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Improving digital competence with pedagogical practices in higher education

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Abstract

The rapid technological development in society requires wide-ranging digital competence from higher education students. In the article, we discuss the inequalities, which are caused by inadequate or missing digital competence among higher education students. Students might have basic skills but less competence about data literacy, information literacy, artificial intelligence literacy or digitality in society. Second, we provide four examples of Finnish higher education courses aimed at supporting the development of various aspects of digital competence. We reflect on the courses by using a critical digital literacy framework.

Introduction

The rapid changes in digital technology create a challenge for educational institutions and their members: students, teachers, and other educational staff. The most important recent change of digital technology in education is the easy and cheap way of using artificial intelligence applications when studying as well as in personal life, life-long learning and professional tasks. Simultaneously, there are many other societal and cultural consequences based on digital technology for which education should prepare students to ensure equal opportunities for learning.

In the present article, we examine the digital inequalities among Finnish higher education students, especially those based on missing or inadequate digital competence and those, which can be addressed by higher education teachers. In their review study, Zhao et al. (2021) identified that one key gap in higher education research is the pedagogy involved in digital competence and its validation. Therefore, through example cases, our aim is to discuss how teaching in higher education can promote students' profound digital competence. We present four courses in which digitality is an essential element and examine them through a research-based framework (Gouseti et al., 2022; Ilomäki et al., 2023a), to address the dimensions of critical digital literacies which these courses support. The aim of this article is to discuss whether the pedagogical practices with digital technology could support and improve students' digital competence, as it is described in this framework, and diminish the digital divide between students.

We use the term 'digital competence', which consists of elements from media studies and computer science to library and literacy studies (Ilomäki et al., 2016). Various definitions of the concept are close to each other. The European Commission has defined it as "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (2018, p. 9). We also refer to 'critical digital literacies', which consist of two types of entities: first, various literacies, such as digital literacy, technological literacy, information literacy, media literacy and data literacy, and second, societal and cultural phenomena that inform practices and experiences. In general, ´critical´ means both an individual's critical attitude towards digital contents and a critical societal approach to the use and resources of digitality (Burnett & Merchant, 2011; Hinrichsen & Coombs, 2014; Pangrazio, 2016).

The terms are close to each other (Zhao et al., 2021), (critical) with digital literacies referring to the European English-speaking culture (Spante at al., 2018). Digital competence and critical digital literacies are evolving concepts and therefore they are often overlapping. In this article, we use the concept 'critical digital literacy' because we want to

highlight broader social, ethical, economic and political factors in digital practices instead of basic technical competence in using digital resources.

A key message in international and national educational policy is to improve students' digital competence and digital literacies continuously, starting from early childhood education to basic, secondary and higher education (OECD, 2022; Staring et al., 2022). Several international and national organizations have defined the necessary elements of digital competencies that all citizens should master. One well-known framework is DigComp2.2, The Digital Competence Framework for Citizens (Vuorikari et al., 2022) in which the main skills are 1. Information and data literacy, 2. Communication and collaboration, 3. Digital content creation, 4. Safety, and 5. Problem solving. The framework is wide and recently updated, and certainly relevant for thinking about higher education students' competencies. However, for higher education, there are demands that focus especially on studying with digitality, and the digital competence that is required may vary based on study domains. Furthermore, rapidly developing algorithm-based technologies, such as data analytics and artificial intelligence (AI), are transforming social and pedagogical practices in fundamental ways, which requires reconsideration of the frameworks, key digital competencies, literacies, and capabilities required from higher education (HE) students and teachers to manage different complex tasks in developing digital contexts (Markauskaite et al., 2022; Tuomi, 2023). These reconsiderations can be reflected and improved through developing new pedagogical practices that prepare students to work with emerging technologies while studying in higher education.

The other message in the policy documents is to diminish the digital divide which increased during the COVID-19 pandemic at schools (Staring et al., 2022), and among higher education institutions (Celik et al., 2023; Zhang et al., 2021). The inequities in higher education, following the restrictions during the COVID-19 pandemic, are widely investigated. These concerns remain in teaching and learning even after the COVID-19 pandemic. Our concern is that although higher education institutions offer (voluntary) courses for improving digital skills, it is often not organized in a systematic way to ensure that the necessary skills for all students are being transferred from the beginning, and furthermore, the students do not acquire the profound new competencies.

