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

Využití ICT ve vysokoškolské vzdělávací instituci v oblasti sociálních věd

Teze disertační práce

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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 21^{st} 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

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Disclaimer: In this document, there will be mentions of several tables and figures present in the full version of the dissertation, but not included here.

1 INTRODUCTION

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 loworder 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 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.

The full thesis text presents nine frameworks and compares their terminology and functionality in real digital environments, including the one used to measure digital skills and competences in the research studies, ICTE-MM (Solar et al., 2013).

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.

2.3 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: the microsystem, the mesosystem, the exo-system, the macrosystem, and the chronosystem.

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.

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, based on figures from the National Statistics Office (Český statistický úřad - CSU) against an EU average.

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.

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.

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. 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.

4.1.3 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.

4.1.4 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). 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.

4.1.5 Research Instruments

The assessment 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) (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 CVs 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.

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 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. 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.

4.1.6 Study 1 results

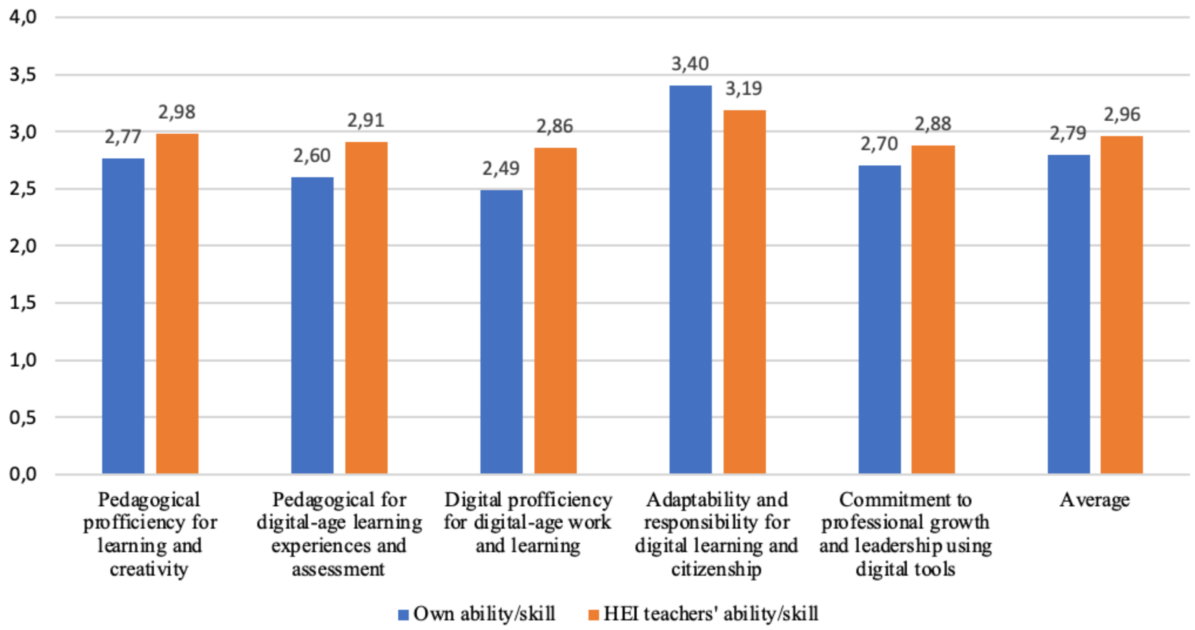

Figure 4. Mean estimate of own and other teachers' ICT-related abilities/skills

Several statistical tests were performed to analyse the collected data. In this document, there will be mentioned several tables and figures present in the full version of the dissertation, but not included here.

The figures resulted from the ICTE-MM-based questionnaire provided 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.

