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BOOK OF ABSTRACTS

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PREFACE

This book of abstracts serves as a compilation of the research and insights shared during the third edition of the International Symposium on Digital Transformation (ISDT), which brought together researchers and practitioners from around the world to explore various aspects of digital transformation. The event garnered significant interest, with 56 abstracts submitted from Europe, North America, Asia and Africa. Each submitted abstract underwent a rigorous review process by at least two members of the scientific committee to ensure the selection of high-quality abstracts for presentation. The book includes 41 abstracts.

The two-day symposium took place from September 11–12, 2024, at Linnaeus University's Växjö campus. It was conducted in a hybrid format for the accessibility of participants around the world. Some presenters joined in person, while others joined virtually via Zoom for rich discussions and knowledge exchange across boundaries. One of the major highlights of the symposium was the four distinguished keynote speakers:

Ms. Trine Jensen, International Association of Universities (IAU), France
Dr. Chiara Bonacchi, University of Edinburgh, UK
Prof. Hendrik Drachsler, Leibniz Institute for Educational Research, Germany
Prof. Sanna Wolk, Chair of The Swedish Association of University Teachers and Researchers (SULF)

The success of the symposium was reflected in both the variety and depth of the research presented. The contributions reflected a broad range of themes, demonstrating innovative approaches to understanding and navigating digital transformation across sectors. These insights align closely with the symposium's overarching goal: to advance interdisciplinary dialogue and collaborative knowledge exchange in this dynamic field. For more detailed information about the program and title of the presentations, please visit: https://lnu.se/en/isdt2024

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INTEGRATING REAL AND VIRTUAL: ENHANCING COMPUTATIONAL THINKING THROUGH GENAI-DRIVEN EDUCATIONAL ROBOTICS

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ABSTRACT
This paper outlines an innovative educational environment that utilizes Generative Artificial Intelligence (GenAI) to cultivate computational thinking (CT) skills among students. Through a technological setup that integrates an animated robot and a real humanoid robot, students tackle CT challenges using Visual Computer Language (VCL). In this environment, students must address challenges formulated by GenAI and propose VCL sequences to solve them. Feedback on their proposed solutions is provided in both virtual and tangible forms, thereby enhancing the learning experience. We highlight the architecture supporting these features and describe the roles of its components in fostering an optimized, efficient, and appealing educational experience focused on CT.

Introduction

Computational Thinking (CT) is a critical skill required for problem-solving through a systematic and multiphase process that enables one to tackle everyday challenges. This skill involves breaking down challenges into manageable parts, identifying similarities or patterns, abstracting away specific details, and designing step-by-step solutions (Wing, 2006). Recognized as essential for students preparing for adulthood in the 21st century, this paper presents our intent to scaffold students' acquisition of such skills within a technological environment supported by Generative Artificial Intelligence (GenAI) (Kurtz et al., 2024). This environment presents tailored CT challenges that students must address by developing solutions using a Visual Computer Language (VCL). These solutions, organized into sequences of blocks, are executable and can be observed in action through an animated robot equipped with interactive features that allow it to respond to spoken words and react to buttons pressed on its body. Alternatively, the solutions can be implemented on a real Humanoid Robot (NAO version 6.00), enabling students to interact with a tangible representation of the robot. In the next section, we will describe the architecture of the environment that supports these features.

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Overview of research and development efforts

In this section, we present our deployed architecture including a description of its components and their roles during the educational experience conducted as part of a student's educational experience. Figure 1 provides an overview of the architecture we developed.

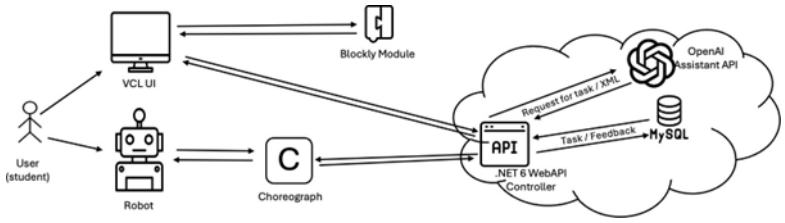

Figure 1:Overview of Architecture

The interaction sequence is triggered by a student (user) who initiates the activity and requests a challenge related to Computational Thinking (CT), which can be solved using the VCL (Visual Computer Language) blocks available in the environment. To facilitate this, the OpenAI service is accessed through a dedicated controller, with a prompt formulated by the VCL User Interface (UI). In response, OpenAI presents a challenge to the student. The student must then address the challenge by proposing a VCL solution in the form of a sequence of blocks. As illustrated, the VCL capabilities in the UI are supported by a Blockly module, which enables VCL notations. These notations are stored in a dedicated MySQL database, accessible through the controller, for research and refinement purposes aimed at enhancing this educational experience. Following the formulation, the student may display the result of the sequence as a series of animations that reflect the programmed sequence. Alternatively, the solutions can be implemented on a real Humanoid Robot (NAO version 6.00), which is accessible through the UI via the same controller that acts as middleware to Choregraphe, facilitating the enactment of the NAO robot according to the formulated VCL solution.

Conclusion

We present an environment designed for students who are required to learn CT-related skills, enhanced by CT capabilities. Furthermore, it offers multiple forms of feedback on their efforts. Our research and development efforts, illustrated in this paper, lay the groundwork for debating the role and the extent to which GenAI is implemented in complex educational contexts and settings. Hence, its perceived position by educational stakeholders in technological settings consists of virtual and tangible aspects necessary for equipping students with the knowledge and skills required in their current and future realistic settings.

Keywords: Computational Thinking (CT), Generative Artificial Intelligence (GenAI), Visual Computer Language (VCL), Humanoid Robot, NAO, Educational Technology

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STUDENTS' PREFERENCES FOR VISUALIZATION TECHNIQUES AND SOFTWARE TOOLS IN ACADEMIC SETTINGS: A COGNITIVE ACTIVITY

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ABSTRACT

Introduction:
Digital technologies play a more active role in the process of modern education, opening new perspectives during teaching and learning. Digital transformation in education means not only the insertion of new technologies into practice but also a paradigm change regarding the approaches students have toward knowledge. The effective use of data visualization stands out among the key components of the transformation in question, turning out to make a significant contribution to better comprehension and long-term memory of complex information. Data visualization methods allow students to visually depict data, hence facilitating the identification of patterns, trends, and other insights that are hard to come by through traditional text-based formats; it makes data more touching. In this increasingly data-driven world, the interpretation and analysis of visual information should be core competencies for students from all walks of disciplines. The objectives of this study are: 1) to explore the most applied visualization techniques and tools according to the frequency; 2) the extent to which the used visualization tools were helpful for students in grasping and analyzing particular educational tasks, like statistical data analysis and presentation of projects; 3) to determine the reasons for students' preferences due to usability, cost, and access. By investigating these preferences, we can deduce some very valuable insights related to how best to design learning experiences that match students' cognitive needs. This has particular poignancy in our efforts to make sure that learners are better prepared with the skills to act optimally in a data-driven world. Within this arena, it becomes important that one considers ways in which visualization tools might support cognitive activities with a view to enhancing learning and engagement. It tries to close the gap between technology and education in order to make the learning environment more effective, helping students to be better prepared to enter into the challenges that the digital age is going to bring with it.

Methods:
The present study collected information from 81 graduate students(M=63, F=18) enrolled in classes involving data analytics and visualization using a mix-method approach: a quantitative online survey combined with a qualitative analysis of the

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open-ended responses. Descriptive statistics such as means and percentages to depict key trends of the students' preference. Inferential statistical tests, t-tests, chi-square test-to test hypotheses on possible differences. Graphical representation use bar chart and pie chart.

Result/Discussion:

The important result was that 84.0% of the responding population favored bar charts for visualization, followed by pie charts at 65.4%, and line graphs at 51.9%. Microsoft Excel was the most utilized software; 71 preferred it because of its ease of access and ease of use. Advanced forms of visualizations, such as scatter plots and heat maps, were less preferred because in these the cognitive load was higher. Advanced tools such as Tableau and R were used less frequently, mainly because they are more complex and expensive. Significant differences in the perceived effectiveness and the usage of different tools were observed in the statistical analyses, including t-tests and chi-squared tests.

One of the primary objectives was the visualization techniques used by graduate students more often; as indicated by the results, it is evident that the biggest preferences include the bar chart, pie chart, and line graph. This confirms the literature that these simple visualizations effectively support comprehension (Mayer, 2021). Maybe this hailed preference for bar charts above all others suggests that learners prefer using visualizations that don't overload them cognitively so that they can process and interpret information more easily effectively (Sweller, 1988). Having compared the perceived effectiveness of these visualizations in terms of their academic tasks, it was found that the bar chart came out to be much academically effective as compared to heat maps. This finding agrees with Mayer's cognitive theory of multimedia learning, which assumes that learners derive benefits from any visuals that would facilitate clear comparisons and direct development of interpretations (Mayer, 2021). With a mean effectiveness score of 3.65 for bar charts versus a mean effectiveness of 2.51 for heat maps, the critical insight is that although advanced visualizations bear a potential for rich information, they may not serve educational purposes quite so well, especially in students who are only developing their analytic competencies. Another goal of the research was an investigation into influencing factors such as ease of use and cost. This makes the strong preference for Microsoft Excel over more complex tools like Python, Tableau, or R a very vital point for educators and software developers. The participants preferred Excel because it was more accessible and hence easy to use; thus, any other tools perceived as easy to use are more likely to gain acceptance in academic settings. This finding is in concert with research by Lin and Yu (2023), that ease of use is one of the determining factors for the acceptance of technology in education.

The third hypothesis found whether there is a significant difference in gender regarding the use of pie charts for visualization and familiarity with Power BI software. There was no significant difference from the results, meaning that both genders like and are equally familiar with the facilities. This is an interesting finding given the literature suggesting possible differences between genders in technology

use and preference. It also calls for equal opportunities to be allocated to all students in the usage of different visualization tools regardless of gender. In sum, these findings ought to have important implications for educators and software developers. Educators will learn from students' preferences for visualization techniques that will help them in curriculum development, making their teaching tools relevant to the cognitive needs and preferences of the students. This will not only increase engagement and improve learning but also help the software developers to learn how to develop educational tools in such a way that usability and accessibility would facilitate the use of visualization software by students. Proper visualization tools should be user-oriented and become an organic element of educational practice. In modern education, which is based more and more on data and information, it is very important to teach learners the skills they need and provide them with instruments for effective work in complicated informational structures.

Emphasis on cognitive activities and the efficiency of different visualization techniques could provide a learning environment that is more adaptive and better prepares students for challenges in the digital age.

Conclusion:
The study points to the critical role and importance of visualization techniques in academia and creates a need for tools which consider learner preferences and cognitive capacity. This will enable us to upgrade the learning experiences and ensure a smoother transition to the digital age for education.

Keywords: data visualization, academic settings, student preferences, software tools, effectiveness, education, digital transformation

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ADAPTIVE PROBABILISTIC VIDEO TRAINING FOR POLICE STUDENTS

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ABSTRACT
Emergency medical services (EMS) are vital, and continuous training is crucial for first responders to deal with high-pressure situations effectively. Traditional training methods have limitations, and an innovative approach to enhancing EMS education is the use of probabilistic interactive video training. This method utilises interactive web-based platforms to offer immersive learning experiences through standard web browsers on computers and mobile devices (Herault et al., 2018a; Herault et al., 2018b). It creates dynamic and personalised learning scenarios that adapt to individual trainees' progress and performance, employing non-Markovian Process principles. Trainees can interact with realistic emergency scenarios, improving their decision-making skills and preparedness for real-life emergencies based on probabilistic models. The approach is accessible and adaptable and enhances training with personalised feedback. A study at Linnaeus University, Sweden, involving more than 200 police and ambulance students each semester, demonstrates its effectiveness in enhancing critical thinking, decision-making skills, and emergency preparedness through the use of varied footage, including 360-degree and drone videos. The goal is to augment traditional EMS training tools with this novel approach and evaluate its impact.

The creation of the training scenarios was guided by the principles of Participatory Design, which shares similarities with the concept of co-design. Participatory Design advocates that the design process, whether it be for social or technological systems, should be democratic and inclusive of users. The rationale behind this is that users, having firsthand experience with the systems, should contribute to their design. Engaging an expert in Emergency Medical Services (EMS) training from the project's outset ensured continuity and expertise throughout the development process. Each specialist featured in the training videos actively participated in crafting their respective scenarios, ensuring their insights influenced the final product. The use of interactive storyboarding techniques facilitated a streamlined filming process by encouraging collaboration among all team members. This preparation was essential as missing critical content could delay the project up to a year due to the infrequency of similar activities (i.e. a fully simulated car accident).

Throughout the filming, editing, and creation of the probabilistic interactive scenarios, close collaboration with the EMS expert was maintained. This extended to

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conducting multiple pilot tests aimed at identifying and rectifying any inaccuracies or bugs. Continuous dialogue between the filming crew and EMS personnel ensured the video content was comprehensive and demonstrated the key elements effectively. While aesthetic adjustments such as colour correction and sound enhancement were solely the editor's responsibility, the editing process was a collaborative effort between the editor and the course's primary instructor. Incorporating the training scenarios into the Learning Management System (LMS) weeks before the start of each course allowed the teaching team to familiarize themselves with the content and conduct necessary tests before granting students access. The training tool was used in two distinct manners: collaborative viewing sessions facilitated by an instructor and individual viewing by students at their convenience. This dual approach enabled the collection of direct feedback, which was instrumental in refining the tool.

The tool demonstrated robust performance, accommodating up to 224 concurrent users each semester starting from 2022, with no significant access issues except for a minor glitch related to the university's LMS in its mobile application, which was promptly addressed by providing an alternative access link. One student mentioned an issue with a long loading time from a WiFi connection and another with a poor mobile data connection. They expressed the need for an offline version. The tool's primary objective—to prepare students effectively for their examinations—was successfully achieved. Informal feedback and, notably, 25 semi-structured interviews conducted with police students in June 2024 offered valuable insights. These students, participating in a predominantly online distance learning program with occasional intensive on-site sessions, provided a unique perspective on the tool's efficacy.

Feedback from both students and faculty has been overwhelmingly positive. Students particularly appreciated the opportunity to view the content multiple times, enhancing their preparedness for examinations. This preference for visual learning over traditional text-based materials was echoed across the board. Faculty members noted the tool's impact on student engagement and enthusiasm, which was supported by data indicating an average of 2.23 views per student over the last three semesters. The success of the tool has led to its integration into the curriculum for the foreseeable future, reflecting its perceived usefulness. All students mentioned wanting this tool in other courses in their education. To further validate these perceptions, upcoming studies will employ a crossover design, coupled with a questionnaire framed around the Technology Acceptance Model (TAM), to objectively assess the tool's impact on examination outcomes. More interviews will be performed each semester to validate the collected data. partnership

Keywords: Adaptive Learning, Probabilistic Training Tool, Police Education, Participatory Design

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TURNING COMPUTATIONAL THINKING RIGHT SIDE UP

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ABSTRACT
Computational thinking (CT) is a thought process that includes a set of cognitive and practical skills used for problem-solving, derived from the computer science discipline. CT has evolved rapidly since 2006, when the concept was revisited by Jeannette Wing (2006), bringing it to the forefront of educational approaches and research communities. CT is considered to become a foundational skill at the core of every modern education system, just like mathematics and the humanities, because it empowers children to make sense of the world around them and acquire agency (Abelson & Kong, 2024).

