1.584	.164	-.417	1.950	.738	.543	.251
	Mean School IS	.720	.257	.597	2.798	.031	.090	1.350	.585	.752	.443
	Mean Internet	-.016	.393	-.012	-.040	.969	-.978	.946	.305	-.016	-.006

a. Dependent Variable: Exam EP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.922[a]	.849	.763	.55359	.849	9.875	4	7	.005

a. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation, Mean Email

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.105	4	3.026	9.875	.005[b]
	Residual	2.145	7	.306		
	Total	14.250	11			

a. Dependent Variable: Exam EP

b. Predictors: (Constant), Mean School IS, Mean Word processor, Mean Presentation, Mean Email

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-3.737	1.584		-2.359	.050	-7.482	.008			
	Mean Word processor	1.097	.423	.510	2.595	.036	.098	2.097	.461	.700	.381
	Mean Presentation	-.925	.290	-.637	-3.194	.015	-1.610	-.240	.139	-.770	-.468
	Mean Email	.753	.317	.479	2.376	.049	.004	1.501	.738	.668	.348
	Mean School IS	.721	.237	.598	3.041	.019	.160	1.282	.585	.754	.446

a. Dependent Variable: Exam EP

Digital competences x Assignment/Exam Course 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.826[a]	.683	.645	.58994	.683	17.956	3	25	<.001

a. Predictors: (Constant), Mean Technology Operations and Concepts PEofEU, Mean Critical Thinking PEofEU, Mean Digital Citizenship PEofEU

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.748	3	6.249	17.956	<.001[b]
	Residual	8.701	25	.348		
	Total	27.448	28			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Technology Operations and Concepts PEofEU, Mean Critical Thinking PEofEU, Mean Digital Citizenship PEofEU

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	.380	.605		.628	.536	-.866	1.625			
	Mean Critical Thinking PEofEU	.749	.167	.694	4.473	<.001	.404	1.094	.811	.667	.50
	Mean Digital Citizenship PEofEU	.319	.226	.283	1.411	.171	-.147	.785	.649	.272	.15
	Mean Technology Operations and Concepts PEofEU	-.177	.204	-.149	-.868	.394	-.596	.243	.428	-.171	-.09

a. Dependent Variable: Exam PEofEU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.794[a]	.630	.586	.63701	.630	14.214	3	25	<.001

a. Predictors: (Constant), Mean Reasearch and Information Fluency PEofEU, Mean Creativity and Innovation PEofEU, Mean Communication and Collaboration PEofEU

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.304	3	5.768	14.214	<.001[b]
	Residual	10.145	25	.406		
	Total	27.448	28			

a. Dependent Variable: Exam PEofEU

b. Predictors: (Constant), Mean Reasearch and Information Fluency PEofEU, Mean Creativity and Innovation PEofEU, Mean Communication and Collaboration PEofEU

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	.810	.565		1.433	.164	-.354	1.974			
	Mean Creativity and Innovation PEofEU	.119	.323	.110	.368	.716	-.546	.784	.729	.073	.045
	Mean Communication and Collaboration PEofEU	.487	.345	.474	1.412	.170	-.223	1.197	.777	.272	.172
	Mean Reasearch and Information Fluency PEofEU	.302	.238	.255	1.272	.215	-.187	.791	.713	.247	.155

a. Dependent Variable: Exam PEofEU

Digital competences x Assignment/Exam Course 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.924[a]	.854	.708	.68168	.854	5.842	6	6	.025

a. Predictors: (Constant), Mean Technology Operations and Concepts GES, Mean Creativity and Innovation GES, Mean Communication and Collaboration GES, Mean Digital Citizenship GES, Mean Reasearch and Information Fluency GES, Mean Critical Thinking GES

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.289	6	2.715	5.842	.025[b]
	Residual	2.788	6	.465		
	Total	19.077	12			

a. Dependent Variable: Exam GES

b. Predictors: (Constant), Mean Technology Operations and Concepts GES, Mean Creativity and Innovation GES, Mean Communication and Collaboration GES, Mean Digital Citizenship GES, Mean Reasearch and Information Fluency GES, Mean Critical Thinking GES