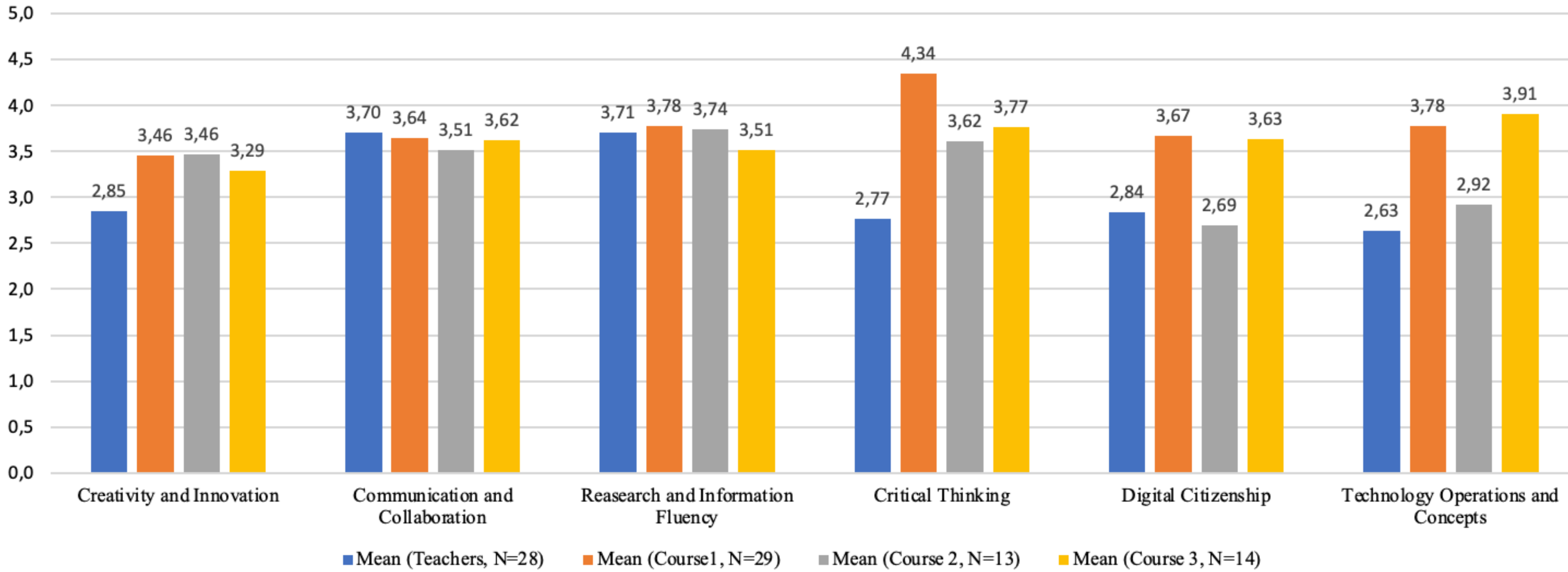

Figure 5. Evaluations of students' digital competences by HEI teachers compared to Courses 1-3 seminar evaluation scores

Table 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 5 shows 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.

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.

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]).

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 $F(5,10) = 4.854$, $p=.016$.

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.

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.

The digital skills-digital competences relationship was investigated only using correlational analysis. 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. 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.

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.

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.