Reflecting teaching practices with digital technology

One key aspect for improving digital competence in higher education is the versatile use of digital technology, embedded in pedagogical activities and assignments, instead of teaching technology use in a fragmented way (Majd et al., 2020). In this article, we use the Critical Digital Literacies framework (CDL; Ilomäki et al., 2023; Gouseti et al., 2022) as an analytical tool for evaluating pedagogical practices with digital technology in higher education courses. The framework is based on the results of a systematic literature review, which were modified for school use. It describes the recent issues and phenomena of CDL that are essential for students to know and understand. Although the framework was originally developed for the school level, we think that it is also relevant for higher education: it provides a more recent approach to digital competence than some previous frameworks and helps to draw attention to new and emerging issues related to students' digital competence. In this framework, some of the sub-categories are likely more suitable for teaching in higher education (e.g. *Data analytics* and *Learning analytics*), while other subcategories (e.g. *Creative digital content expression* and *Source validation and verification*) might be more suitable for the primary and secondary

school. Previous approaches have addressed educators' competence, e.g., DigiCompEdu (Punie et al., 2022) and a framework for social and health care educators (Ryhtä et al., 2020) but the CDL framework focuses on students.

The critical digital literacies framework consists of eight major dimensions: technology use, data literacies, information literacies, digital content creation, digital communication and collaboration, digital well-being and safety, digital citizenship, and digital teaching and learning. The dimensions consist of three to six sub-dimensions (see Fig. 1, Gouseti et al., 2022). Because the phenomena classified in the review are complex, open to interpretation and somewhat overlapping, the sub-categories are the authors' conclusions derived from the reviewed documents (see the review method in Ilomäki et al., 2023a). The sub-categories are described in Gouseti et al. (2021). After the first version, we added one sub-dimension under data literacies, *the operating principles of artificial intelligence*, which was not yet addressed in the reviewed articles and policy documents, due to its very rapid uptake in educational applications and practices. The use of AI is also a part of other dimensions, as a technological tool, although it is not mentioned separately; for example, creative digital expression is also possible with AI applications.

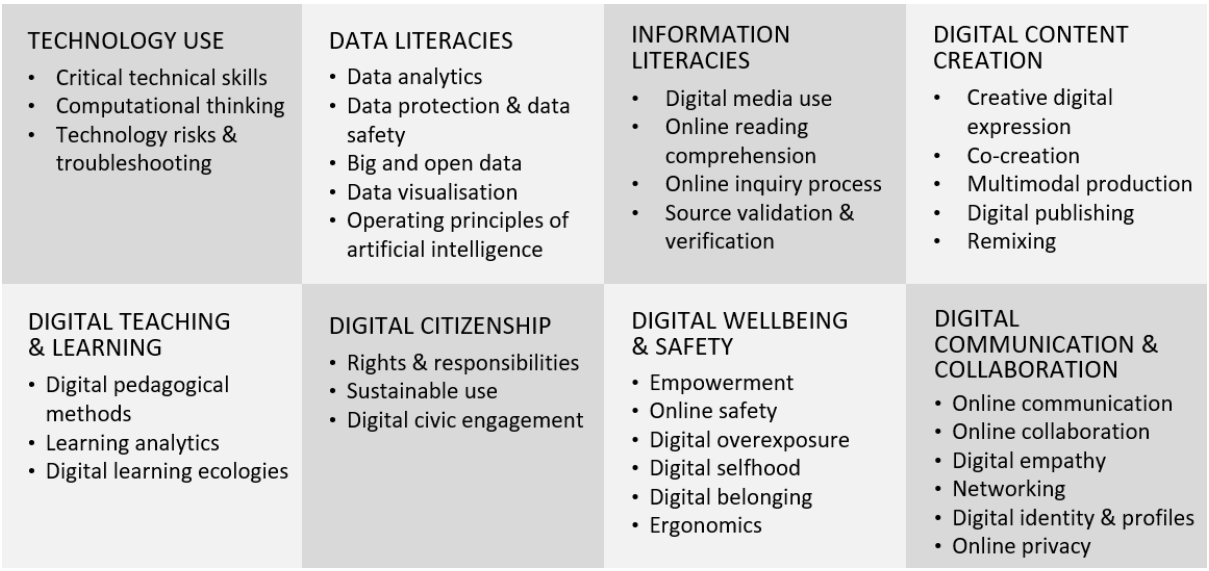


Figure 1. The dimensions and sub-dimensions of the Critical Digital Literacies framework (Gouseti et al., 2021).