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	1.235	1.624		.761	.476	-2.737	5.208			
	Mean Creativity and Innovation GES	-1.026	.554	-.562	-1.850	.114	-2.382	.331	.460	-.603	-.289
	Mean Communication and Collaboration GES	1.229	.867	.572	1.417	.206	-.893	3.350	.664	.501	.221
	Mean Reasearch and Information Fluency GES	.222	.587	.172	.379	.718	-1.213	1.658	.615	.153	.059
	Mean Critical Thinking GES	.892	.754	.615	1.182	.282	-.954	2.737	.614	.435	.184
	Mean Digital Citizenship GES	1.200	.407	.837	2.947	.026	.204	2.197	.373	.769	.460
	Mean Technology Operations and Concepts GES	-1.941	.481	-1.169	-4.036	.007	-3.117	-.764	.054	-.855	-.630

a. Dependent Variable: Exam GES

13.4. Independent Sample T-Test – Homogeneity of Variance

T-Test

Group Statistics

	What is your gender?	N	Mean	Std. Deviation	Std. Error Mean
Average DS Word	Female	10	4.6000	.51640	.16330
	Male	12	4.2500	.62158	.17944
Average DS Numbers	Female	10	3.5000	.70711	.22361
	Male	12	3.1667	.93744	.27061
Average DS Presentation	Female	10	3.7000	.94868	.30000
	Male	12	3.6667	.65134	.18803
Average DS Email	Female	10	3.8000	.91894	.29059
	Male	12	3.9167	.79296	.22891
Average DS Internet	Female	10	3.2000	.91894	.29059
	Male	12	3.2500	.86603	.25000
Average DS File Manager	Female	10	3.5000	.97183	.30732
	Male	12	3.4167	.79296	.22891
Average DS School IS	Female	10	3.6000	.96609	.30551
	Male	12	3.4167	.99620	.28758
Average DS Statistics	Female	10	2.2000	1.39841	.44222
	Male	12	1.9167	1.31137	.37856
Average DS Academic DB	Female	10	1.9000	.87560	.27689
	Male	12	2.7500	1.13818	.32856
Average DS Sharing Documents	Female	10	3.4000	1.07497	.33993
	Male	12	3.7500	.86603	.25000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Average DS Word	Equal variances assumed	.032	.859	1.418	20	.086	.172	.35000	.24690	-.16502	.86502
	Equal variances not assumed			1.443	19.999	.082	.165	.35000	.24262	-.15609	.85609
Average DS Numbers	Equal variances assumed	.378	.545	.925	20	.183	.366	.33333	.36036	-.41837	1.08504
	Equal variances not assumed			.950	19.843	.177	.354	.33333	.35104	-.39930	1.06597
Average DS Presentation	Equal variances assumed	1.387	.253	.097	20	.462	.923	.03333	.34209	-.68026	.74693
	Equal variances not assumed			.094	15.502	.463	.926	.03333	.35405	-.71919	.78586
Average DS Email	Equal variances assumed	.096	.760	-.320	20	.376	.752	-.11667	.36479	-.87760	.64427
	Equal variances not assumed			-.315	17.973	.378	.756	-.11667	.36992	-.89393	.66060
Average DS Internet	Equal variances assumed	.119	.733	-.131	20	.448	.897	-.05000	.38117	-.84511	.74511
	Equal variances not assumed			-.130	18.818	.449	.898	-.05000	.38333	-.85285	.75285
Average DS File Manager	Equal variances assumed	.450	.510	.222	20	.413	.827	.08333	.37592	-.70083	.86750
	Equal variances not assumed			.217	17.380	.415	.830	.08333	.38320	-.72381	.89047
Average DS School IS	Equal variances assumed	.008	.928	.436	20	.334	.668	.18333	.42080	-.69443	1.06110
	Equal variances not assumed			.437	19.493	.333	.667	.18333	.41957	-.69333	1.05999
Average DS Statistics	Equal variances assumed	.197	.662	.490	20	.315	.630	.28333	.57856	-.92353	1.49020
	Equal variances not assumed			.487	18.775	.316	.632	.28333	.58212	-.93605	1.50271
Average DS Academic DB	Equal variances assumed	.717	.407	-1.930	20	.034	.068	-.85000	.44031	-1.76848	.06848
	Equal variances not assumed			-1.978	19.903	.031	.062	-.85000	.42968	-1.74657	.04657
Average DS Sharing Documents	Equal variances assumed	.891	.356	-.846	20	.204	.407	-.35000	.41347	-1.21249	.51249
	Equal variances not assumed			-.829	17.242	.209	.418	-.35000	.42197	-1.23932	.53932