Considering that CT is expected to evolve rather than remain in its present state to become a central component of the education system, there are different future landscapes for CT. These include becoming an advanced educational skill, an essential competence for new-age citizens, and a mental enhancer, making CT a fundamental part of the broader educational agenda that nurtures innovative and critical thinkers. CT will likely expand beyond traditional digital and programming skills to encompass a wider range of competencies, including ethical reasoning, data literacy, and interdisciplinary problem-solving (Dolgopolovas & Dagiene, 2021).

Different theories and models have been proposed and used to develop and implement CT into educational contexts and curricula. The diversity of approaches, combined with advancing technologies—particularly digital technologies and more recently artificial intelligence—makes CT education grow faster but also increasingly complex. This necessitates a systems thinking approach when dealing with CT education to embrace the complexity of CT integration into education. This theoretical lens, which is scarce in the CT literature, considers the ongoing dynamics in the development of CT from different perspectives, both theoretically and practically. We adopt this approach in our research on CT, using a systems thinking lens to integrate CT into educational approaches and yield a comprehensive understanding (Hamidi et al., 2023).

Such a systems thinking approach leads us to go one step further and ask questions about the prospects of CT education. What happens if the current approaches continue? What failures could be happen if current trends persist? For example, one failure is already seen in the Swedish education system, where there is a debate about reverting to traditional pedagogical methods of teaching and learning rather than digital ones (Forsler & Guyard, 2023). Answering such questions requires the articulation of a vision of what the CT system ought to be, which could be envisioned through the application of a systems thinking framework called idealized design

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(Ackoff, 2001). This involves redesigning a system that its designers would replace the existing system with right now if they were free to replace it with any system they wanted. We believe that such knowledge is essential if the education system wants to set meaningful goals for the future of CT education. Note that this perspective aims to create an ideal-seeking system that strives for continuous improvement rather than achieving an ideal state. This extended abstract outlines the approach we are taking to envision an ideal CT education based on systems thinking theoretical perspectives. Our research aims to envision the ideal situation for avoiding failures and ensuring meaningful advancements. Applying systems thinking modeling techniques within an idealized design approach, this process consists of two steps: idealization and realization, as described by Ackoff (2001). We begin by formulating the mess and end with the design of implementation and controls. While the entire process requires extensive research, our current research focuses on some stages of the idealization phase.

Keywords: Computational thinking, systems thinking, idealized design

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ENHANCING PROFESSIONAL DEVELOPMENT IN THE SWEDISH PUBLIC SECTOR: STRATEGIES FOR EFFECTIVE INTEGRATION OF MICRO-CREDENTIAL FRAMEWORKS FOR COMPETENCE MANAGEMENT

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ABSTRACT

We have recently seen an increase of AI-driven tools for competence management described as skills intelligence or skills-based approaches to internal mobility in organisations. Skills intelligence can involve using generative AI (GenAI) for tagging skills in professional development programs so that we can match employees to the right learning content. The strategic agenda for the digitalization of the public sector in Sweden, also known as the "Municipal Handshake for Welfare Development through Digitalization" (SKR, 2024), has suggested that the talent pool for the public sector in 2030 must rely on upskilling and reskilling of exiting workforce. The strategy focuses on adoption of emerging technologies and apply expertise effectively (SKR, 2022). In 2022 the IBM's annual poll of global IT senior decision makers found that 39% of the participants adopt AI-solutions to mitigate labour and skills shortages (IBM, 2022). Big data analysis (BDA) can help organizations predict future trends, make proactive decisions and support informed choices (Elgendy et.al., 2021). Large Language Models (LLMs) are particularly good at handling unstructured data and can be used to extract meaningful features from documented skills with help of Natural Language Processing (NLP) technology (Min et.al., 2023). The issue identified as main focus for this study is that formal degrees as proxy for matching competences may result in poor performance of an AI-driven model. This has been addressed by Brown et.al. (2021) with micro-credential frameworks that use unbundled and stackable accreditations. An European approach to micro-credentials have also been addressed in the European Pillar of Social Rights Action Plan as a recommended strategy to achieve the 2030 target of 60% of all adults participating in training every year (Cedefop, 2023). The Swedish strategic project "The competence pass" started in September 2021 and finished in June 2024 by the Government's partnership program for skills supply and lifelong learning in Sweden. The results suggest that the integration of micro-credentials as an option to formal learning has the potential to improve competence management in municipalities (Vinnova, 2022).

The objective of this study is to find strategies that address the competence supply gap in the Swedish public sector from an adult learning perspective. By understanding the benefits of micro-credentials, we can propose effective strategies using educational technology. The research questions for this study in progress are:

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RQ1: How can micro-credentials enhance professional development and competence management in the Swedish public sector?

RQ2: How can Swedish public sector adopt emerging technologies to apply and share expertise effectively in cross-functional work teams?

Data was collected from a deductive thematic analysis during focus group interviews (n=3) with Swedish organisations that are early adopters of micro-credential frameworks. The three themes relevant to competence management were generated from a benefit analysis among key stakeholders (n=4) in a professional development initiative for public sector. This initiative already had pre-labelled data for skill levels and national authorities have ensured that the content is evidence based and relevant to the profession. The stakeholders were asked to identify potential benefits and barriers if they would integrate micro-credentials in the existing program. The responses were grouped based on similarities and we then used frequency distribution to limit the study into three themes related to the EU recommendations for integration of micro-credentials (figure 1).

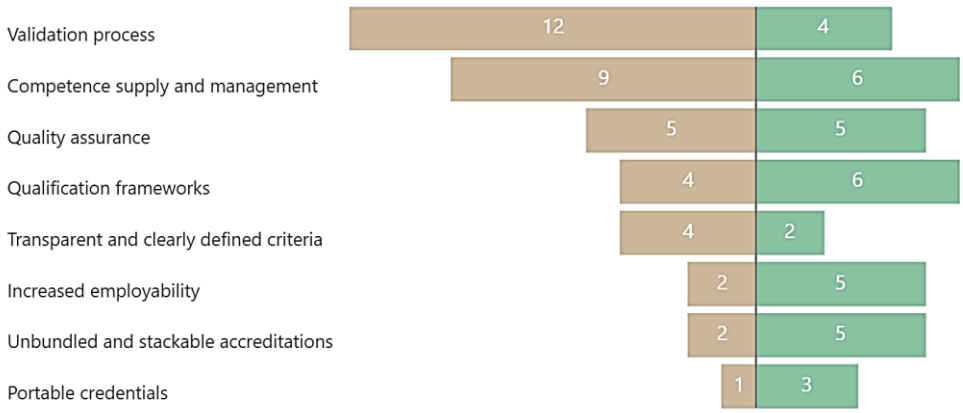

Figure 1. Tornado chart of the frequency of types divided into barriers and benefits, identified among key stakeholders (n=4) in a professional development initiative for public sector

The early adopters of micro-credential frameworks were recruited by the project coordinator for "The competence pass". The participants in the focus group interviews were asked to elaborate on challenges and their solutions to integrate micro-credentials in their organisations. This process was repeated for all three themes, but due to time restraints group 1 mainly responded to the first theme.

The key stakeholders had the theme *"Learning outcomes will have been assessed against transparent and clearly defined criteria"* [Theme 1] as the recommendation for micro-credentials with the most potential benefit to public sector. According to the early adopters the validation process should include submitting a self-evaluation as well as documentation of acquired knowledge, but to ensure a valid evaluation it is crucial with a skilled assessor to enable trust and quality. As shared by group 1: *"We created a digital platform with worked examples, assignments based on real-world scenarios and checklists for the validation process"*. This validation process was confirmed by group 3, who also added: "*The assessor should have strong*

understanding and practical experience of the competence included in the issued micro-credential". Since the government has initiated a public record in a national repository for skills (i.e. competence wallet), there was expectations from the participants in the focus group interviews that micro-credentials also will become portable between different employers.

The second most frequent recommendation was *"They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity"* [Theme 2], which was linked to competence management and a national coordination of professional skills. Despite acknowledging the importance of reskilling and upskilling to meet new demands, all participating groups admitted that their initial challenge was to match the available training with the demands of skills in the organization. These skills shortages could be communication and language skills, compliance in cyber security and data protection or health and safety. It was also mentioned that more generic skills are possible to combine with more than one micro-credential and it is beneficial if they become stackable.

The final recommendation was *"Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs"* [Theme 3]. All three groups mentioned that they were using micro-credentials to support flexible learning pathways. Group 2 emphasised: *"Formal education is not specific enough when we need to create cross-functional work teams. The skill set is also used by employees to increase employability or follow a career path"*. The flexibility is also relevant to address the emerging skills in society and bridge the gap between formal education and employment with micro-credentials.

These preliminary findings are currently to basic for answering the research questions but will become part of my master thesis with major in educational technology at Linnaeus University. We have only addressed three specified themes that are relevant to the EU recommendations on integrating micro-credentials and the study only reached a limited number of respondents. This create less reliability, but it is common to increase coding reliability in thematic analysis with the use of multiple researchers that use a shared book of codes, which allow to apply the same codes in several data sets.

This study emphasised the importance of finding effective strategies to implement micro-credential frameworks for competence management in public sector. The findings suggested that unbundled and stackable accreditations can be portable between different employers and support flexible learning pathways. These potential benefits will make it possible to respond to emerging skills in society and support the creation of cross-functional work teams. One implication now is that the national repository for micro-credentials needs funding and governance to become available. The understanding of competence supply with micro-credentials will contribute to adult learning strategies for public sector in Sweden. Also, in the field of educational technology, the conclusions will create a better understanding of how skills intelligence can involve using generative AI for tagging skills in available

learning content with the demands of skills in the organization. Which can be translated into a computational data model.

Further research with the inclusion of the recommendations *"Micro-credentials are owned by the learner, can be shared and are portable"* and *"They may be stand-alone or combined into larger credentials"* would add further insights to this research. We appreciate the voluntary participation of key stakeholders and early adopters of micro-credential frameworks in the interviews and data collection. No potential conflict of interest has been reported regarding the publication of this study.

Keywords: Micro-credentials, skills intelligence, generative AI, professional development, public sector

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A DESIGN THINKING APPROACH IN GAME DESIGN-BASED LEARNING

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ABSTRACT

Design Thinking (DT) is a user-centred methodology where designers develop innovative solutions by exploring users' needs, defining problems, prototyping, and presenting designs (Huq & Gilbert, 2017). Existing research suggests that incorporating DT in education can enhance students' skills (Scheer et al., 2012) and knowledge acquisition (Cook & Bush, 2018). However, challenges remain, such as aligning DT with curricula, adapting to existing school structures, and managing the inherent ambiguity of the process (Carroll et al., 2010; Al-Zebdyah, 2022; Panke, 2019).

This paper presents preliminary findings from two school interventions conducted under the ongoing European project "*Extending Design Thinking with Emerging Digital Technologies*" (Exten.(D.T.)^2). Following a design-based research methodology (Bakker, 2018), the project employs constructionist media, to enhance the pedagogical value, digitization and implementation of Design Thinking (DT) in school settings. In this context, learners engage with key concepts and generate powerful ideas by constructing and tinkering with digital creations that hold personal or collective meaning (Papert, 1980; Kafai & Burke, 2015). In this paper, we focus on how this approach can not only facilitate DT implementation in schools but also align with curriculum objectives, enhancing domain-specific knowledge.

During the DT activities designed for the interventions discussed here, students tackled real-world issues by designing and refining digital games, based on the preferences and feedback from a certain audience. Using two free, open-source digital authoring tools, ChoiCo and SorBET, they created or modified digital game prototypes from scratch, employing a block-based programming language. ChoiCo supports the development of choice-driven simulation games (Grizioti & Kynigos, 2021), while SorBET enables users to modify or fully design classification games (Grizioti & Kynigos, 2024).

In the first intervention, a group of six 12-year-old students in a Math class worked in teams and modified the ChoiCo game: "*Shopping in the Supermarket*"[1]; designed to

[1] http://etl.ppp.uoa.gr/choico/?shopping_Eng

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engage them with concepts like multiplicative relationships, arithmetic operations, and mental calculations. Players select products from a pantry that alter predefined fields such as "Money," "Total Pieces," "Health," and "Joy," represented by positive or negative values or algebraic expressions. The objective is to collect as many pieces as possible without letting any of the variables exceed preset upper or lower limits (e.g., keeping *"Health"* above zero). The students' task was to adapt the game to create a more engaging math practice experience for younger students (ages 10-11). Acting as designers, students modified the game's content by adding or removing products or fields, defined the consequences of choices, and programmed the game rules using block-based programming.

In the second intervention, titled *"Cyber Security with SorBET"*, 30 students aged 12-13 in a computer science class, collaborated in pairs and designed classification games aimed at raising awareness about online safety for various stakeholders, such as their friends or family members. In these games, as players, users need to correctly classify the falling objects, in a critical-time context, by placing them in the appropriate category - applying decision-making practices to achieve high scores. As designers, the students determined the game categories, chose the objects to be displayed for classification (as images or text), and set the pace and frequency at which they would be displayed, during gameplay.

Throughout both interventions, two researchers guided the students, helping them navigate the digital tools and facilitating their activities. Data collection methods included audio recordings of students' discussions, screen recording videos, questionnaires, and interviews with students to capture their learning experiences and reflections.

Preliminary results underscore the potential of integrating constructionist media into Design Thinking activities to support domain-related learning outcomes. In the *"Shopping in the Supermarket"* project, students effectively used negative number values to represent negative consequences while also engaging in meaningful data collection and analysis (Shah & Hoeffner, 2002). They gathered user feedback through questionnaires and interpreted the data using graphical representations (Garfield & Ben-Zvi, 2009). Additionally, students developed and solved numerical and algebraic expressions (Radford, 2018) and integrated verbal problem-solving tasks into their modified games.

Similarly, in the cybersecurity project, students reported a deeper understanding of cybersecurity concepts, evident in their ability to incorporate the information they gathered into their game designs. For instance, a team focused on online phishing developed game elements that depicted suspicious messages or ads containing scam details, which they composed themselves using images or text editors. These objects were then assigned to categories as "*definitely trustworthy"*, *"appears safe but needs investigation"*, or *"scam"*. During interviews, a student commented: *"I learned about firewalls, which I knew nothing about, and I learned about different viruses and how they get into our computers"*. Another student pointed out that learning occurred *"both from the online resources given and the fact that apart from just reading them*

we used them to create something for someone else - a game", emphasizing the hands-on approach under which they accessed learning content, underscoring the value of designing with others in mind.

In conclusion, integrating constructionist media into DT activities holds promise for creating dynamic, collaborative learning environments that promote concept development and domain-specific learning outcomes aligned with curriculum objectives. By leveraging digital authoring tools, DT provides a purposeful, context-driven framework that emphasizes relevant, user-focused problem-solving, enabling students to apply their knowledge in meaningful, real-world scenarios. Further research and broader implementations could yield deeper insights into the educational benefits of such interventions. Future directions include the development of a specialized DT model for educational in-school settings and the creation of robust assessment tools to support educators in evaluating student learning outcomes.