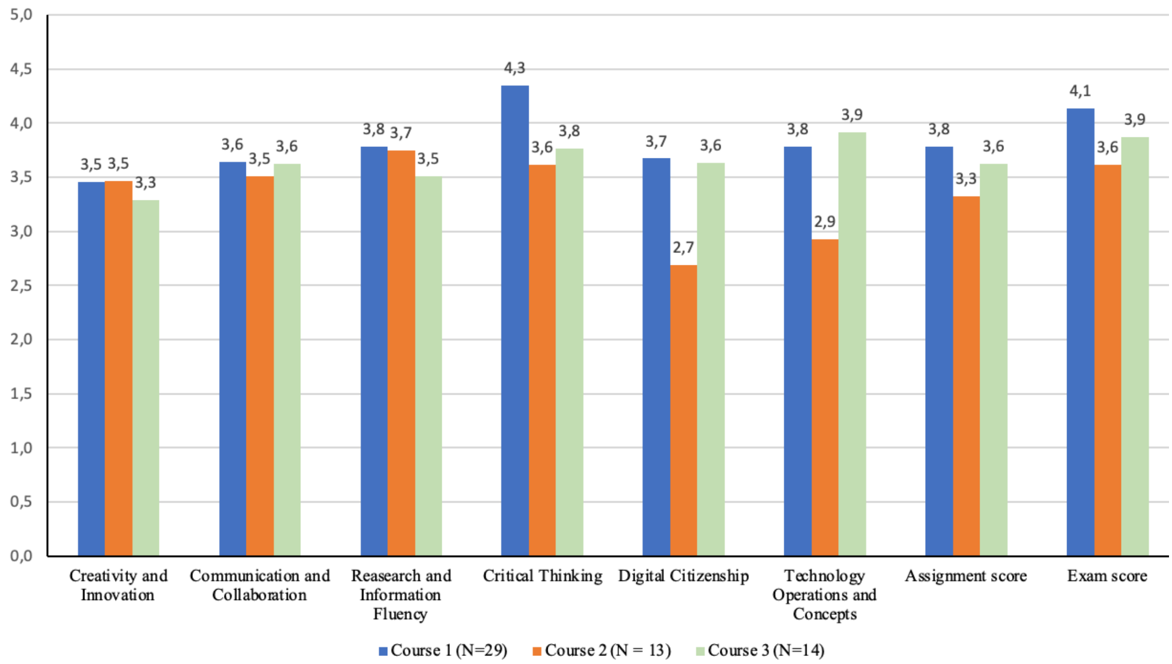

Figure 7. ICTE-MM Digital competences measured in course assignments and exam scores per course

Further statistical tests show 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.

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 significance of the results 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.

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.

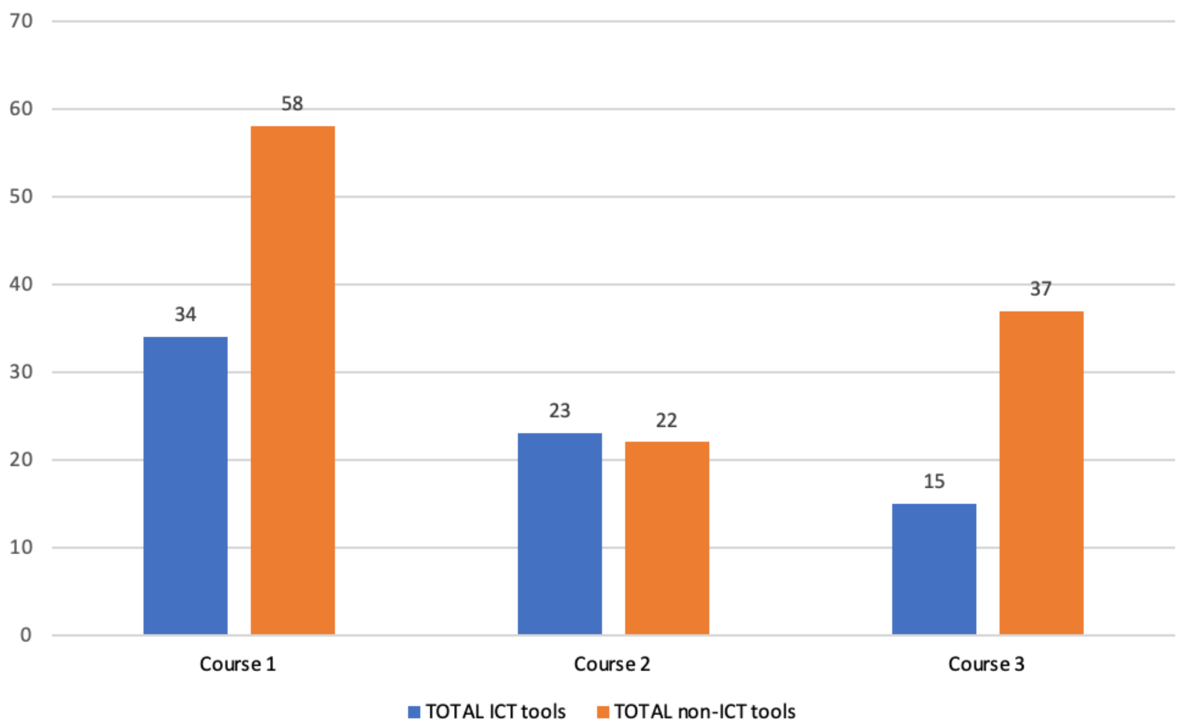

Figure 8. Frequency of occurrence of teaching tool type in course feedback per course

The relationship between the exam and assignment scores for all three courses was analysed using correlational analysis. Figure 9 shows the path diagram of the correlational relationship between exam and assignment scores.