Higher education students' digital competence and digital resources

In general, higher education students are expected to have basic digital skills: they communicate regularly via digital tools and social media, use the Internet for information searches, and use conventional educational technology applications when studying. However, they are not "digi-natives" who use new technology without any need for teaching and training, as sometimes believed (Kirschner & De Bruyckere, 2017; Sánchez-Caballé et al., 2020) and they do not form a homogeneous group based on their digital competence, not even within one educational institution. Their digital competence, attitudes, experiences, and resources vary, as the following examples of recent studies show. In their systematic literature review, Zhao et al. (2021) concluded that students' (and college teachers') digital competence was at a basic or medium level, and even if they thought that they had a good level of performance in some topics, most of them felt insecure when they encountered complex problems. In another systematic literature review, Sánchez-

Caballé et al. noticed (2020) that competence varies according to the economic situation and access to technology. Non-technical library students in Czech had problems in programming, integration of services and content, technical problem solving and copyright related questions, but they had strengths in information and data literacy and, naturally, field-specific topics (Cerny, 2021). Tzafilkou et al. (2022) reported in their study in two universities in Greece that there were no gender differences in the competencies, which is contradictory to previous studies. Instead, they noticed a significant gap between age groups: students between 25 and 35 had the highest level of competence on factors "Store, Manage and Delete" and "Protect" (these both are technical skills), while the youngest team of 18–24 had the lowest scores on those factors. As the authors concluded, the undergraduate students met difficulties in protection and file management tasks, which the authors regarded as a serious risk, because the younger age groups use the Internet, text, and multimedia much more frequently than older age groups (25–64). Gutiérrez-Ángel et al. (2022) reported in their review that university students are digitally literate related to communication and collaboration, but they are on a lower level in terms of digital content creation. As a summary, we may agree with Zhao et al. (2021) in their conclusion that it is not easy to get a full picture of higher education students' digital competence through previous research: the studies are fragmental, focus on some individual institutions or study programs and are often based on self-evaluations.

The results from studies during the COVID-19 pandemic showed inequalities among higher education students, e.g., in USA, the inequalities were caused by the limited resources at students' homes, such as poor Internet connections (Quach & Chen, 2021) and in New Zealand, students' poor confidence and competence in using digital tools in education (Hartnett, Butler, & Rawlings, 2023). Post-COVID-19 studies inform us about other inequalities among higher education students. In their study, Pohlenz et al. (2023) investigated German students' attitudes to digitality in education, and they identified three groups of students in the interests and attitudes for digitality: *Proponents* favor new online tools, are rather autonomous in organizing studies, and do not necessarily need permanent personal support and interaction. S*keptics* do not support online learning and are partly against it, encounter problems in organizing their studying and prefer more personal support and interaction. *Pragmatics* are somewhere between these two groups. The authors (ibid.) emphasize that the digitalization of teaching and learning is a social problem, such as a question of didactics or quality assurance, not a technical problem.

Digital competence and digital resources are naturally connected. van Deursen and van Dijk (2016) reported in their study in the Netherlands that using a higher diversity of devices is related to a higher diversity of Internet use, more Internet outcomes and better Internet skills. They emphasized that the effects of Internet attitudes on Internet skills were stronger than the effects of many socioeconomic variables, and attitudes were particularly important at the beginning of Internet appropriation. They suggested that Internet attitudes should also be considered as part of the first-level digital divide—the psychological part. Younger people were more likely to only use a tablet or smartphone, an age-related "mobile underclass"; as the authors say, because these mobile tools are not equal to desktop and laptop computers and using only mobile or non-mobile devices limits the potential range of Internet activities and outcomes (ibid.). In short, for better competence students need computers.

Interestingly, a digital gap does not only exist between institutions, but also within educational institutions. Even within institutions, digital resources and competences vary, as Soomro et al. (2020) have noted. In some faculties and with some educators, students have better opportunities to learn digitality in and for their studies than in some others. However, in this article we do not focus on institution-level solutions but on course-level pedagogical practices.