Keywords: Design Thinking, Game-Based Learning, Educational Technology

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GREEN TALK: USING DIGITAL VOICE ASSISTANTS FOR MORE EFFICIENT ENERGY CONSUMPTION IN FAMILIES

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ABSTRACT
Smart meters convey information on energy consumption to raise people's awareness and lead to reflection about energy use. However, studies show that after a short period of time, people lose interest in the information displayed on smart meters. Smart meters are typically designed for motivated individuals in full control of their household energy use, but research indicates differing levels of engagement and motivation. Moreover, focusing on the individual overlooks the complexity of family households: there is a need to focus on families as the key unit of analysis and to better understand the use of smart meters, by investigating different roles and responsibilities in households.

Problem statement

How do digital voice assistants (VAs) can be used to foster dialogue in the family and to motivate family members to engage with energy consumption information, negotiate reduction goals and come up with solutions towards energy consumption efficiency?

Background and relevant work

The goal of reducing resource consumption in households is at the centre of environmental policies. Various eco-feedback technologies targeting a domestic setting have been developed to support these policies. However, studies of energy feedback applications, such as smart meters, are disappointing: after a short period of time, people lose interest in the information displayed, with relapsing effects (Froehlich et al., 2010; Hargreaves, et al, 2010; Hazas et al, 2012; Pierce et al., 2010; Strengers, 2011; Pereira et al, 2013). Smart meters are typically designed for individuals who are envisioned to be highly motivated and in full control of their household energy use. However, research shows differences in the ways in which users adopt them (Strengers, 2011, 2014; Hargreaves, Nye and Burgess, 2010), with differing levels of engagement and motivation, and subscription to different norms

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and attitudes with regard to conservation (Bertoldo et al., 2015). Research also highlights the need to focus on families as the key context for analysis to further develop supporting technologies and better understand their uses (Hargreaves et al, 2010; Dillahunt and Mankoff, 2014, Barreto et al 2013; Neustaeder, Bartram and Mah, 2013). Different forecasting models have been employed (e.g. Lazzari et al , 2022) to model expected user behaviour based on past consumption.

Moreover, most households are composed of families with children with various roles and responsibilities regarding the use of resources. In this respect, research needs to look at how smart meter enabled applications are viewed by both parents and children, how different members of the household/family negotiate roles, participate in decision-making and are involved in a variety of home activities affecting energy consumption (Riche, Dodge, & Metoyer, 2010; Barreto, M., Karapanos, E., Nunes, N., 2013). In this context, a central challenge is to increase households' interest and engagement with information about energy consumption conveyed by smart meters and sustainability goals.

This research will explore and validate the potential of the recent widespread interest in digital voice assistants (VAs) such as Amazon's Alexa to promote active conversations about energy consumption and reduction within the family (see, for example, Gnewuch et al. 2018, Giudici et al. 2022, Sadek et al. 2023). We believe that these conversations around energy issues will boost understanding and reflection around energy consumption and promote concrete activity towards energy efficiency. Beirl, Rogers, and Yuill (2019) and Sciuto et al. (2019) showed that families are incorporating conversational agents' technologies in their current digital tools ecosystems. Their findings suggest that families developed new rituals around VA features, and these new rituals contribute to social and emotional bonding and family cohesion. These results are relevant for our research insofar as they show that families develop specific practices around VAs, and these practices, in turn, serve to stimulate conversations and reflection regarding energy efficiency.

Methods

The research involves 3 distinct steps.

Step 1, initial deployment of a VA in households and collection of data concerning the use of smart meters. In terms of methods, we will collect logs of the VAs to see how this technology is adopted in homes (the logs are to be approved by the participating families before being released for research). We will also use questionnaires to the households inquiring about the ways they use the smart meters and collect data regarding the actual consumption of energy in the households.

Step 2 concerns conducting participatory design and user-centred design approaches with the families. The methods to be use include initial interviews with the participating households to gain knowledge about the family dynamics and their use of digital technologies. After, the family-based design sessions will actively engage with the participants in creating prototypes that encapsulate the main design

ideas. The workshops will be recorded (given participants' consent) and the outcomes of the sessions will be analysed within the design team.

Step 3 concerns the actual intervention/deployment and evaluation. In terms of methods, we will have the deployment of the VA prototype in the homes of participating families and the data collection of energy. Furthermore, questionnaires and interviews will be conducted to explore in more depth how the VAs were used and the actual motivations and reasons why certain behaviours are changed or maintained. Finally, the analysis of the Alexa logs – recording of Alexa conversations. The participants will be asked for consent regarding the recording of Alexa's logs and the logs will be subject to approval by participants.

Expected contributions and conclusions

Our project will pursue three distinct goals. First, we will develop an analytical framework that allows the description and identification of distinct household practices around the smartmeters. This will enable us to investigate how households understand resource conservation, identifying which norms and attitudes guide this understanding. Second, we will investigate whether and how the use of smartmeters is negotiated in the family and whether and how such negotiation influences the setting of common goals and energy conservation in the home. This knowledge will contribute to the current understanding of the potential role of the VA as a promoter of reflection about energy efficiency, and as a mediator in the use of smartmeters. Third, we will be involving households in the design process of a VA following a participatory design approach. This approach will elicit information about VA use and understand families' specific circumstances, behaviours, and needs. This approach will also allow understanding, from the way the different households engage with the design process, their likes and dislikes, and barriers to adoption.

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Keywords: ICT for sustainability, energy consumption, voice assistants, family interactions, households

INTRODUCING AI AS A SUBJECT IN SWEDISH EDUCATION

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ABSTRACT
The increasing presence of AI across social domains has stirred interest in the importance of individuals possessing AI-related skills and knowledge, often referred to as AI literacy. This literacy is commonly defined as competencies allowing individuals to critically evaluate and engage with AI technologies (Long & Magerko, 2020; Ng, 2021). Consequently, AI as a subject matter is being introduced in educational contexts worldwide, for example in existing subjects or separate AI school subjects (UNESCO, 2022). In Sweden, the empirical context of this paper, AI became an elective subject in upper-secondary STEM programs in 2024, including both theoretical and practical approaches to AI, with an expansion to all programs in 2025. As such, the new AI subject must be compatible with a range of program goals and content. Our paper focuses on how AI and the associated AI literacy are conceptualized in the national curriculum and relevant guiding materials.

To date, AI education research has often focused on the theoretical dimensions of AI education e.g., AI definitions, practical applications of AI in everyday life, identification and recognition of AI systems, data structures, propositional logic, Python programming, natural language processing, computer vision, and machine learning (Sperling et al., 2024). This aligns with a functional literacy perspective, where AI literacy translates into a generic set of cognitive skills and includes competencies and skills for using AI in work and life, with a tendency toward instrumental understandings of AI (Velander et al., 2024). Therefore, calls for more critical literacy perspectives have been made (Merchant, 2021; Leander & Burris, 2020) to include, for example, questioning issues of power and control that underpin AI integration in society (Lankshear & Knobel, 1998; Merchant, 2021).

Acknowledging the discussions above and the conceptual ambiguity of AI literacy, we examine how AI is conceptualized, including associated AI literacy perspectives, in AI-related steering documents for the AI subject in Swedish upper secondary school. Our paper contributes knowledge on the opportunities for upper-secondary school students to develop AI literacy and what being AI literate means. The following

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research question guides our study: How are AI and AI literacy conceptualized in current policy, guiding documents, and support materials for the AI subject in Swedish upper secondary school?

To this end, we performed a document analysis (DA) on data related to the AI subject, comprising the national curriculum for upper secondary school, syllabi, and supplementary documents like commentaries and professional development texts, developed by the Swedish National Agency for Education, to guide and support teachers. As an analytical lens, we use Lankshear and Knoble's (1998) literacy framework, which takes a sociocultural perspective on literacies to examine the presence (or absence) of any of three equally important and interrelated literacy perspectives: operational (competency/mastery, to use AI in a range of contexts in an appropriate manner); cultural (being literate in regards to something, i.e. understanding AI as situated in different contexts); and critical (understanding the socially constructed and context-sensitive nature of human practices used for meaning-making, as well as the ability to take active part in the transformation of such practices (Lemke, 1998). Following Bowen's (2009) three-step approach to DA, our analysis first focused deductively on identifying and coding relevant text passages using Lankshear and Knoble's framework. Close reading with inductive coding followed, focusing on content in the previously identified passages from each perspective on AI literacy. The final step included condensation and a write-up of the results.

Early results indicate a dominant operational literacy perspective on AI in the course syllabi. While operational competencies such as the ability to use AI in different contexts are important for engaging with AI from cultural and critical literacy perspectives, this presupposes relating and embedding operational competences in sociocultural contexts. Moreover, the results indicate that AI is conceptualized as a technology that we need to understand to use it responsibly, be able to evaluate its outcomes, and discuss its possible implications. A more critical perspective is absent, however, like identifying, questioning, re-imagining and actively contributing to transforming AI practices. In contrast, supplementary documents and support materials available to teachers reflect a more holistic approach in our analysis, where operational literacy is often linked to cultural and critical perspectives. For example, support materials on teaching about information search and retrieval and search algorithms (e.g., Sundin & Haider, 2016) are informed not only by technological constraints and abilities, but also cultural values, norms and commercial interests. Investigating these aspects of search and information retrieval includes inspecting algorithms and data as well as their outcomes and implications. From a critical perspective, these can be questioned and re-constructed to reflect on the values represented (or absent) in AI contexts. In conclusion, the analyzed documents represent AI literacy in different ways which, when translated into teachers' practice, may shape students' opportunities to develop AI literacy with implications for e.g., equity and students' life and work in a rapidly changing world with AI. This extends to teacher education, which must consider relevant steering and support documents when preparing the next generation of AI teachers (cf. Örtegren & Olofsson, 2024).

Keywords: AI literacy, teacher education, document analysis, upper secondary school, Sweden

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WHAT LITERACY?
AN INTEGRATIVE REVIEW OF AI EDUCATION IN MIDDLE SCHOOL

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ABSTRACT

Artificial Intelligence (AI) has rapidly advanced over the past year, significantly influencing the conversation about the future(s) of education (Tuomi et al., 2023). At the same time, today's children and youth are growing up in an AI-infused world being the first generation whose education, healthcare, and leisure activities are significantly influenced and mediated by AI-powered applications. This raises considerable expectations for compulsory education to ensure that students of all ages gain an adequate understanding to critically evaluate and engage with AI technologies. Such understanding, also referred to as *AI literacy* (Holmes et al., 2022), has become the focus of a steadily growing number of research initiatives, each with distinct goals and perspectives. *AI literacy* has predominantly been developed within the computer science domain (Sperling et al., 2024) and has strong connections to data literacy or digital literacy (Olari & Romeike, 2021). These connections are particularly visible in various national AI curricula, which predominantly take on a technological perspective by covering AI technologies and applications, including techniques like machine learning and natural language processing (Miao & Shiohira, 2022). At the same time, it is argued that AI technologies often operate autonomously and can adapt according to the context, making them capable of making decisions and actions based on predictions. Therefore, it has been argued, a focus on AI ethics, data biases, surveillance, and the potential impact on employment and sustainable development are pivotal as part of AI literacy (Holmes & Porayska-Pomsta, 2022).

Several literature reviews and syntheses have explored AI literacy in various domains, including K-12 education (eg.., Casal-Otero et al., 2023; Stolpe & Hallström, 2024). However, to the best of our knowledge, previous research rarely specifies how AI literacy should be introduced to students of specific age groups or whether it should be integrated into existing subjects or taught as a standalone subject. The increased engagement in this area, also raises critical questions of *what literacy* emerges in relation to AI and which perspectives on AI literacies are reflected in the scientific literature.

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Aim and research questions

This extended abstract presents preliminary findings from a literature review conducted as part of the Swedish Research Council-funded research project "AI Literacy for Swedish Primary Education – a Co-design Project."[1] The project develops a scientific foundation for AI literacy in social science and STEM classrooms. Middle school is in focus as the use of digital (AI) technology begins to boom in the lives of 9-13-year-old students, needing proper guidance. The aim of this study is to refine the scope and essence of AI literacy relevant for middle school students while striving to develop new models and approaches to this emerging research field. We address this aim through the following research questions:

1. What is the current state of AI literacy relevant for 9–13-year-old-students?

2. What characterises the emerging literacy(ies)?

In this study we argue that AI literacy can be understood as a social construct emerging from the many complex relationships between social, material and semiotic resources and that it serves diverse strategic purposes in different political and organisational contexts (Selwyn, 2024). To methodologically advance and critically explore the current nature of AI literacy in the scientific literature, with a focus on middle school education we decided to adopt the GeST *framework* by (Lupton & Bruce, 2010) originally developed for information literacy. The GeST framework approaches literacy from three interlinked perspectives: (1) as a set of *generic* and individual skills, (2) as *situated* in social practices, or (3) as *transformative* for both individuals and society. Broadly speaking, the generic perspective captures a more behaviourally oriented form of literacy, the situated perspective emphasises sociocultural dimensions, and the transformative perspective focuses critically on emancipation.

Method: Integrative review

In response to our research questions, we conducted an integrative review intended to evaluate the literature in a manner that could both advance the knowledge of AI literacy in the context of middle school education *and* generate new approaches and frameworks (Snyder, 2019). Thus, an integrative review is commonly applied to address emerging topics and to assess, critique and synthesise the literature for new theoretical perspectives and dimensions. In line with Whitemore & Knapfl's recommendation (2005), the goal is to critically address and examine the main ideas and relationships in a transparent and structured way. Consequently, this puts focus on methodological rigour, rather than following specific standards.

The literature search was done on January 10th, 2024, in Scopus, a well-recognised bibliometric database, using the search query ("AI literacy" OR "artificial intelligence

[1] https://www.vr.se/swecris.html#/project/2022-03553_VR

literacy") AND (K-12 OR middle OR primary). Out of the 80 identified peer-reviewed papers (journal articles and proceedings), 20 were excluded before screening due to non-compliance with the initial inclusion criteria (English). A two-stage screening process was then conducted, incorporating added exclusion criteria, ultimately resulting in 24 included papers for analysis (Figure 1).

During the final stage of the analysis the 24 papers underwent a more comprehensive analysis in relation to the GeST framework. As the generic, situated and transformative perspectives could be found within one paper, we needed to develop a fine-grained analytical lens. Inspired by Bruce and Lupton (2010) we selected three propositions: (1) AI literacy is…, (2) AI literacy is important because…, and (3) AI literacy is being taught and learnt through… (Table 2). Consequently, each article was considered with nine possible mappings in mind.