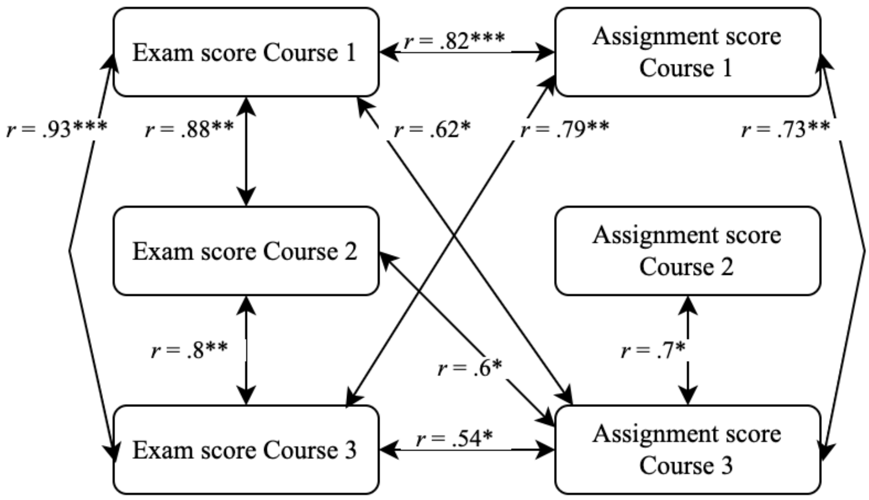

Figure 9. Correlational relationships between exam and assignment scores

4.2 Study 2 – Semi-structured interviews

4.2.1 Study design and procedure

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. 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.

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.

4.2.2 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.

4.2.3 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.

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.

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.

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.

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.

“…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 ICT in teaching, and student’s performance in social sciences

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, were mentioned that they can influence this performance. 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.

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.).

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.

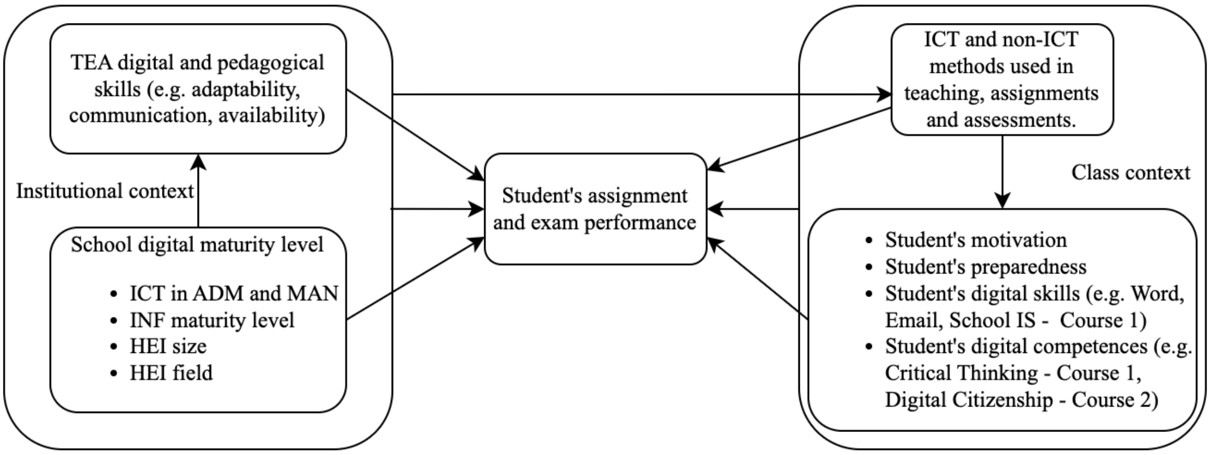

Figure 15. Relationships between ICT-dependent factors and student's course performance per context type