Higher education students' digital competence and digital resources in Finland

Due to the digital matriculation exam at the end of upper secondary school in Finland, all upper secondary education students have basic digital skills - but necessarily not more - and they have a portable computer as well as access to an efficient and fast Internet connection. However, this does not yet guarantee wide digital competence and necessary extensive skills. As Kaarakainen, Kaarakainen, and Kivinen (2018) reported, upper secondary school students' use of digital technology as well as their competence vary. Similarly, their information literacy skills vary, and many students do not reach the appropriate competence level in these skills for higher education. Hämäläinen et al. (2021) reported about students' skills of paying attention to multiple aspects of credibility in online texts, and the skills varied from very good to poor. In most upper secondary classrooms, digital technology is used at a basic level, such as using Word, PowerPoint, Internet for information searches and a digital learning environment (Ilomäki, Lakkala, Muukkonen et al., 2023b), but, e.g., collaborative creation online is not in use. In general, we may say that many of the upper secondary students do not reach necessary digital competence for studying at the higher education level.

A European Eurostudent VIII study was conducted during the COVID-19 period (2022). Besides questions concerning studying during the COVID-19 pandemic, it included one self-evaluation question about whether the student's digital skills were sufficient compared to what is required when they were studying and a few questions about digital resources. The results from Finland were among the highest. About 91 % of Finnish students used the Internet daily, almost every student had either a computer or a tablet at home and 93% had an adequate Internet connection at home. These are high numbers compared to information about students at school level, where students mainly have tablets or mobile phones at home and also the resources between schools vary (Tanhua-Piiroinen et al., 2016). It thus looks like students' digital resources increase as they get older. Higher education students regarded their (self-evaluated) digital competence as being quite high, but there were major differences between universities and polytechnics and between faculties and study programs; students studying languages, literature, history or arts were less confident compared to students studying digital technologies. In addition, female students and those over 40 years of age evaluated their skills as being lower (Saari, Koivuranta, & Nevalainen, 2023).

There does not seem to be a digital gap concerning the access to digital technology: students usually have their own devices and the Internet access is possible at home and naturally at the higher education institutes. However, there is a need to support especially younger students' digital competence at the beginning of higher education, and perhaps some older freshmen and some students who recognize the shortcomings in their basic digital competence. The overall challenge is to ensure that all students have sufficient-level skills, such as information, digital or data literacy, AI literacy and an understanding of privacy and ethical concerns (Silvola et al., 2021; Muukkonen et al., 2024).

Examples of pedagogical practices in higher education courses

We aim to bridge the gap between students' digital competence and the emerging demands of advanced digital technologies and suggest how to support them in educational practices. To do so, we present examples of pedagogical

practices in higher education courses and describe them with a research-based framework of critical digital literacies. Those dimensions of CDL that are centrally addressed in each course are highlighted and discussed.

The cases were selected based on the authors' experiences from their own courses. We selected cases in which teachers emphasized learning of new competencies in using digital technology and related these to innovative pedagogical practices (Fraser, 2019). In this sense, the courses are not typical Finnish higher education courses which employ less technology.

Case 1: Project work and workplace skills course in Agricultural sciences

The course is primarily for third-year undergraduate agricultural sciences students to acquire various career- and workplace-relevant skills and project work practices at the University of Helsinki. Students' self-evaluated learning of knowledge work competence during the course is reported in Lakkala et al. (2023). The course was obligatory for the students and students earned three ECTS credits (European Credit Transfer and Accumulation System) by completing it. The course duration was one period, including two 3-hour meetings every week (33 hours in total) and independent work between meetings individually or in groups.

During the course, students' career skills were promoted through writing personal curriculum vitae and a job application, creating a LinkedIn profile, giving a personal "elevator pitch" and building a personal portfolio, as well as interviewing a professional in the field in pairs and practicing arguing in groups. Students also practiced project work skills by producing a project plan in small groups through completing the planning process as in professional project work (e.g., defining goals, brainstorming solutions, making a budget). Experts from another university unit selected the project topic and evaluated the responses, based on a real goal from an existing project. The course was graded as a pass or a fail.

The Moodle digital learning environment was used as a basic platform for sharing course instructions, educational materials as well as links to relevant sources and applications. Also, the completion of assignments related to career skills was coordinated through Moodle. For the project planning assignment, Microsoft Teams was used so that each group had its own channel for communication and for producing required documents. Otherwise, the groups chose which other tools they wanted to use in their group communication and project planning activities. For example, most groups decided to use WhatsApp for communication between the members outside contact sessions.

The group activities and assignments supported students' critical digital literacies in the following ways:

- **Technology use**: *Critical technical skills* were promoted explicitly through a home assignment in which students read about digital tools in project work, and through an introductory lecture about the topic. In addition, the groups completed an assignment in which they had to make a plan using a template provided by the teachers about what digital tools they would use in their project work and for what purposes. A lecturer commented on each plan and asked to correct them if they were incomplete.