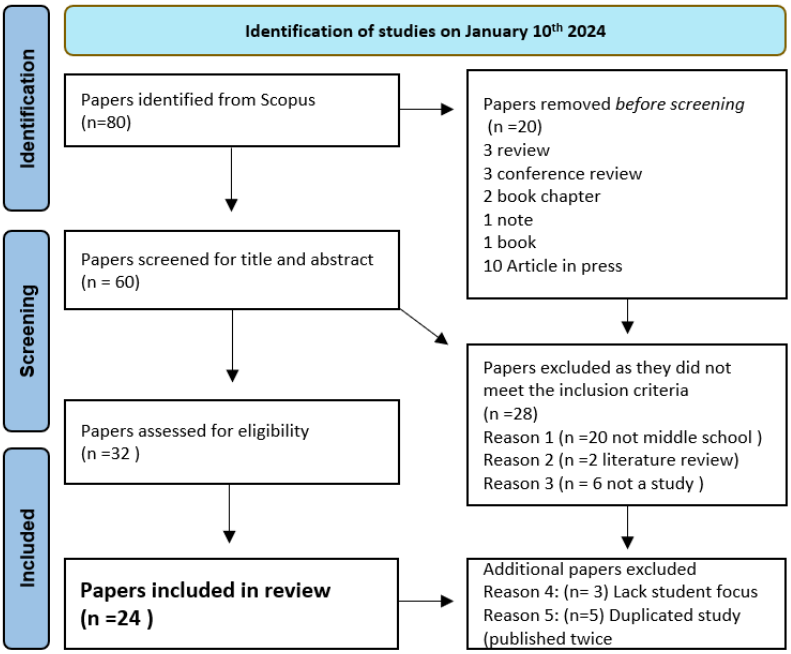

Figure 1. Study selection

Preliminary findings

In response to our first research question, the results indicate that AI literacy is growing in interest in the scientific community with almost 3/5 of the contributions (n=15) published only the past two years and with an even distribution between conference proceedings and journal papers. AI in the context of K-12 education is a subject of interest in many parts of the world, with the dominating authors countries United States (n=10) and China (n=5), and with one study each from Austria, Spain, Belgium, Malta, Denmark, Greece, Finland, Canada and the UK. While the conceptualisation around AI literacy is still vague, we found overarching topics related to: 1. The development of teaching materials (n=11), consisting of various

interventions that develop digital and analogue methods for teaching with and about AI; 2. Curriculum Development (n=6), focusing on what students should know about AI; 3. Attitudes and Competencies (n=5), measuring teachers' and students' attitudes toward AI; and 4. Professional Development (n=2), addressing the professional development of educators in the context of AI literacy.

The GeST mapping, which is still a work in progress, indicates that the generic, situated, and transformative perspectives emerge in relation to the three distinct propositions across the different papers. A generic perspective is reflected in most of the papers (n=35). The situated perspective (n=16) and the transformative perspectives are reflected much less frequently (n=17). Several of the papers fall into more than one category and very few papers adhere to only one of the perspectives. Thus, on a general level, the GeST mapping shows that AI literacy in middle school education emerges primarily as a generic set of measurable skills related to theoretical knowledge about how AI works and where it is applied. These skills are expressed as something that can be learned by individuals independent of context and assessed through quantitative methods. While theoretical knowledge and skills related to AI are fundamental, they are not enough to fully engage in the conversation of how to use and develop AI that serves the interests of all people. In other words, a generic perspective on AI literacy risks limiting students understanding and agency in relation to AI. It also risks limiting learning and teaching to things that are predictable and known, which is not the case when it comes to the rapid development and implementation of AI technologies. For those reasons, situated and transformative perspectives, which consider the contextual, material, and social aspects of teaching and learning and foster critical thinking, should be given greater consideration. From a methodological standpoint, our adapted GeST framework proved instrumental in highlighting the current emphasis on different aspects of AI literacy. It can be used in future research to capture and analyse the various AI literacies being introduced worldwide and to serve as a tool for designing AI curricula that promote critical thinking and active citizenship among middle school teachers and students.

Keywords: AI in K-12, AI literacy, AI readiness, primary education, middle school

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INCREASING MOTIVATION AND ENGAGEMENT IN ONLINE PROGRAMMING EDUCATION

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ABSTRACT

According to the OECD, programming is one of the essential skills in the 21st century. Following the recommendation, many Nordic countries have started to integrate programming education into their educational curricula as early as primary school. Despite that, many people still struggle to learn programming, which is indicated by, for instance, the low pass rate of introductory programming courses. Another problem is that only 17% of all students in the field of Information and Communication Technologies in the European Union are women. Such a low rate indicates that most women will not benefit from the growing demand for people with programming skills.

Research shows that smaller classes with fewer than 30 students are the most effective environment to teach programming. Part of the reason is the personalized feedback and the possibility to more easily adapt the learning path towards the needs of a smaller group. However, larger classes are required to satisfy the growing demand, yet such a programming learning environment is less effective. To adapt the learning path towards the students, their attitudes, disposition, and motivation need to be considered — non-cognitive factors driving people's behavior. The influence of these factors on learning success is well documented in other disciplines, but not well-researched in computing education yet. Additionally, addressing these factors in large classes and online contexts is also a challenge. Creating a learning platform that can adapt the learning path towards the individual student can help to address the non-cognitive factors. Adding a personalized conversational agent, also referred to as chatbot, carries a potential to increase the students' motivation and engagement, consequentially affecting their learning behaviors. Therefore, such technologies can help to make larger classes, or online courses, more effective.

The primary objective of this research is to explore, through the mixed-methods approach enabling the triangulation of data from qualitative and quantitative research, the relationship between motivation and engagement and their effects on learning programming. In particular, the aim is to assess how motivation and engagement can be strengthened by the personalization of the learning path and the usage of a conversational agent. Both components utilize the latest advances in large language models to improve the personalization and raise the quality of the conversation with the students.

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After conducting a comprehensive literature review of the field, a learning platform will be designed to allow personalization of the learning path of students. Next, a conversational agent will be integrated into it to provide the students with a personalized real-time tutor. During the conversations with the students, a sentiment analysis will be conducted to understand their emotions and experiences. Utilizing large language models, the conversational agent will be able to react to the students according to their needs. This way, the conversational agent will not only be able to provide meaningful feedback to the students, but also act humanely to build a strong relationship between the conversational agent and the students. As final step, the learning platform will be used in different courses and the effectiveness will be evaluated. These studies should also focus on the effect on underrepresented groups.

The proposed approach can help to broaden computing literacy, help to decrease the gender gap in computing, and make programming education more inclusive for future generations.

Keywords: computing education, ai, personalization, programming

EXPLORING SCIENCE CENTER VISITORS' EXPERIENCES OF FULL-DOME CINEMATIC VIRTUAL REALITY PRODUCTIONS

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ABSTRACT

Introduction

Immersive virtual reality (VR) is increasingly adopted in science centers to engage the public with science. Recent additions are digital full-dome immersive theatres (360 degrees) with large video projection (Schnall et al., 2012). The full-dome format is emerging as a cross-media and transdisciplinary educational tool, offering a unique experience (Cîrstea, 2023). As a niche format, it engages viewers through its immersive nature, which enhances emotional connection and memory retention, driven more by the filmic form than the content (Cîrstea, 2023; Plummer, 2023). The hemispherical projection surface envelops the observer's entire visual field, fostering a continuous, immersive experience (Lensing, 2023). Additionally, the full-dome environment's ability to offer multiple perspectives, seamless size scale transitions, and dynamic simulations provides significant educational advantages over traditional formats (Yu, 2019). This wraparound visual experience, combined with tightly integrated narration, creates a compelling "narrative journey" that enhances storytelling and learning (Yu, 2019). However, despite the increasing adoption of full-dome formats in science centers, there is a lack of research on how visitors perceive these immersive cinematic experiences, particularly regarding the emotional and cognitive impacts of storytelling in such settings.

Full-domes can present non-interactive cinematic productions, real-time simulations of virtual environments, live art performances, or virtual field trips, all complemented by surround sound (Lantz, 2007). Unlike head-mounted displays, full-domes offer a 360-degree field of view with limited interactivity, and a shared experience, making them particularly suited for cinematic virtual reality rather than for interactive games or simulations. Full-domes represent a fusion of art and science, functioning as a media form ideal for science communication (Lantz, 2011). Additionally, the full-dome documentary is regarded as one of the most recent innovations in edutainment film formats (Cîrstea, 2023).

This study examines a science center's use of full-dome cinematic VR productions, with a strong focus on storytelling (Wolfe et al., 2023). The emotional dimension of storytelling is not merely supplementary to scientific content; rather, emotions serve

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as a key driver of both understanding and misunderstanding in science, significantly influencing visitors' learning experiences (Sinatra, 2022; Falk & Gillespie, 2009). VR

cinematic productions intricately combine immersive technology with narrative elements to evoke emotions and engagement, with these components influencing one another in profound, sometimes unexpected, ways. Narratives fuel immersion by engaging emotions and heightening sensory experiences, while immersion, in turn, enhances the depth of the narrative. Thus, the effectiveness of a VR cinematic experience is contingent upon how effectively the plot, thematic appeal, visual and auditory effects, and narrative strength engage the audience both emotionally and cognitively.

Immersion and emotion both influence learning, but their relationship is complex. Barreda-Ángeles et al. (2020) found that more immersive presentations elicit stronger emotional responses but lead to less cognitive engagement when a 360° video is viewed through a VR headset compared to a computer screen. Similarly, Rose (2018) argues that affective engagement can be detrimental to cognitive engagement, as a high sense of presence may discourage a reflective stance toward the content. Therefore, this study aims to explore how cinematic VR storytelling productions are experienced in a full-dome theatre. We address the following research question: *How are VR cinematic storytelling productions perceived by visitors in a science center, and which elements of the productions have the most impact, as revealed by their descriptions of the most memorable moments from the show?*

Empirical setting

The digital full-dome examined in this study is a new attraction at the Universeum Science Center in Gothenburg, Sweden. It features a 443 square meter tilted hemispherical screen that envelops the audience. This installation is part of the national Wisdome project, based on visualization research conducted at the Norrköping Visualization Center and Linköping University. Currently, Universeum offers eight shows, ranging from 30 to 45 minutes in length, including three 2D and five 3D productions. Drawing from documentary film research (Studt, 2021), the shows are categorized into three genres: documentary, non-fiction, and animated fiction. All the programs focus on scientific topics, such as the mysteries of space, the depths of the ocean, visualization techniques, and molecular-level explorations.

Method

The study employs a mixed methods approach, combining a web-based survey and interviews with visitors. Participants are recruited voluntarily from regular visitors for interviews and all visitors are encouraged to scan the web-survey QR code after the show. Both methods focus on understanding visitors' motivations for attending the science center, using Falk's (2006) identity-related motivators, as well as their experiences of the show in terms of entertainment and educational value. The survey, inspired by a full-dome planetarium study (Peavy, 2019), also assesses what aspects of the show that are valued or less appreciated by the visitors. The post-show group interviews, lasting approximately 10 minutes, are recorded and transcribed. Memorable moments are gathered through free-text responses in the survey and via

free recall in the interviews, following the method used by Barreda-Ángeles et al. (2020).

Preliminary findings

To date, 182 survey responses and 15 group interviews have been collected. The distribution of shows among the survey respondents by genre includes 132 documentaries (63 in 2D, 69 in 3D), 32 non-fiction shows (9 in 2D, 23 in 3D), and 18 animated 3D fiction shows. The respondents consist of 20% children aged 4-14 years, 5% teenagers and young adults aged 15-24 years, and the remaining majority adults over 25 years, many of whom accompanied children. Gender distribution is balanced. The most common identity motivator is acting as a facilitator for a family member or friend. On a 7-point Likert scale, with "not at all entertaining" to "extremely entertaining," the average rating for entertainment value was 5.8. For educational value, rated from "not at all educational" to "extremely educational," the average rating was 5.7. Entertainment and educational value ratings showed a correlation. A significant difference was found in the entertainment value, with 3D shows rated significantly higher than 2D shows. However, no significant differences were observed in educational value between 2D and 3D formats, nor were there differences across age groups, gender, or between the various shows. The analysis of free-text survey responses and interviews is ongoing but has revealed interesting descriptions of participants' memorable moments and understanding of the shows. This qualitative data highlights the types of affective and cognitive engagement recalled by visitors, providing insights into key elements of the VR storytelling compositions.

Discussion and implications

The findings of this study have significant implications for science communication, informal learning, and the advancement of immersive reality technologies. Firstly, by employing a mixed-methods approach, the study addresses the existing research gap concerning the use of immersive reality full-domes in science centers and highlights their potential as powerful tools in increasing public engagement and understanding of scientific concepts. Additionally, the findings may inform the design of immersive technologies in science centers and museums, emphasizing the importance of narrative and affective impact in informal learning experiences. Overall, this study enhances understanding of engagement dynamics in immersive virtual reality environments and underscores the potential of immersive media in science education.

Keywords: Digital full-dome, immersive virtual environment, engagement, informal learning, storytelling, science center

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LEVERAGING AI IN BEHAVIOR CHANGE TECHNOLOGY: TRANSFORMING RECYCLING PRACTICES ON LNU CAMPUS

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ABSTRACT

Inefficient waste separation hampers recycling efforts, causing both environmental and financial challenges. A 2013 study in Borås found that 53% of waste is incorrectly sorted, resulting in an annual loss of 13 million SEK primarily due to logistics costs (Rousta et al., 2013). Additionally, research at Halmstad University showed that while 80% of students consider recycling important, 50% fail to separate waste properly (Holmberg et al., 2014). These findings indicate that existing solutions, including awareness campaigns, education in schools, and digital information centers, are insufficient. Despite decades of investment in sustainability programs, proper waste separation rates in Sweden remain low.

Research at the University of Twente identified three main reasons for improper waste sorting on campus: perceived inconvenience, lack of accessible bins, and insufficient waste management knowledge. Notably, significant improvements can be achieved by addressing even one of these issues (Claes, 2022). Among these, the lack of knowledge is a critical area where innovative solutions can make a substantial impact.

Existing research in behavior change technology for waste separation is limited, with one notable study achieving only a moderate 13% improvement in waste separation (Claes, 2022). However, this increase falls significantly short of bridging the 50% gap between properly and improperly sorted waste. The primary shortcomings of this solution include the considerable time required to manually redesign the digital experience if it fails to effectively address the issue, its limited flexibility in redesigning the experience, and its inability to adapt to different audiences in real-time, particularly when users become disengaged.

This research paper aims to explore whether a digital behavior change tool powered by a generative AI can efficiently improve the waste separation on LNU campus. To address the issues identified, we propose the Trash Recycling AI (TRAI) – a web-based application designed to improve waste separation practices through engaging AI-driven experiences.

TRAI offers high accessibility through QR codes placed at recycling bins, requiring only a phone with internet access. Users can quickly identify the correct disposal bin by scanning a barcode or taking a picture of an item, making it an easy and fast tool

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for those on the go. The full TRAI experience leverages generative AIs participating in a conversation with a user as an engaging persona to deliver waste management information in an entertaining manner. The system analyzes user sentiment and adapts responses to be as engaging as possible, incorporating statistics and motivational elements. Successful interactions include conveying at least one fact about the negative impact of poor waste disposal, one fact about the positive impact of recycling, and providing specific disposal instructions with reasoning.

Preliminary feedback from a diverse group of potential users has been highly positive. We expect high engagement and a significant increase in properly allocated waste on campus.

Our next steps include conducting a controlled experiment with 10 to 20 participants, refining the tool based on feedback, and performing a larger test on the Linnaeus University campus. Efficiency will be measured by the percentage of properly disposed items before and during the tool's availability to assess impact. Engagement will be tracked by the number of successful interactions and instances of early termination.

If successful, TRAI could offer substantial benefits, including efficiency, scalability, modifiability, cost-effectiveness, and minimal maintenance. These attributes make it a promising solution for broader research and adoption, potentially transforming waste management practices in educational institutions and beyond.