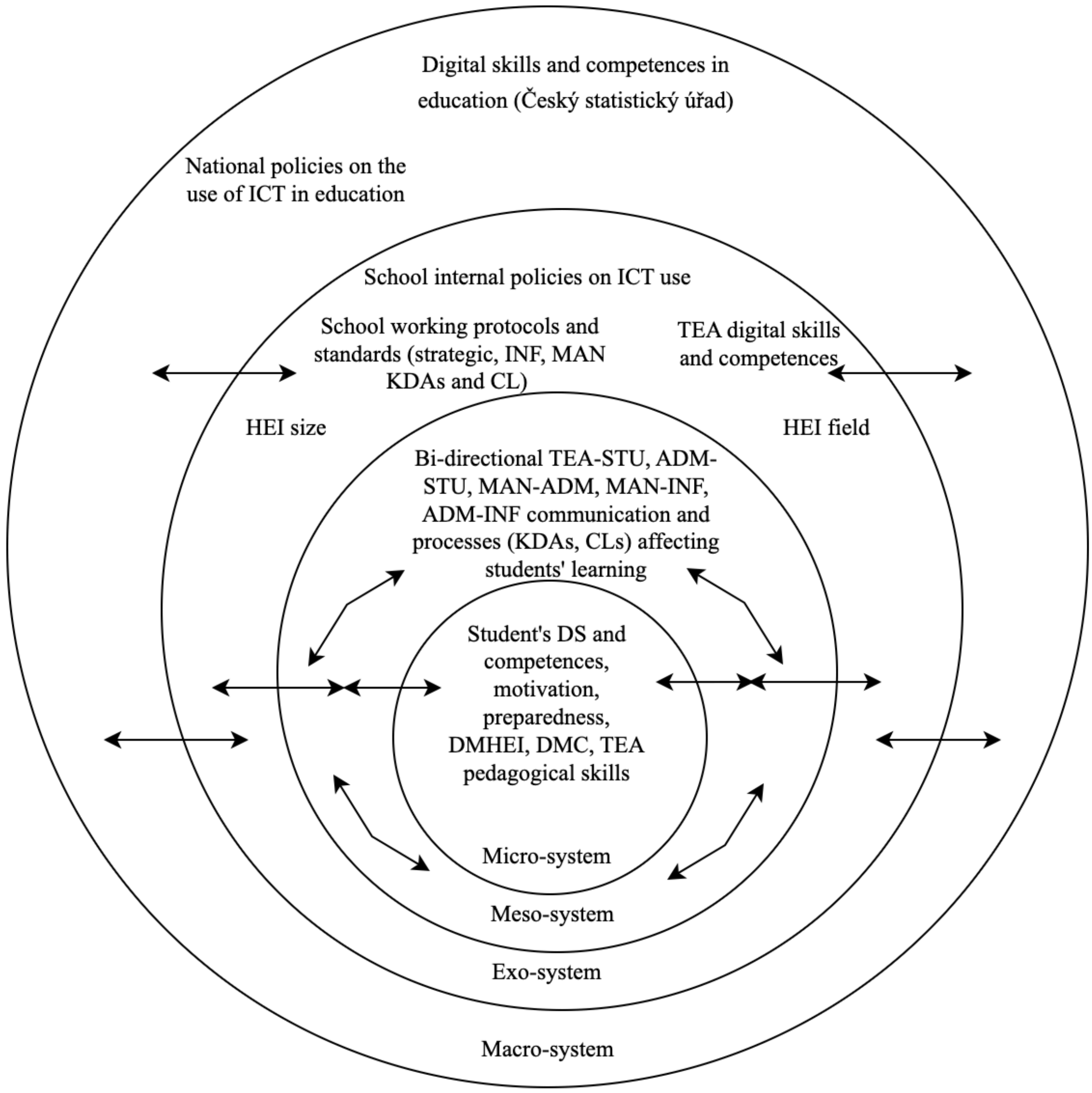

Figure 14. Factors of influence on the use of ICT in education per ecological system

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.

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 are part of the full thesis, and they are 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.

5 CONCLUSIONS

The findings show that the use of ICT in teaching in social sciences classes in a HEI at least partially predicts 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. 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.

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