- **Information literacies**: *Online inquiry process* was practiced in the project planning assignment to search for information from a wide variety of sources as the basis for the project solution. Links and documents to

various background materials were provided to students via the Moodle platform, but online inquiry skills were not explicitly taught or practiced.

- **Digital content creation**: Many assignments supported *Multimodal production* because students were assigned to produce convincing and selling digital presentations both individually and in the project groups. *Digital publishing* was practiced by producing a blog post in groups based on an expert interview. The students received some links to websites that included guidelines about how to write a good blogpost. All pair and group assignments represented practices of *Co-creation* with a requirement to produce a digital outcome as a task performance. At the beginning of the project work assignment, a lecturer gave an introduction about how to use digital tools in project work and what the key issues are that should be taken into account in technology-supported teamwork and document co-production (authoring responsibilities, commenting, versioning, naming and managing files, etc.).

- **Digital communication and collaboration**: The students gained experience in genuine *Online collaboration* through conducting the project planning assignment by using various online tools, especially the Microsoft Teams platform, which is widely used in the workforces for project and team work. The course lecturers created the team areas, provided document templates for various project tasks and gave instructions for using Teams for online meetings and document co-authoring, but the groups were responsible for managing and organizing their own team channel. Competence related to *Digital identity & profiles* was promoted through an assignment that involved creating a personal profile in LinkedIn and receiving feedback on its quality from a lecturer.

- **Digital teaching and learning:** Students' self-regulation skills for utilizing available *Digital learning ecologies* were promoted through pre-assignments before every contact session, following the flipped classroom approach (one *Digital pedagogical method*), and through integrating students' e-portfolio work (which is part of their bachelor's degree) with the course assignments. Students received a link to an introductory video explaining the flipped classroom approach and detailed instructions for the e-portfolio assignments.

Case 2: Increased study well-being through digital control - Academic Skills II course

Academic Skills II is a course primarily for first year students at the Swedish School of Social Science, University of Helsinki, and about 110 students participate in the course each year. In their first term the students take part in Academic skills I, which gives them some basic knowledge on how to study at a university level. In their second term the students take part in Academic Skills II, which contains academic writing skills, information searching and reference management, including learning to use Zotero, the reference management tool. A central component in this five credits course is called *Study skills.* The aim of this smaller part of the course is to help the students to be more conscious regarding basic and essential skills such as time management and to strengthen the students' meta-cognitive skills, to help them reflect on their strengths and weaknesses in their own style of study.

Moodle is used as the digital learning environment and for sharing the assignments and relevant materials, as well as the students' texts. The Study Skills part of the course is introduced through a lecture on site or online via Zoom, in which a study psychologist participates. There are three bigger assignments for the students: a) a time follow up-assignment, b) a "change a habit" assignment and c) a SWOT analysis in which students are asked to evaluate their strengths, weaknesses, opportunities and threats regarding their personal learning strategies and study habits. All assignments are done individually and the first two are also discussed in smaller groups on site or online via Zoom.

Since a central part of time management and planning skills for young people in today's society is to be conscious about digital distraction, one of the first assignments in the course is to fill in a media use questionnaire regarding the students' perceptions of their (social) media habits and time spent on gaming, social media and other types of amusement through the Internet. After this, the students perform the first of the main assignments, i.e., the time follow-up assignment that they are asked to perform for one week. The students are given a timesheet to closely follow how they spend their time during this week: how much time is spent on studying on site or remotely, on work, on leisure time activities, on sleeping etc.

The results from the media use questionnaire have shown that nearly half of the students are concerned about their use of screens (the exact meaning of "use of screen" is determined by the student); close to 40% of the students fear that their digital habits will disrupt their sleep; and that around 45% of them feel that their screen use impairs their academic success. It was therefore evident that there is a need to put more effort into making the students conscious about how their digital habits affect their studying. As a result, the time follow-up sheet was developed so that the students also follow the time they spend on digital leisure more closely, i.e., how much time is spent on certain social media platforms, on various streaming services, on gaming etc. The students are asked to use a range of apps to help them monitor their usage. The aim is thus to gain specific knowledge about how they use their time with regard to digital services. For the students to gain more knowledge about how the content of the digital entertainment/distraction may affect their well-being, the students are also asked to reflect on how they feel after having spent time on social media or taken part in online streaming services.