Keywords: Behavior Change Technology, Artificial Intelligence, Efficiency, Waste Sorting, Sustainability, Campus Environment

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SHARING PRACTICES ON COMPUTATIONAL THINKING EDUCATION

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ABSTRACT
The CoTEDI project contributes to the further development of a STEM attitude in education by means of computational thinking (CT) development, where the focus is on the implementation of to design educational programs to be used to reinforce, learn and teach CT. It encompasses a new approach to implementing CT in primar schools and child facility centres, including special educational needs, diversity and inclusion. This addresses the need for richer computational skills for all in fully digitized and increasingly AI-enriched societies in Europe (Niemelä, Pears, Dagiene, & Laanpere, 2022; Hamidi, Mirijamdotter, & Milrad, 2023). This requires citizens to take agency over a wide range of technologies rather than being reduced to mere consumers. Building the foundations for such agency already in early childhood requires conditions for CT development and education to be facilitated professionally by teachers and child attendants. Through CT, the project develops and incorporates methods, problem-solving techniques, and logical reasoning into age-appropriate playful activities and experiences to enable children to solve problems in different areas and within different domains by means of creativity and exploration (Batur & Brinda, 2022; Sultan, Axell, & Hallström, 2023). This offers excellent opportunities to provide developmental support and respond to children's abilities and specific learning needs.

CoTEDI brings together 16 universities and educational institutions from 6 different countries to create, test and share worked educational programmes (EP) that allows professionals in primary education, childcare and special primary education to adopt strategies to work with digital technologies with children in the age groups of 4 to 12 years. To address the educational needs and learning capabilities the project brings together teachers and childcare professionals with researchers from educational psychology, technology enhanced learning, computer science and game design. This ensures that the EP developed by the project partners are not only sound CT education, but professionally grounded into organisational and cultural educational

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practices for ensuring appropriate alignment to age-related learning needs, inclusiveness, as well as diversity of and within the cohorts that are present in schools.

The several participating primary schools and child centres have been fully involved from the start to inform and align the technologies and technical approaches used in the EPs to the practices, values and principles. Based on their support and developmental needs, the project is designed so that teachers and child supervisors are given the opportunity to meet the teaching and learning needs of young children as specifically as possible through the integration of CT development.

The starting point for all project partners is to collect and exchange existing practices, approaches and digital teaching resources for CT and to identify the teaching needs of educators and childcare workers. To this end, variations in applications of programming, both with the use of technology (plugged-in applications like programmable robotics, on-screen & online programming environments, video games, music producing, etc.), tangible interactions with zero-code-adaptable robotics and games, and so called unplugged applications that address CT without the use of digital technologies are collected and further developed (Fanchamps et al., 2024). In tight collaboration with practitioners, the technologies and solutions are extended into EPs, where each EP creates a pattern of resources & tools, rules, as well as specific learning and supportive tasks (Glahn & Gruber, 2020; Zapata-Caceres, Martin-Barroso, & Roman-Gonzalez, 2021), that can be adjusted by practitioners to meet specific educational needs and objectives. To facilitate inclusion and diversity, such EPs must allow for a broad continuum of computational thinking activities that allow for continuously increasing challenges, conceptual understanding, as well as child creativity and exploration.

Implementing the project will ensure that through the EPs, an optimized methodological and pedagogical approach the application and development of CT will be made more widely accessible in the form of open educational resources that are available and teachable from early project stages. Because the teaching and training materials are based on a widespread of ready-made technical solutions, teaching practices, and conceptual possibilities, factors of diversity and inclusion are considered as a rich starting point for the development process rather than its end. This will enable educational professionals to discuss, explore, and implement CT education in a differentiated and adaptive way. With this respect this contribution presents first results of the project and provides insights on the state of using digital technologies at pre- and primary school level.

Keywords: Computational thinking education, digital transformation, educational innovation, primary education

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INNOVATIVE PEDAGOGY IN K-12 EDUCATION: A COMPREHENSIVE STUDY OF COMPUTATIONAL AND DESIGN THINKING WITH EMERGING TECHNOLOGIES THROUGH THE EXTEN(DT)² PROJECT.

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Abstract

Introduction: In the dynamic landscape of education, innovation plays a crucial role in driving progress. Supported by Horizon Europe and Innovate UK, the Exten $(DT)^2$ project emerges as a transformative initiative aiming to propel Design Thinking into the digital age (Extendt2, n.d.). This integration enhances pedagogy, promotes sustainable digitization, and encourages broader adoption of Design Thinking (DT). It also seeks to reshape interdisciplinary learning and foster essential 21st-century skills (Milrad et al., 2023). Computational Thinking (CT) equips learners with adaptability and innovative thinking abilities (Yadav et al., 2011; Oh et al., 2018). Design and Computational Thinking are increasingly acknowledged as effective pedagogical approaches (Bocconi et al., 2016), valuable for skill development and problem-solving (National Research Council, 2010; Panke, 2019). Incorporating these adaptable activities into classroom projects aligns with the objectives of twenty-first-century education, bridging student learning with digital fabrication (Iwata et al., 2020). The project also leverages emerging technologies (ET) to enhance these methodologies (Veletsianos, 2016), as DT and CT are recognized for developing 21st-century skills (Li and Zhan, 2022).

Study gap and Motivation: The integration of DT, CT, and ET holds promise in enhancing the feasibility, accessibility, and inclusivity of K-12 education for students, teachers, and administrators. However, gaps persist in understanding the specific challenges, opportunities, and potential impacts of this integration (Samberg, 2018).

While each approach—DT, CT, and ET—is increasingly recognized for its individual merits, comprehensive studies on their combined application in K-12 education remain limited. There is a critical need to explore the feasibility, accessibility, and inclusivity of these pedagogical methods, as well as how data-driven insights can inform educational practices. This study aims to address these gaps by investigating

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effective strategies for integrating DT, CT, and ET to create a more accessible and inclusive educational experience. Such efforts are crucial for advancing sustainable methodologies in K-12 settings. Through the lens of the Exten (D.T) ² project—leveraging technologies like ChoiCO, SoBert, MalT2, and GearsBox—this study embarks on a multifaceted exploration. Its goal is to inspire transformative pedagogical practices that cater to diverse learner needs across the educational spectrum. The study's motivation is to foster robust skill development, promote innovation, and motivate students, teachers, and administrators to unlock new opportunities for educational advancement.

Research Questions: The following research questions were identified for assessing the overall investigating aim of this study:

RQ 1a: How can the combined use of CT and DT, with ET, enhance the educational experience of teachers and students in K-12 settings as reflected in existing literature?

RQ 1b: What is the current state of CT and DT with ET in K-12 education, as reflected in social media opinion with a focus on identified gaps, trends, and areas for further exploration?

RQ 2: How can the data obtained from questionnaires with text analytical approach be utilized to understand factors that impact the feasibility, accessibility, and inclusivity of these pedagogical approaches in Exten (D.T) ²?

RQ 3: How can the findings obtained from the study serve as a catalyst to inform useful decisions when implementing CT, DT with ET in K-12 education?

Methods: Data related to DT, CT, and ET in K-12 education was collected from Facebook, Web of Science, Google Scholar, Research Rabbit, and other reliable scholarly repositories. Additionally, the study analyzed data collected through questionnaires, which gathered experts' opinions on the integration of the Exten (D.T)^2 project in educational settings. The study utilized both programming and non-programming techniques to achieve its objectives. Formal scholarly datasets were prioritized to publications from the past 12 years and studies worldwide published in English. These datasets were analyzed using VOSviewer, along with machine learning (ML) and deep learning (DL) techniques, to explore trends and gaps in academic literature. Facebook posts, specifically focused on opinions and reviews related to the intersection of DT, CT, and ET in K-12 education, were scraped with Bardeen, a web extension tool and analyzed using Orange BioLab, ML, and DL. In ML, topic modeling and sentiment analysis are employed, and network graphs used for visualization. While in the DL techniques, on the other hand, utilized the BERT model and Naive Bayes for performance evaluation. Orange BioLab facilitates sentiment analysis, presenting results through intuitive bar plots. Additionally, topic modeling techniques such as MDS and LDAVis are utilized to provide comprehensive insights and visual representations of the data. Expert opinions collected through questionnaires were examined with NVivo and MS Excel to gather insights on feasibility, accessibility, and inclusivity. Together, the insights from these analyses aim to provide a comprehensive understanding of the combined use of CT, DT, and ET in K-12 education and inform future implementations.

Outcomes: The study from formal scholarly dataset underscored the importance of interdisciplinary approaches, innovative teaching methodologies, and the necessity for further research to effectively integrate these concepts. It also highlighted the significance of CT skills, coding practices, AI and DT for enhancing problem-solving abilities and improving creativity among students. However, it also revealed challenges such as the scarcity of studies focused on design thinking and the need for more exploration with computational thinking and emerging technologies.

The study from social media data highlighted the importance of skill development, innovation, and enhancing learning outcomes. However, challenges such as privacy concerns, disparities in access to technology, and ethical considerations emerge, underscoring the importance of addressing these issues to ensure ethical implementation of CT, DT and ET in K-12 education. Additionally, the analysis suggests a pressing need for teacher training and support programs to equip educators with the necessary skills and knowledge to integrate these tools into their teaching practices. Furthermore, the social media analysis highlighted the issues and challenges that need attention in translating theoretical concepts into real-world applications and the development of practical solutions that bridge the gap between theory and practice within educational settings.

The study from the questionnaire revealed the importance of continuous professional development opportunities, adequate resource allocation, seamless technological integration, supportive educational policies, inclusive teaching practices, comprehensive support systems, and accommodations for diverse student and educator needs to enhance feasibility, accessibility, and inclusivity.

Conclusion: In conclusion, the findings of this study reveal the critical importance of a multifaceted approach to integrating CT, DT and ET within K-12 education. The analysis has identified significant gaps in understanding the specific challenges, opportunities, and potential impacts of this integration, emphasizing the urgent need for research to bridge these divides. A comprehensive curriculum design framework that incorporates these elements can significantly enhance students' critical thinking, problem-solving, creativity, and collaboration skills.

The study faced several limitations. Due to time constraints, data scraping was performed only on the Facebook platform, excluding others like LinkedIn and Twitter. The questionnaire-based data collection method may have missed in-depth insights that could be obtained from direct interviews or voice mining. Additionally, the analysis focused solely on textual posts, overlooking the emotional value of images and emojis in comments. Moreover, advanced DL techniques for data analysis were not utilized, which could have enhanced the accuracy and depth of insights. Considering these limitations, future research should adopt a more comprehensive approach by incorporating multiple platforms and diverse data collection methods to gain a deeper understanding.

Keywords: Computational Thinking, Design Thinking, Emerging Technologies, K-12 education, 21st century skills, Exten (D.T) [2]

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LEVERAGING DIGITAL EDUCATION PLATFORMS: INSIGHTS FROM AN EMPIRICAL STUDY OF THE POLITICAL COMMUNICATION COURSE

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ABSTRACT
The digital revolution in education has fundamentally reshaped the learning landscape through the integration of sophisticated educational platforms and tools. These innovations have democratized access to knowledge, offering unprecedented flexibility and convenience to learners worldwide. This paradigm shift is particularly advantageous for non-traditional students and those juggling educational pursuits with professional or personal commitments (Garrison & Kanuka, 2004). Moreover, the incorporation of interactive elements such as discussion forums, adaptive quizzes, and immersive multimedia resources has catalyzed student engagement and fostered a more dynamic, collaborative learning ecosystem (Hrastinski, 2008).

This paper presents a critical analysis of state-of-the-art educational platforms, elucidating their merits, identifying areas ripe for innovation, and showcasing case studies from the Political Communication course. The research is a component of an ongoing innovation project in its nascent phase, which meticulously examines the digital tools employed in this course, culminating in evidence-based proposals and recommendations. Preliminary findings indicate that these platforms possess transformative potential to revolutionize conventional pedagogical methodologies and significantly enhance learning outcomes (Means et al., 2013).

Our recommendations will delineate strategies for optimizing tool utilization and augmenting interactive features to bolster student learning and engagement. By synthesizing empirical data with theoretical frameworks, this study aims to contribute valuable insights to the burgeoning field of digital education, particularly within the context of political communication. The implications of this research extend beyond academia, offering potential applications in professional development and lifelong learning initiatives.

Keywords: digital education, educational platforms, political communication, interactive learning, pedagogical innovation, e-learning effectiveness

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BRIDGING COMPUTATIONAL THINKING AND ARTIFICIAL INTELLIGENCE IN SWEDISH CLASSROOMS: THE POTENTIAL OF EMERGENT TECHNOLOGIES IN K-12

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ABSTRACT
Artificial intelligence (AI) and other emergent technologies are increasingly used in different areas of our modern society thus the importance of developing digital competences among young students is a clear necessity. Efforts towards the development of digital competences in K-12 education have been made with the introduction of programming and computational thinking (CT) in different countries around the world. However, AI-related education in K-12 is still trying to find its place (Touretzky & Gardner-Mccune, 2019). In the particular case of Sweden, efforts towards developing digital competences among K-12 students have been made with the introduction in 2018 of programming education in the subject matters of mathematics and technology (Skolverket, 2018). However, both CT and AI literacy have only been implicitly included in the current study programs (Skolverket [the Swedish National Agency for Education],2022). Developing AI literacy in young students is therefore among the urgent challenges that Swedish K-12 education must face in the coming years.

In order to better understand the challenges of introducing AI concepts to students that have no previous formal education in this field, we conducted a small exploratory study with a class of 8th graders (17 students aged 14-15) that was carried out during the autumn semester 2023/2024 in a municipal school in southern Sweden. This group of students had previous experience doing basic programming, as they had received education in this topic as part of their study programm, however they had received no previous formal education in AI technology. The study consisted of six workshop sessions for a total of 16 classroom hours. The activities carried out with the students were mainly focused on introducing basic concepts of AI and machine learning (ML), with only a few activities focusing on traditional rule-based programming. These workshops were loosely based on the MIT AI Ethics Curriculum (Payne, 2019) and the AI literacy competency framework from Long and Magerko (2020), for those activities focused on AI, and the framework for assessing development of CT (Brennan & Resnick, 2012), for those activities focused on CT and rule-based programming. Regarding the pedagocical

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methods, for the design of the activities for this workshop series we used *challenge-based learning* and *inquiry-based learning*, both with a constructionist approach, thus these workshops had a special emphasis on hands-on activities.

The selection of tools we used was based on the specific topics that we wanted to cover for introducing the students to general concepts of AI technology while at the same time reviewing some basic concepts of programming. Some of these tools are well-known, such as Machine Learning for Kids, Scratch and Teachable Machine, which are widely used as they are web-based tools that can run on any laptop computer. However, we also used some other less known tools such as Misty Robotics, a so-called social robot which uses AI-based technology such as natural language processing, computer vision, and other functions based on ML techniques. The selection of educational tools for these workshops was made not just to cover the specific topics of CT and AI, but also to offer a fun experience that would increase students' engagement in the activities.