When the time follow-up assignment has been completed, all students and the teacher meet for a second session and the results from the media use questionnaire are presented to the students. The teacher also presents research results on topics related to digital distraction and multitasking. The students elaborate on what they have learned about their personal use of time and their digital habits in smaller groups and together the students identify their biggest time thieves and how to manage them. The students then reflect together on how the content in social media and streaming services affect their well-being. The range of expressions (e.g. hate speech) used in social media and their possible effects on people's well-being are discussed. The students are encouraged to consider actions that might be taken when they encounter interaction online that contains derogatory or inappropriate messages.

After completing these assignments, the students individually choose one habit related to digital distraction or another habit that they would like to change in order to enhance their personal well-being. The students write down their personal goals related to the habit they wish to change and plan what steps they need to take to change the habit. The students have one week to try to change the habit they have chosen, after which they report in writing on their success or failure to change their habit and evaluate how useful the assignment felt. All students meet again to discuss what they

have learned and after that, the students individually do the last assignment, the SWOT analysis based on what they have learned about their own study strategies and digital habits.

The assignments in this Study skills part supported the students' critical digital literacies in the following ways:

- **Digital well-being and safety:** The assignments supported understanding and reflecting on *Digital overexposure.* Time spent using various digital services is followed up by students using apps to monitor their usage of social media and other online entertaining services. The use of time and phenomena like addiction, multi-tasking, digital distraction etc. are discussed in relation to study strategies and study well-being. The students set a goal and practice how to change habits to enhance their well-being related to digital habits. The digital habits are evaluated as a part of the students' SWOT analysis.

- **Digital interaction and collaboration:** The content of social media and other parts of online entertainment and the effects of this content on students' well-being are discussed. Students are encouraged to reflect on styles of expression and how these may influence other users' well-being, as well as on ways to act when derogatory or otherwise inappropriate interaction is identified. These especially support *Digital Empathy.*

Case 3: Learning analytics module

Learning analytics (LA) module consisted of two courses, Data processing, data management and ethics in learning analytics, and Learning analytics for teachers and students. These courses were a collaboration between the Faculty of Information Technology and Electrical Engineering and the Faculty of Education and Psychology at the University of Oulu, Finland. Both courses were worth five ECTS, thus students were able to earn ten ECTS during the learning analytics summer module. The courses were targeted at the master's-level degree students in education, and the students registered through the Open university. The diversity of participants provided a valuable atmosphere for these courses: master's students provided their up-to-date theoretical understanding about the processes of learning, while the students registered through the Open university were often professionals working in the field of education, thus bringing their practical experience back to the conversations in the lectures.

Both courses consisted of 10 lectures (2 hours each) and they were taught by two teachers, and three invited teachers from several fields.

1. **Course Data processing, data-management and ethics in learning analytics**

The course focused primarily on ethical and privacy questions in the fields of learning analytics and AI. The aim of the course was to provide knowledge and skills needed to understand and critically evaluate data driven applications of artificial intelligence and learning analytics in an educational context. The aim of the course was to increase students' awareness of ethical and legal aspects of AI enhanced learning analytics design and use, as well as to increase their critical literacy in a range of learning analytics applications from the aspect of ethics and legal issues.

The course was taught by two main teachers (each from the collaborating faculty) and two invited guest teachers. The main themes were AI ethics, norms, and guidelines, privacy and data protection, design and implementation of learning analytics tools, and enablement of students.

During the course, students prepared a group assignment, which was completed as a home task and presented by students in the final seminar. The group assignment required students to work in (preferably) multidisciplinary groups, apply the knowledge from the lectures and evaluate chosen learning analytics and/or artificial intelligence applications from an ethical perspective. Students were free to choose the application they wanted to evaluate, but were required to make their evaluations according to seven criteria: Human agency and oversight; Technical robustness and safety; Privacy and data governance; Transparency; Diversity, non-discrimination and fairness; Environmental and societal well-being and; Accountability. Students also used Ethical Guidelines from the European Commission for trustworthy AI and self-assessment List for Trustworthy Artificial Intelligence. The group assignment resulted in a presentation introducing the completed evaluation and detail about each evaluated criterion. Teacher feedback was provided to students in the final seminar. Additionally, during the course students familiarized themselves with the AI literacy framework (Long, & Magerko, 2020) and had a chance to evaluate their own competencies using a prepared form.

The group activities and assignments supported students' critical digital literacies in the following ways:

- **Data literacies**: Students' knowledge on *Operating principles of AI* was promoted through lecture materials focusing on AI definitions, AI development through time, several types of AI applications as well as AI biases. The course also provided information about AI literacy and evaluating one's own AI literacy skills. *Data protection and data safety* skills were addressed in parts of the course focusing on personal data protection legislation and data management practice. The course also supported understanding *Data visualization* by focusing on the cycle of visual learning analytics and importance of user perspectives in the visual presentation of data.
- **Digital communication and collaboration:** In the discussion on personal data protection, the topic of *Online privacy* was also covered, providing students with an overview of social media platforms and their personal data policies.
- **Digital wellbeing:** *Empowerment* of students as users of AI and learning analytics applications was one of the major topics covered by the course. Students familiarized themselves with various conceptualizations of agency, and they could reflect on their own agentic experience and to evaluate selected digital tools in the light of user empowerment.
- **Digital teaching and learning:** The overall topics of *Learning analytics* and AI in education context were introduced to the students with several application examples from a variety of contexts.

2. Course Learning analytics for teachers and students

The course focused primarily on basic conceptions of learning analytics, and its applications in educational context. The course provided knowledge about the design of learning analytics-supported pedagogical practices, implementation of learning analytics tools for different educational purposes, understanding of the options and limitations of learning

analytics, as well as practices with learning analytics and AI applications. The aim of the course was to provide participants with a basic understanding of preparing data for analytics, interpretation of educational data, and applications of learning analytics and AI in different pedagogical settings. The main themes of the course were learning analytics for students, learning analytics for teachers, data preparation and data literacy, and learning analytics-supported pedagogical designs. The course consisted of lectures and three hands-on practice sessions with learning analytics and AI tools, a course portfolio and three smaller lecture assignments. The course portfolio had the elements of a structured, analytical learning diary, and it encouraged students to bridge the course readings (scholarly articles and handbook chapters) with their experiences from lectures, demo sessions and hands-on practice sessions. The course portfolio guided students to build an overall understanding about the phenomenon of learning analytics, and to find their own approaches to the theme based on their previous knowledge and working experience.

The course assignments, lectures and hands-on practices provided students with practical critical digital literacies in the following ways:

- **Data literacies:** Three lectures focused on *Data analytics* by familiarization with educational datasets, such as study registry data and log data from the learning environment. In these lectures, studies focused on how the data preparation phase may influence reliability and interpretability, and how different datasets and different analytical processes influence the ways they can be used and interpreted in educational practice (*Data protection & data safety*). Finally, students could try to prepare an open dataset for data analysis and visualization with Microsoft PowerBI. For learning *Data visualization*, students had a chance to practice creating LA visualizations with the Microsoft PowerBI platform. At first, they were introduced with two accessible educational datasets. To prepare for the hands-on practice session, students designed the things they would like to visualize from the data. Teachers guided them step-by-step on how to use PowerBI, and they had online support during the preparation of the visualizations. Finally, the students' visualizations were shared with others in the course and discussed in joint conversations.

- **Digital well-being and safety.** The aim of the course design was to support *Empowerment* of students with different educational backgrounds to find their own approach for understanding and utilizing learning analytics. Furthermore, the agency of students as users of learning analytics and the privacy perspectives of learning analytics stakeholders were discussed thoroughly in the course (*Online safety*). The challenges with invisible data collection through free applications and services, or the unawareness of the children about the data collection targeted into their learning activity were particularly addressed as fundamental ethical issues of learning analytics that teachers must be aware of.

- **Digital learning and teaching.** The direct focus of the course was *Learning analytics*. All lecture materials and assignments were specifically designed to introduce students to the topic of learning analytics and its successful use in teaching and learning, as approached from both teacher and student perspectives. The course lectures introduced students with a range of principles and examples of how to design learning analytics for teachers' use and for learners' use. In the course portfolio, students had a chance for analytical reflection on how they would apply learning analytics in their teaching, and the limitations of learning analytics use for teaching and learning. In the course portfolio, students had smaller design tasks to plan the purposes they

would recognize for dashboards and visualizations in certain pedagogical designs that they could select. These tasks prepared them to design and utilize learning analytics in their own professional contexts.