The main methods we used for data collection during the workshops were: (1) screen recordings, (2) sound recordings, (3) participant-generated content, and (4) observations and field notes. The method for the data analysis was qualitative content analysis. We used the AI literacy and competencies from Long and Magerko (2020) to assess the activities regarding AI and ML, and the framework for CT assessment from Brennan and Resnick (2012) to evaluate the activities regarding rule-based programming. Our results suggest that there are several challenges when introducing young students to basic concepts of AI and ML and even regarding traditional programming we identified some relevant issues. For example, in one of the activities where students were given different challenges of programming small robots, out of five challenges, only the first one (the simplest which required the use of loops) was completed by all the students. The other four challenges which required using programming concepts such as conditionals, logic/arithmetic operators and variables, were completed by less than 50% of the students. As for the activities related to AI and ML, after the students tried different tools working with concepts such as image and sound recognition, training ML models and trying different methods such as unsupervised and supervised ML, over 90% of them managed to provide a definition of AI that is at least partly related to the main AI competencies listed in the framework for AI literacy (Long & Magerko, 2020). Nevertheless, when engaging in activities where the students had to create a working solution based on AI and ML, the rate of success was as low as 20%. Among the possible reasons for this relatively low performance of students when devising a working solution using rule-based programming and AI methods could be their limited skills in traditional programming. In addition, althugh students seemed to have managed to acquire an understanding of basic AI concepts and principles, this knowledge might still be superficial and thus the students struggled when trying to transfer the knowledge they acquired on AI to other contexts different from those they had to deal with during the workshops. An integrated and complementary teaching of CT and AI is therefore necessary for developing AI literacy, increasing digital competences and fostering problem-solving skills.

In future studies we intend to continue exploring how to bring together CT and AI in K-12 education using social robots and other types of physical computing. The idea is to explore the possibilities offered by the many sensors and input methods that modern robotics have to study to what extent AI methods such as ML can help students create innovative solutions that, in combination with traditional rule-based programming, could improve their skills to solve problems and create innovative digital solutions.

Keywords: Computational Thinking, Programming, Artificial Intelligence, Machine Learning, AI literacy, K-12 education

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EDUCATORS' PERCEPTIONS AND MENTAL MODELS OF AI AND SOCIAL-INTELLIGENT ROBOTS IN ACADEMIC SETTINGS

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ABSTRACT

Background: In the 1990s, Sweden launched a nationwide program providing subsidised computers and broadband internet access (Scott, 2018). This initiative bridged the digital divide, fostering a digitally skilled population and transforming education through interactive, personalised learning experiences (Barkoczi et al., 2020; Bhimwal & Mishra, 2023; Scott, 2018; Wang et al., 2024). It also paved way for the success of companies like Spotify and King, which continue to transform lives globally (Scott, 2018). Despite the initiative's potential, adoption of digital technologies has been hindered by a lack of digital literacy, training and skills among teachers, particularly in integrating advanced technologies like Artificial Intelligence (AI) into the school curriculum (Scott, 2018; Velander et al., 2023a; Velander et al., 2023b, pp. 124-135). This challenge is heightened by AI's fast-paced evolving nature and related technologies, such as Large Language Models (LLMs) or robotics. In fact, according to Jensen Huang's recent keynote featuring social robots integrated with LLMs at Computex 2024, "***the next wave of AI is physical AI***". These models autonomously perform complex tasks, making them integral to various industries (Huang, 2024). Also, they might exhibit human-like cognitive interaction and advanced human-robot communication through their understanding and adaptable nature (Atuhurra, 2024; Belpaeme et al., 2018; Cox, 2021; Kumar, 2023). However, integrating socially intelligent robots into educational settings might require promoting further teachers' digital competencies and training. By focusing on the human-in-the-loop approach, educators need to understand how they can adapt and adopt collaborative teaching models where these machines can support teachers with monitoring of social cues, detect student engagement, track performance, enhancing educational experiences and leading to better learning outcomes (Fong et al., 2003; Dautenhahn, 2007).

Motivation and Study Gap: Research suggests that teachers' acceptance of social-intelligent robots depends on their confidence and experience with the technology (Rani et al., 2023). Additionally, positive student responses to AI educators are influenced by the ease of use and task complexity (Al Darayseh, 2023; Chen et al.,

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2023). To successfully adopt AI and socially intelligent robots in educational settings, robust pedagogical frameworks and enhanced teacher understanding are crucial.

Study Aims and Objectives: This study aims to understand teachers' perceptions, knowledge, and expectations of socially intelligent robots in education. It also explores the significance of AI literacy in enhancing the integration of these robots in teaching (Ho et al., 2021; Srinivasan, 2019). The objectives of the study includes RO1: To explore challenges teachers face when implementing AI and intelligent robots in educational context, focusing on perceived usefulness, and the adequacy of existing pedagogical frameworks. RO2: To optimize the use of social-intelligent robots in education, instructional methods should focus on improving student engagement and learning outcomes.

Study Design: In this mixed-methods study, participants engaged in a structured intervention using social robots to enhance teaching and learning. An initial workshop with 7 participants, including teachers, teacher educators, and educational technologists from Spain, France, Sweden, and Japan, focusing on grades 4-9 and upper secondary education was conducted. The workshop included pre- and post-session questionnaires to capture participants' initial attitudes, experiences, and changes in perceptions. During the 3-hour interactive session, participants engaged in hands-on activities with social-intelligent robots and discussions aimed at shifting their perceptions of AI and social-intelligent robots in education. The intervention was closely monitored, and feedback was collected to enrich quantitative data with qualitative insights, providing a comprehensive understanding of the impact of AI and robots on educational practices.

Initial Findings: The study's initial findings align with the research objectives. For **RO1,** participants exhibited moderate to low knowledge of AI and socially intelligent robots, alongside concerns about readiness, student distraction, and over-reliance on technology, highlighting the challenges teachers face. These insights reveal the perceived usefulness and adequacy of existing pedagogical frameworks, informing the development of targeted training programs to enhance teachers' AI literacy and integration strategies. For **RO2,** despite knowledge gaps, participants identified specific roles for robots that enhance educational outcomes, such as assisting in various tasks and providing diverse perspectives. This indicates potential instructional methods to optimize AI use in education. Scenarios for integrating robots into lesson plans, like improving writing skills and teaching different subjects, illustrate how AI can be effectively employed to address variations in technology performance and improve student engagement.

Future Expectations: The study is expected to demonstrate improved instructional engagement among teachers using socially intelligent robots and will include additional workshops for tertiary educators and possibly K-12 students in Sweden. This will provide the study with a better perception on how to improve academic engagement amongst K-12 students in Sweden. Also, to identify better insights from the provided data, topic models and sentiment analysis will be employed to understand attitudes, and perception gaps between teachers and students.

Possible Outcomes: Enhanced teacher competency in utilizing robotics and AI within the classroom. Furthermore, the development of a robust framework will facilitate the effective integration of AI and socially intelligent robots into educational practices, preparing K-12 students for future technological advancements. Teacher training programs will offer workshops on robotics and AI techniques, fostering institutional collaboration and guiding the integration of AI to address educational challenges and opportunities in Sweden.

Keyword: Artificial Intelligence (AI), Social-Intelligent Robots, Mental Models, Educators, Teaching Practice

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GENERALIZABLE FRAMEWORK FOR TRACING AND SUPPORTING SELF-REGULATED LEARNING IN K-12 DIGITAL LEARNING

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ABSTRACT
In parallel with the growing adoption of educational technology, personalization has come to focus as a means for improving the quality and effectiveness of the learning process (Kavčič et al., 2022; Li & Wong, 2020). Despite the acclaim that personalization through digital learning environments makes learning more meaningful, balances learner's interest and challenge, supports learner motivation, improves the creation of connections between different subject areas, and enables deep learning (FitzGerald et al., 2018; Li & Wong, 2019; Porath & Hagerman, 2021), several empirical studies also indicate that technological tools in education do not automatically lead to hoped results, and even hinder the actual learning (Bingham, 2017; Porath & Hagerman, 2021). It has been acknowledged that effective use of digital learning materials requires advanced self-regulated learning (SRL) skills (Kavčič et al., 2022). However, in many cases, adaptive educational technology takes the central role in leading the learning process without actively involving learners, which may harm the cognitive and meta-cognitive processes of SRL (Molenaar, 2022; Molenaar et al., 2021). This is particularly concerning as this hinders learner autonomy and the essential foundations of lifelong learning.

Over the last decades, the research focus on SRL has increased considerably (Panadero, 2017). SRL refers to the process where the learner actively leads one's learning process through planning, monitoring, and reflection across preparatory, performance, and appraisal phases of learning (Panadero, 2017; Puustinen & Pulkkinen, 2001). In parallel with the development of SRL conceptual frameworks, new approaches for measuring SRL are evolving. With AI and machine learning advancements, the focus is shifting from self-reported instruments towards extracting and interpreting online trace data based on real-time events, offering more objective and dynamic insights into SRL (Du et al., 2023; Molenaar, 2022). In this new wave of SRL measurement, intervention that supports SRL is intertwined with measuring the progress of students' SRL behavior (Panadero et al., 2016). This is closely related to open learner modelling (OLM), the computational process of visualizing trace data of a learner's knowledge and learning process, enabling better self-knowledge for a student (Hooshyar et al., 2020). However, approaches for

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interpreting the trace data and using this as a basis for scaffolding the SRL process remain challenging and are the area of active research.

The purpose of the study

We will develop the learner modelling approach (e.g., Hooshyar, 2024) that supports student autonomy and effective learning of domain knowledge (i.e., Algebra 8th grade) while also scaffolding the development of SRL skills through opening the learner model that adaptively involves learners in regulating their own learning.

The following goals have been set:

1. To identify the most influential interventions for supporting SRL in K-12, and means for tracing and supporting SRL in digital learning environments.
2. To validate the SRL framework and interventions in digital learning environments to improve learning outcomes in the domain knowledge Algebra 8th Grade.
3. The goal is to develop a learner modelling approach and subsequently an open learner model that considers both domain knowledge (Algebra 8th grade) and self-regulated learning.
4. To evaluate the effectiveness of the proposed approach with a focus on the effect on learning outcomes, SRL skills, motivational beliefs and cognitive overload.

Methodology

To achieve the goals, a systematic literature review, a Delphi study to actively involve stakeholders, and several iterations with quasi-experimental research design are planned for developing the prototype that will be tested in OpiQ, the digital textbook provider.

Expected findings

As a result of this research a novel approach and a prototype for hybrid regulation for learning is developed. Hybrid regulation allows combining data with human insights, enabling real-time and adaptive transitions between teacher, learner, and technology (Molenaar, 2022). As a result, the learner's development is supported holistically, encompassing both the acquisition of domain knowledge and the learning of SRL skills.

Keywords: self-regulated learning, open learner modelling, hybrid regulation of learning, K-12 education.

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EXPLORING GENERATIVE AI'S ROLE IN HIGHER EDUCATION STUDENT'S STUDY PROCESS

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ABSTRACT

Generative artificial intelligence (GenAI) is advancing at rapid pace, presenting both significant challenges and transformative opportunities for higher education pedagogy [1]. Challenges related to pedagogy, research, and GenAI integration in learning have been highlighted by several studies [2,3] The concept of trust relating GenAI should also be explored, since it influences on how students act based on their trust or mistrust in technology [2]. Given the close ties to the professional world, universities of applied sciences are increasingly compelled to incorporate GenAI into learning, as it adds value to the student experience through personalization, which in turn potentially enhances academic performance [4]. Graduates proficient in GenAI will potentially also accelerate the adoption of AI technologies in the workforce.

Our research aligns with the strengths of universities of applied sciences and their role in developing pedagogical solutions related to the digital transformation of operational environments. The pilot study aims at enhancing understanding of GenAI's impact on students' studying and provide valuable insights for future research. Pilot is divided into two main parts. First, we aim to investigate students' initial attitudes and usage patterns regarding GenAI in their studies, with the objective of understanding their experiences and perceptions of its use.

Secondly, we designed a framework that integrates GenAI into five consecutive learning tasks, each focusing on a distinct type of application throughout the study process, encouraging its practical use. GenAI was integrated into the course's experiential learning process, where interdisciplinary student teams collaborated on authentic work-life assignments. This aimed to enhance competence development, facilitate problem-solving, foster active student engagement and enable application of knowledge in real-world contexts. GenAI was applied across different contexts within the study process to encourage student collaboration, support learning and teamworking, and foster reflection. This research aims to identify the best practices and challenges in integrating AI as an intelligent assistant for student teams. The goal is to enhance collaboration and problem-solving by exploring how GenAI can effectively support team dynamics, acting as a collaborator and work enhancer [5,6].

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AI assistant framework was designed in Spring 2024 and the implementation began in Fall 2024, with results expected to be available by the end of the year. We conducted the survey in the spring of 2024 across two universities of applied sciences (n = 163) drawing on insights from previous studies [7,8] to inform the design of the questionnaire. Statistical analysis is currently underway, including quantitative analysis of the survey results.

Initial analysis of the survey results provides preliminary insights into how students are incorporating AI into their learning processes. The participant pool for the study was predominantly composed of students from business-related fields. The most prominently used GenAI application among the respondents was ChatGPT, with 59% reporting the use of version 3.0 and 4% using version 4.0. The survey results indicated that students employed Gen AI tools for various academic purposes, with a particular emphasis on exploring and understanding new concepts, assisting in ideation, and using GenAI as a tool for information searches. 52,5% of those respondents who used GenAI had not formally studied it's usage, while about 30% mentioned independently studying it. An important aspect of the study was to examine how students perceive and are aware of organizational guidelines and practices related to GenAI utilization within their studies. The survey revealed significant uncertainty among students regarding institutional practices. The results indicated that approximately 19% of the respondents either were unsure or felt that the use of GenAI tools was prohibited in their studies. Many of the respondents were also unsure about the procedures for using GenAI tools in learning tasks or how the use of it would impact their assessments, highlighting the need for transparency regarding GenAI's role in academic work and evaluation processes. A statistically significant relationship was found for example between individuals' trust in GenAI and their frequency of Gen AI use ($\chi^2 = 8{,}70$, $p = 0{,}016$). Results revealed that 63,6% of those who expressed high trust in Gen AI also reported frequent or occasional use, suggesting that higher trust in GenAI is linked to more frequent use of it.

Preliminary results from our pilot survey and the implementation of AI assistant intervention within students' study processes provide valuable insights into how GenAI is currently used by UAS students. These findings highlight the need for further development in AI literacy, integration, and student support, as well as the importance of clear guidelines and permissible uses to ensure equal access to GenAI tools and the necessary competencies for their effective use. Additionally, the pilot highlights the need to explore best practices for supporting and instructing students, particularly in promoting equality and providing adequate support to ensure the appropriate and ethical use of GenAI in higher education.

This study underscores the transformative potential of GenAI in higher education through targeted pilot initiatives. These pilots are designed to explore structured GenAI integration into study processes, with the goal of addressing challenges such as digital literacy, trust, and dependency. The findings offer a practical framework for GenAI utilization in educational contexts and highlight essential areas for future research and development. Moreover, the intertwined nature of research and development in these pilots supports international collaboration objectives for

universities of applied sciences, driving the creation of new models for intelligent experimentation and pedagogical innovation.

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Keywords: generative AI, higher education, study process, learner centeredness, digital transformation

AWAITS: AN ACADEMIC WRITING AI TUTORING SYSTEM WITH RETRIEVAL AUGMENTED GENERATION FOR SUPPORTING COGNITIVE SKILLS

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ABSTRACT

Background

Recognizing the challenges students often encounter in navigating extensive course materials or other academic resources to identify useful information is crucial to their academic success [1]. The sheer volume of academic content available for topics or subjects can be overwhelming and time consuming for both teachers and students seeking precise information for their pedagogical inquiries. This challenge is particularly pronounced among first-year university students, especially those grappling with the nuances of academic writing, which can be even more daunting for non-native English speakers [2].

While Artificial Intelligence (AI)-enabled technologies are advancing at a rapid rate, there is a notable gap in the ability of educators to keep pace with these innovations [3]. Many educators often find it difficult to integrate AI tools into their existing curriculums, often due to a lack of sufficient training and support in using these technologies [10]. This disconnect not only dampens the effectiveness of AI tools but also affects the overall pedagogical process for both educators and learners, as there is a missed opportunity to utilize these advanced technologies to their full potential [4]

To address these challenges, this project introduces the Academic Writing AI Tutoring System (AWAITS) that supports both educators and students with their cognitive skills [5]. AWAITS will be built upon an existing academic chatbot, known as “CHAT4-ISP” which is an educational system that leverages Generative AI (GenAI) capabilities to support students in academic writing such as grammar, syntactic and semantic structure of submitted articles [6].

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Research Gap / Motivation

The emergence of GenAI offers promising opportunities for personalized learning [1], but integrating GenAI into education presents challenges. These challenges encompass ensuring fairness, addressing ethical concerns, and managing occasional errone outputs. These flawed or erroneous outputs may be due to factors linked to incomplete training data, flawed algorithmic design, or unforeseen environmental influences [7]. GenAI-enabled chatbots often suffer from hallucination issues, which can impede their effectiveness in supporting students' cognitive skills. Overcoming these challenges requires addressing and mitigating these hallucination effects to enhance the reliability and educational value of AI-powered chatbots. To reduce hallucinations, this study will be leveraging Retrieval Augmented Generation (RAG) technologies which combine retrieval-based and generative models to produce more accurate and contextually relevant responses by focusing on referencing provided documents as a reliable source of information [8] [9].

Research Aim

The primary objective of this study is to develop a proof-of concept system called AWAITS. The system will enhance critical thinking, and cognitive skills in academic writing for students. This initiative will also be tailored to equip students and educators with essential 21st-century skills by preparing them for a competitive labor market. AWAITS will be evaluated through systematic interventions across various educational levels, including secondary and tertiary institutions, to demonstrate its effectiveness and potential for broader educational adoption.

Study Design

The study will integrate both technical evaluation and user experience analysis by employing a two-phase experimental design to assess the use of RAG technology within educational AI-enabled chatbots. The initial phase (controlled analysis phase) will conduct a controlled experiment to determine the technical functionality of RAG feature in the AWAITS system compared to a standard version CHAT4-ISP. Both versions, (CHAT4-ISP and AWAITS) will be subjected to the same set of queries in a controlled experiment in a Question-and-Answer (Q&A) format. This approach allows a direct comparison of system features to reference and utilize external information, focusing on the enhancement provided by the RAG technology.

Following the technical assessment, the second phase transitions to an emphasis on real-world user interaction. In this phase, educators and students will engage actively with both versions, providing feedback on their experience. This user-centric approach is designed to assess the practical usability and educational value of the system. Feedback from this phase will capture subjective assessments and personal reactions, offering insights into user behavior, preferences, and overall satisfaction with the system.

Initial Findings

The initial pilot study on CHAT4-ISP has yielded promising outcomes, demonstrating the substantial potential of AI in providing valuable support within academic settings. It was also noticed that the system has proven beneficial for both educators and students by offering teacher-like suggestions and improvements. Students have utilized these AI-generated recommendations to enhance their work, while educators have been able to streamline their feedback process by leveraging the AI as an initial feedback loop before providing their own input. This approach has enabled teachers to save time, allowing them to focus on more personalized guidance and instruction. Overall, the integration of AI has shown promising potential in augmenting the learning experience for both students and educators [6].

Future Expectations and Outcomes

Development and testing of AWAITS is expected to further establish its readiness for broader implementation and adoption. The ultimate goal is to create an affordable, user-friendly, and effective educational tool that can be deployed in schools to enhance the learning process by providing real-time academic support. By emphasizing RAG technology, the study aims to improve the reliability and effectiveness of the system, further supporting educators and students in their tertiary endeavors.

Keywords: AI, Education, Chatbots, Hallucination, Academic Writing, RAG

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ARE CUSTOMERS SATISFIED WITH FINTECH PAYMENT PLATFORMS?: A STUDY OF SAVINGS AND LOANS COMPANIES OPERATING IN ACCRA METROPOLIS

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ABSTRACT
The role of the Savings and Loans Industry in our economy has been significant in providing essential financial services to micro, small and medium-sized enterprises, the informal sector and households. Ghana's Savings and Loan Companies operate predominantly in the informal sector of the Ghanaian economy. Hence, their customers and target market are unique relative to Ghana's universal and commercial banks. The emergence of FinTech Payment Platforms has brought about significant advancements in the financial services sector, offering innovative solutions that challenge traditional banking practices. FinTech Payment Platforms, in particular, have gained widespread popularity and acceptance due to their ability to revolutionise payment processes, enhance security, and improve consumer convenience in mainstream universal and commercial banks. FinTech Payment Platforms offer customers the convenience of making secure and quick payments anytime and anywhere, often through mobile devices or online interfaces. They eliminate the need for physical cash or traditional payment methods, making transactions more efficient and accessible. Fintech payment platforms focus on delivering seamless user experiences for customers. They provide user-friendly interfaces, intuitive design, and personalised features that cater to individual preferences. However, customers' acceptance of FinTech payment platforms in the savings and loans sector is very low compared to commercial and universal banks. This study explores the factors influencing acceptance of FinTech Payment Platform offered by Savings and Loans companies operating in Accra Metropolis and customers' satisfaction with such FinTech Payment Platforms. The study will specifically examine factors influencing customers' acceptance of FinTech payment platforms in savings and loan companies in Accra. The study will also analyse customer satisfaction with FinTech payment platforms for savings and loans companies in Accra Metropolis. The study will use 400 customers from Savings and Loans companies in Accra Metropolis. The study is quantitative; hence, it will collect primary data using research questionnaires. Structural Equation Modelling (SEM) will be used to analyse the data collected. Technology Readiness Index (TRI) Theory and Dynamic Capability theory are the theories that will underpin the study.

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The study's findings are expected to have theoretical, practical, and policy implications in the Savings and Loans Sector, FinTech Payment Ecosystems, and the financial sector. Theoretically, the study will expand the application of the theories to FinTech Payment Platforms. Practically, the study will help the board of directors and management of Savings and Loans Companies to appreciate the relevance and impact of integrating FinTech Payment Platforms on customer satisfaction in Savings and Loan Companies. The study findings will also help FinTech firms design FinTech payment platforms to meet customers' satisfaction in the Savings and loans companies in Ghana. This will encourage using FinTech payment platforms in Ghana's savings and loans sector. Bank of Ghana and other policymakers will find the findings of this study helpful in developing policies that will enhance the adoption of FinTech Payment Platforms in Saving and Loans Companies. Besides, the study findings will lead to more informed policies that will strengthen the various stakeholders' interaction in Ghana's FinTech Payment Ecosystem.

Keywords: FinTech Payment Platform, Savings and Loans Companies, Customer Satisfaction

CUSTOMER VALUE CO-CREATION THROUGH SELF-SERVICE TECHNOLOGY: QUALITATIVE RESEARCH ON SST IN LARGE CHAIN SUPERMARKETS

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ABSTRACT

In today's retail landscape, digital technologies like self-service technology (SST) have become essential factor for businesses that aim to maintain their competitive market positions and enhance customer experiences. This digitalization has transformed the nature of service delivery and the way retailers engage with their customers. Various studies have explored different aspects of SSTs such as, SST adoption, usability, and technology acceptance. However, empirical studies on the process of value co-creation through SSTs and their impact on consumer experiences had been under-researched. To delve deeper into these aspects, this thesis investigated how SSTs in large chain supermarkets influenced consumers' value co-creation in a multicultural society where individuals with diverse technical proficiencies and backgrounds coexist. It focused on three sub-questions: How did SST impact consumers' experiences in supermarkets? How was value co-created through the integration of SST in supermarkets? And how did consumers navigate SSTs in supermarkets? To conduct this study, a qualitative approach, combining semi-structured interviews and observational studies, were carried out in a supermarket in East London, UK. Eventually, the interview involved 10 participants from a diverse group of consumers who regularly used SSTs in a prominent supermarket. Meanwhile, 74 observations were carried out in the same supermarket which involved examining consumers using SSTs and service providers who were responsible for maintaining the SST infrastructure. The collected data from interviews and observations were analyzed thematically. The findings illustrated that SSTs had a positive impact on consumers' shopping experiences, specifically for small purchases. This technology played a pivotal role in enhancing convenience and efficiency as it streamlined transactions through speed, ease of use, and time-saving aspects, thereby reducing checkout queues and fostering *Value-Driven Efficiency*. Moreover, SSTs empowered consumers by enabling informed decision-making and providing control over their shopping process. The ability to scan items independently and manage their transactions enhanced consumers' sense of autonomy and relief, particularly for those with social anxiety. This empowerment was a critical aspect of *Autonomous Value Co-Creation*. Applying Service-Dominant (S-D) Logic, the study demonstrated that value was co-created collaboratively, as consumers actively engaged with SSTs using their skills, while service providers provided immediate assistance when problems occurred. This synergy fostered a *Value-Enriched Shopping Experience* through shared participation. Finally, the findings highlighted common challenges associated with SST usage, such as problems with scanning items without barcodes, purchasing age-restricted items, SSTs freezing, or not displaying discounted prices. Participants provided suggestions to

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further enhance their shopping experience and streamline the checkout process such as implementing practical advancements like larger scanning spaces and return functionality and incorporating technological features like auto-identity readers for age-restricted items and automatic weighing for barcode-less items, presenting insightful *Value-Driven Refinements*. Nevertheless, despite these technical glitches, the consumers were able to navigate successfully either by themselves or with the help of the assistant. Consumers exhibited adaptability and patience, normalizing these issues as routine occurrences. To conclude, the overall impact of SSTs on consumer value co-creation was positive. Value was co-created through shared participation of consumers and service providers as SSTs facilitated a collaborative nature of value co-creation, and consumers navigated through successfully despite a few technical challenges. Comprehensively, this research advanced the understanding of SST's role in digital retail transformation and value co-creation, particularly in multicultural environments. This research expanded S-D Logic by demonstrating the collaborative dynamics between consumers and service providers. It has also offered actionable insights for retailers seeking to optimize service exchange through efficient digital interactions. For practitioners, the findings suggested specific design improvements, such as larger scanning spaces and auto-identity readers, which could significantly improve user experience. Ultimately, by emphasizing the collaborative co-creation process between consumers and service providers, this study not only advanced academic discussions around Service-Dominant Logic but also provided actionable recommendations for practitioners and retailers to design more inclusive and intuitive self-service technologies that foster better customer engagement, satisfaction, and loyalty.

Keywords: self-service technologies, value co-creation, service-dominant (S-D) logic, service delivery, digital transformation, self-checkouts

ENABLING DIGITAL BUSINESS MODEL TRANSFORMATION FOR SUSTAINABLE MANUFACTURING THROUGH SERVITIZATION

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ABSTRACT

Introduction: The manufacturing sector stands at a critical juncture, facing dual pressures of environmental sustainability and digital transformation. As a significant contributor to global carbon emissions and resource consumption, the industry is under increasing scrutiny to adopt more sustainable practices. Simultaneously, the rapid advancement of digital technologies is reshaping production processes and business models. This research explores the intersection of these trends, examining how digital technologies can enable manufacturers to transition towards more sustainable practices through servitization strategies, with a particular focus on circular economy principles.

Background: Manufacturing firms face mounting pressure to adopt sustainable practices while maintaining competitiveness in an increasingly digitalized world. Servitization, the shift from product-centric to service-oriented business models, offers a promising pathway to address these challenges. However, the complex dynamics of how digital technologies enable this transition, particularly in fostering circular economy principles, remain underexplored.

Research Question: "How do digital technologies facilitate the transition of manufacturers towards circular economy principles through servitization strategies?"

Theoretical Framework: This study employs the Multi-Level Perspective (MLP) from sustainability transition theory to analyze the socio-technical transitions involved in digitally enabled servitization. The MLP framework allows for a nuanced examination of interactions between macro-level landscape pressures (e.g., environmental regulations, technological trends), meso-level industry regimes (established manufacturing practices), and micro-level niche innovations (digital servitization initiatives).

Methodology: We conducted a qualitative, multiple case study analysis of three manufacturing firms that have successfully implemented digitally enabled servitization strategies. Data collection involved analysis of academic literature, industry reports and company documents. We employ an abductive analytical approach, iterating between empirical findings and theoretical concepts to develop our insights.

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Findings:

Digital technologies serve as fundamental enablers of servitization, facilitating:

- Enhanced product monitoring and predictive maintenance
- Resource optimization and performance improvement
- Development of innovative service-based business models

Servitization strategies, when enabled by digital technologies, can strongly align with and promote circular economy principles.

The success of sustainability transitions through servitization is significantly influenced by the alignment between technological capabilities, service strategies, and circular economy practices.

Theoretical Contribution: This study extends sustainability transition theory by integrating digital technology, servitization, and circular economy perspectives within the MLP framework. We propose a novel conceptual model, the "Digital Servitization Transition Pathway," which outlines the multi-level dynamics involved in sustainable manufacturing transitions.

Practical Implications: Our findings provide strategic guidance for manufacturers on leveraging digital technologies for sustainable servitization. We offer insights into how various digital technologies can enable different servitization strategies and promote circular practices. Additionally, we provide recommendations for policymakers to create supportive environments for these transitions.

Limitations and Future Research: While our study provides rich insights from three cases, future research could benefit from quantitative analyses across larger samples to validate our findings. Longitudinal studies could track transition pathways over time, and cross-cultural studies could explore variations in the adoption and impact of digital servitization strategies.

Conclusion: This research advances our understanding of how digital technologies enable the transition towards sustainable manufacturing through servitization. By adopting a multi-level perspective, we provide a comprehensive view of the complex interactions involved in these socio-technical transitions, offering both theoretical advancements and practical insights for shaping the future of sustainable manufacturing.

Keywords: Servitization, Digital Technologies, Circular Economy, Sustainability Transition, Manufacturing, Multi-Level Perspective, Industry 4.0

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AI BENEFITS AND CHALLENGES IN SUPPLY CHAIN MANAGEMENT

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Keywords: Supply Chain Management, AI, Industrial AI, Benefits, Challenges.

Abstract

The recent advancements in AI technology present significant potential for improving operations, functions, and systems within supply chain management. However, the impact of AI on supply chain management and the associated benefits and challenges remains largely unexplored within the domain. The significance of this thesis lies in the limited research on supply chain sectors from the perspective of AI. Despite the potential advantages of AI, challenges may also arise such as security vulnerabilities, privacy concerns, and ethical issues. This thesis aims to explore the benefits and challenges of utilizing AI in supply chain management within manufacturing companies, who have implemented or plan to implement AI.

Purpose Statement and Research Question

Guided by the objective of the thesis, which is to explore the benefits and challenges of AI adoption in supply chain sectors and to investigate which aspects are addressed and achieved through adopting these AI technologies, this thesis adds to some of the gaps identified in previous research. It does this by exploring the potential effects of incorporating AI in supply chain management within manufacturing entities. An initial literature review presented some information systems typically used within supply chain sectors, existing technologies, the attempts of using AI in supply chain, as well as the challenges and opportunities experienced. A survey with managerial and supply chain decision-makers and professionals was conducted to support research findings and offer insights into the impacts of AI. The thesis aimed to identify the benefits and challenges that influence decision- makers, with the goal of answering the research question RQ: “What are the benefits and challenges of adopting AI in supply chain management within manufacturing companies?”