Case 4: Course data protection and management for human sciences

The course aimed to provide knowledge, skills, and practical support for doctoral students working with human data. It was organized as a collaboration between the Faculty of Humanities, the Faculty of Education and Psychology and the Oulu Business School at the University of Oulu. This one ECTS course had a practical focus and it consisted of three lectures, a workshop, and a home assignment. The course aimed at helping students better understand data management and protection requirements as well as finding solutions and taking practical steps towards good data management practices such as data storage and compliance with the data protection legislation in their research projects.

The lectures had three main themes: the main principles of data management and safe data storage; personal data protection; and open data. The course took an approach of introducing these themes in the frameworks of the data lifecycle. The workshop provided students with an opportunity to evaluate risks for their data processing (collection, analysis, storage, sharing) against key risk criteria (e.g., volume, sensitive nature of data, vulnerable position of data subjects, use of innovative technologies) as described by the General Data Protection Regulation (Regulation 2016/679) and to prepare appropriate information for data subjects. The home assignment required students to create their data management plan.

The course supported the students' critical digital literacies in the following ways:

- **Technology use:** The course supported *Critical technical skills* and understanding *technology risks* by requesting that students analyze a variety of research data storage solutions and introducing data encryption methods.
- **Data literacies:** *Data protection and data safety* knowledge and practical skills were supported by lecture materials and workshop tasks. Concepts of personal data and special categories of personal data were covered in detail and by discussing individual cases presented by students. Teachers also provided feedback for students on their data management plans and data storage considerations. The topic of *Open data* was addressed in the context of open science with the focus on opening and re-use of research data. For instance, open data principles, open data archives and open licenses were introduced and discussed. Students' skills in the domain of open data were supported by a task in which each student created a metadata description needed to facilitate re-use of their research materials.
- **Digital citizenship:** *Rights and responsibilities* were discussed in the context of research data.

Discussion and conclusions

The digital divide pertains to social, technical, and socio-technical domains and can be observed through unequal access, capabilities and outcome (Carter et al., 2020; Hilbert, (2011). Our focus has been on students' digital competence development, this being an important part of addressing existing and emerging inequalities.

The four case examples represent different pedagogical practices, and they support different aspects of critical digital literacies. The first case follows an idea of authentic project work with a wide range of semi-professional practices. The course is organized at a department level. The second example is a component of study skills and it supports students' personal consciousness about digital well-being, and an individual teacher can organize the activities. The third example is a combination of two distinct domains, including both theoretical understanding and hands-on activities. It is aimed for both teachers and students. The fourth example is also a combination of two different domains, supporting doctoral students' competencies. The third, fourth and fifth examples are joint teaching implementations by two faculties and their organization demands crossing the boundaries of traditional domains. These three last examples show that many of the phenomena of digitality stretch to multiple domains and demand versatile expertise.

All the main dimensions of the CDL framework were covered through these course examples as well as many of the sub-categories, and these examples covered sub-categories which are less emphasized in school education. The framework was a useful tool to which to reflect on the course practices, but it had a shortcoming: the lack of profound analysis of issues concerning AI. The review was conducted until 2020, and at that stage, there had been few studies concerning AI in education (e.g., ChatGPT, the most well-known AI-application, was launched in 2023), nor was it presented in any of the reviewed policy documents. For instance, the AI literacy framework suggests 16 AI specific competencies (e.g., recognizing AI, having understanding of how AI makes decisions and what ethical questions are related to AI) which individuals need to successfully understand, use, and collaborate with AI (Long & Magerko, 2020).

The studies about higher education students' digital competence or critical digital literacies are few and fragmented, as discussed above. It is difficult to make plans and decisions for supporting students' digital competence if we do not know what to support and which student groups to support. The course examples are suggestions on how to teach aspects of digital competence, either integrated into a course of another topic (examples one and two) or as main topics of individual courses (examples three, four and five), and as such, these practices support all students. We may believe that within a short time, also various practices with AI and for learning the use of AI will change course practices.

In this article, we did not discuss higher education teachers' competence in using digital technology in their teaching practices, but teachers and their competence is naturally a key in supporting students. There are also digital gaps among teachers, e.g., based on age, gender, and the subjects to be taught (Sánchez-Caballé, & Esteve-Mon, 2022). On the suggestion of Sillat, Tammets, and Laanpere (2021) we agree that we need to understand and promote educators' digital competence to support their professional development so that they are able to support students' digital competence in various learning assignments and even change profoundly their teaching contents and practices and teaching to meet the challenges posed by digitality.

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