Selection criteria for literature

The search method included Scopus and Google Scholar to identify relevant studies on AI in supply chain management, for the literature review. Criteria included keyword relevant publication in reputable journals, and high citation count. Irrelevant results were removed through automated filters and manual screening. The final selection comprised approximately 44 studies that met the criteria.

Empirical study

An empirical study was conducted using a mixed-methods approach, which incorporated

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a survey to gather responses and insights from supply chain professionals about the benefits and challenges of adopting AI in supply chain management. The survey consisted of both open-ended and Likert scale questionnaires. It was designed to answer research questions and was distributed online via email and LinkedIn. Responses were received from 50 employees in supply chain management, information systems, and technology strategy departments within different manufacturing companies. The respondents were chosen based on convenience and availability, which has led to challenges in gathering many respondents. The distribution of roles of respondents was as follows: 14% of the respondents held top management roles such as Chief Supply Chain Officer, Vice President of Excellence & Scaling, Head of Software and AI Engineering, and Senior Procurement Officer. 38% of the respondents held senior management roles such as Head of Supply Chain, Head of Procurement, Senior Director, and Senior Manager. 24% of the respondents held managerial roles such as Supply Chain Manager, Category Manager, and Data & Analytics Manager. Lastly, 24% held specialist roles such as Supply Chain Excellence Specialist, Buyer, and Planner. The distribution of respondents based on company size was as follows: 34% of the respondents worked in companies with over 10,001 employees. Another 34% worked in companies with a size of 5,001-10,000 employees. 22% of the respondents worked in companies with a size of 1,001-5,000 employees. Lastly, 10% of the respondents worked in companies with 1,000 employees or fewer. Among these, 70% were in the manufacturing industry and 52% had implemented, were currently implementing, or were planning to implement AI in their supply chain systems.

The thesis followed the convergent mixed method; a design that combined both quantitative and qualitative data to thoroughly analyze the research problem (Creswell and Creswell, 2017, p. 39). Both qualitative and quantitative analysis of the responses were conducted. The quantitative analysis followed Creswell & Creswell (2017) six steps, including reporting participant information, determining response, conducting descriptive statistical analysis, evaluating the instrument' reliability, identifying statistics and the statistical program, and presenting and interpreting results. The online survey included 12 Likert scale questions ranging from 1 (strongly disagree) to 5 (strongly agree) to measure various opinions. Statistical analysis using IBM SPSS grouped questions into two main variables, BQ and CQ, representing benefits and challenges. The overall level of experience was used as a dependent variable to show c§orrelations, with descriptive statistics organized by question concentration areas. The qualitative data, consisting of open-ended survey questions, was analyzed using a thematic analysis process. This involved data preparation, reviewing all data, beginning data coding, developing descriptions and themes, and presenting the descriptions and themes. The qualitative part of the thesis included five major open-ended questions focusing on key themes, along with questions about the respondent's role in the supply chain and their industry. These mandatory questions explored the use of AI technologies in supply chain operations, such as demand forecasting and inventory optimization, motivations for AI adoption, and the impact on various operations. Respondents also provided examples and perspectives on how AI could enhance competitive advantage and the challenges faced in implementation.

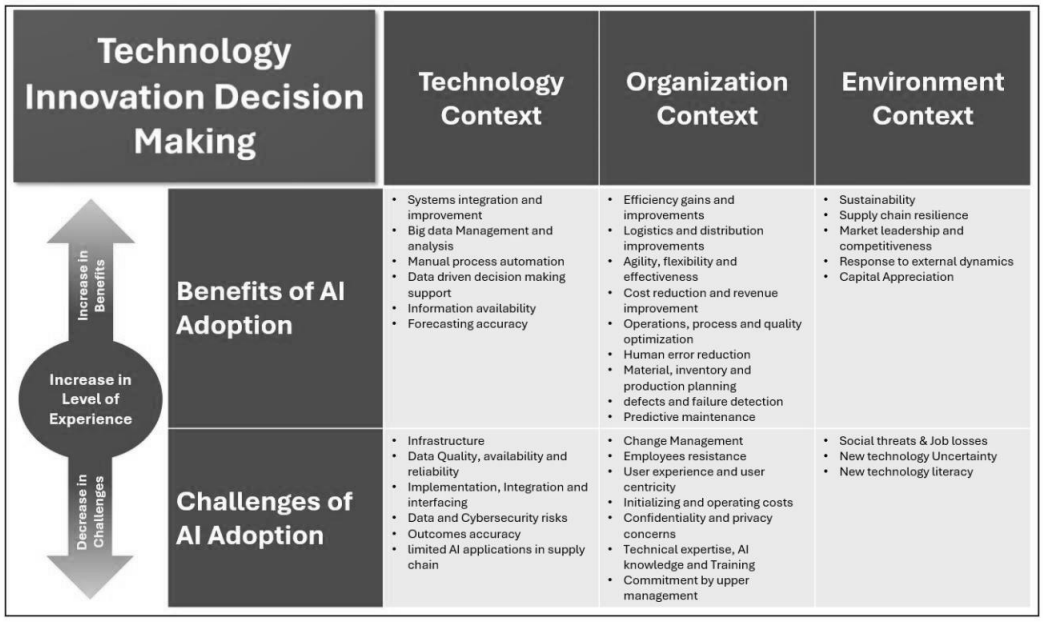
The key findings were then mapped to their corresponding contexts within the Technology-Organization Environment (TOE) framework (Yogesh et al., 2012). The TOE framework is a theoretical model at the organizational level, suggesting that a company's decision to adopt new technologies is influenced by three aspects i) the technological context, ii) the organizational context, and ii) the environmental context (Yogesh et al., 2012). This thesis finds the TOE framework suitable for understanding AI adoption in supply chain sectors for the following reasons: i) Technological: The framework covers the available AI technologies and applications, as well as the compatibility of AI with

existing supply chain systems. ii) Organizational: The framework allows organizations to identify obstacles and enablers for AI adoption and assess the readiness of the concerned organizations. iii) Environmental: The framework helps companies predict potential challenges and opportunities from the external environment (Yogesh et al., 2012).

The main themes identified from the findings include Technological Benefits, Technological Challenges, Organizational Benefits, Organizational Challenges, Environmental Benefits, and Environmental Challenges. The thesis identified several benefits of AI adoption in supply chain management, aligning with some key findings from other studies. Technological benefits include systems integration and improvement, big data management and analysis, manual process automation, data-driven decision making, information availability, and forecasting accuracy. Organizational benefits include AI impact of enhancing labor efficiency, logistics and distribution, agility, flexibility, and effectiveness. It also facilitates cost reduction, operations, process and quality optimization, and reduces human error. Environmental benefits showed that AI adoption promotes sustainability, supply chain resilience, market leadership and competitiveness, responsiveness to external dynamics, and capital appreciation. These benefits collectively contribute to the overall improvement of supply chain management, making it more efficient, effective, and sustainable. See figure 1.

Figure 1

Benefits and challenges of AI adoption in Supply Chain Management



The matrix in figure 1 illustrates the identified benefits and challenges of AI adoption, as wellas the relationship between the increase in the level of experience and the corresponding increase in adoption benefits and decrease in challenges. An increase in experience leads to anincrease in benefits and a concurrent decrease in challenges.

While AI adoption in supply chain management offers numerous benefits, it also presents several challenges. Technological Challenges include lack of data infrastructure, rigid infrastructure, quality, availability, and reliability of data, implementation, integration, and interfacing of AI with existing systems, data and cybersecurity risks, accuracy of outcomes, and limited number of AI applications that can be integrated into supply chain systems. Organizational challenges include change management, employee resistance, user experience and user centricity, lack of technical expertise, AI knowledge, and training, initializing and operating costs, confidentiality and privacy concerns, and

commitment by upper management. Moreover, environmental challenges include social threats and job losses, uncertainty about new technology, and new technology literacy. These challenges collectively contribute to the complexity of AI adoption in supply chain management, requiring careful consideration and strategic planning. The findings also revealed a relationship between the benefits and challenges of AI adoption and the level of experience of employees. It was observed that an increase in the overall level of experience leads to a decrease in challenges and an increase in benefits. See figure 1.

Conclusion

The primary contribution of this thesis is to provide insights about the technological, organizational, and environmental benefits and challenges associated with utilizing AI technologies in supply chain management. These findings will provide decision makers with a deeper understanding of the associated outcomes and equip them with the knowledge needed to overcome obstacles while utilizing AI. Furthermore, the findings will enable supply chain professionals in manufacturing companies to set clear expectations and select the relevant AI solutions needed to optimize various functions within their organizations. The main limitation of this master's thesis was the difficulty in obtaining a large number of survey responses within a short timeframe, as many targeted employees did not participate. Additionally, focusing on supply chain professionals and manufacturing companies posed challenges, given the relatively new adoption of AI technologies in both manufacturing and service sectors. Due to these limitations, a survey method was used for data collection. Future research could benefit from case studies in companies that have implemented AI in their supply chains, allowing for a detailed assessment of benefits and challenges over time. Expanding research to other sectors and using larger samples could also provide broader insights and enable generalization.

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A SOCIO-TECHNICAL PERSPECTIVE ON THE ADOPTION OF DIGITAL TRACKING TECHNOLOGIES FOR CIRCULAR ECONOMY IN THE SWEDISH PREFABRICATED CONCRETE SECTOR

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ABSTRACT

Background and gap: The construction sector is globally a major consumer of natural resources and a significant contributor of extensive resource exploitation and waste generation (Bonoli et al, 2021; Fei et al., 2021). In Sweden, the construction and demolition sector alone generate approximately 10 million tonnes of waste annually (Byggföretagen 2019). This waste generation process aligns with the linear economy. Therefore, transitioning from a linear to a circular economy (CE) in the construction sector is crucial for advancing several United Nations Sustainable Development Goals (SDGs). This transition promotes sustainable resource use through improved waste management practices and reduces environmental impact through climate mitigation actions (Eurostat, 2023).

Digital Tracking Technologies (DTT) offer a promising solution to enhance sustainability and material circularity, particularly in the concrete industry (Camodeca & Almici, 2021; Del Rio et al, 2021). DTTs are pivotal in advancing construction circularity by enhancing material traceability and transparency, ensuring compliance, enabling effective lifecycle management, and facilitating data-driven decision-making (Davari et al. 2023). Notwithstanding such benefits, the construction industry is slow to adopt Digital Technologies (DT) in general (Davari et al. 2023; Dervishaj et al, 2023; Giovanardi et al., 2022; Wuni, 2022). Currently, several concrete manufacturing companies use DTT, such as QR codes, mainly for project planning rather than for CE purposes. These companies face barriers to adopting DTT for CE, including high start-up costs, complex supply chains, and lack of technical skills, which hinder the full implementation of DTT in promoting circular practices (AlJaber et al., 2023; Lobo et al., 2021). Thus, it is crucial to focus on how these companies can effectively leverage DTT for CE practices.

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Current studies in the construction sector often focus on individual technologies such as Building Information Modeling (BIM), the Internet of Things (IoT), Radio Frequency Identification (RFID), and blockchain, emphasising their technical aspects (Vahidi et al., 2024; Dervishaj et al, 2023; Teisserenc & Sepasgozar, 2021). This narrow focus overlooks the socio-technical dynamics in the concrete sector, including the interplay between technological advancements, regulatory frameworks, industry practices, and societal trends. Consequently, there is a gap in understanding how these technologies collectively impact and transform the sector within the context of a CE.

Aim: This study aims to analyse the multi-level dynamics that lead to the barriers and opportunities in adopting DTT for CE in the Swedish prefabricated concrete sector.

Theoretical framework: The study employed the Multi-Level Perspective (MLP) framework to analyse the socio-technical transitions required for DTT adoption. MLP provides a structured approach to understanding the interactions between three levels: niches, regimes, and landscapes. The niche is a protected arena (from the existing system) arena at the micro level where radical innovations emerge. The regimes, at the meso-level, encompass the established practices and rules that stabilize existing systems. At the macro-level, landscapes include broader societal influences such as economic systems, cultural norms, and regulatory frameworks (Geels, 2002; 2011). The regime level involves actors whose actions are influenced by various contextual factors, including their attitudes, behaviours, and perceptions (Geels 2002). Understanding the interactions and influences of these actors are central components of the MLP framework, which is the central part of this study.

Methods: The study utilised a mixed-method approach, combining quantitative text analytics and qualitative semi-structured interviews following Creswell's (2014) methodology. Text analytics was used to identify prevailing themes and sentiments from academic literature and social media discussions related to DT (various technologies that digitise processes and enhance efficiency) generally for circularity in the construction industry. This was achieved through techniques such as word cloud visualisations, topic modelling, and sentiment analysis. Simultaneously, semi-structured interviews with 10 key Swedish construction stakeholders were conducted to get their in-depth perceptions and the contextual factors influencing the adoption of DTT (technologies for tracking and monitoring materials, resources, and processes). Furthermore, a triangulation strategy was adopted to cross-reference the sentiment analysis results with insights from the interviews. Through this, the study captured both broad societal attitudes and specific industry viewpoints. This multi-layered approach enabled the identification of patterns across niche innovations, regime behaviours, and landscape-level influences, providing a deeper understanding of the socio-technical dynamics shaping the adoption of DTT in the concrete industry.

Key Findings: Thematic analysis of the interview data revealed 22 driving factors, 24 barriers, and 15 opportunities associated with DTT adoption in the sector. Key drivers identified for DTT adoption include regulatory support, technological advancements, and increased stakeholder collaboration. However, significant barriers persist, such as technical limitations, financial constraints, and resistance to change within the industry. The opportunities identified revolve around the potential at the *niche* level for creating standardized protocols for DTT implementation for improvement at the *niche* level include developing standardized protocols and enhancing training programs for industry professionals. Corroborating these findings, text analytics reveal that the most frequent terms in academic literature and social media posts regarding the adoption of DT for CE include 'sustainability,' 'circularity,' and 'digitalisation'. These *landscape* factors are interpreted as drivers for the adoption of DTT. Topic modelling identified themes such as the benefits of DT for material traceability, while the sentiment analysis indicated a generally positive attitude at the *regime* level towards DT, recognizing its potential to enhance CE practices. Together, insights from both text analytics and interviews provide a comprehensive understanding of DTT adoption, mapped to the MLP framework. At the niche level, findings suggest innovation potential, with actors pushing for DTT adoption to improve resource efficiency and circularity. At the regime level, while there is recognition of DTT's importance, established practices, resistance, and financial concerns continue to hinder large-scale adoption. Positive societal attitudes toward sustainability at the landscape level exert pressure on both niche innovations and regime shifts, creating favourable conditions for progress in the sector.

Conclusion and Recommendation: To encourage DTT adoption, introducing *incentives and subsidies* for industry stakeholders is recommended to stimulate investment. Additionally, *training programs* should be developed to address skill gaps, equipping professionals to adopt DTT more effectively. *Improving technology solutions* to ensure seamless integration into existing workflows will reduce disruption and build confidence in the transition to digital solutions

Future Works: Future research should prioritise expanding stakeholder engagement and ensuring inclusion in data collection across various regions. This approach will provide a more diverse and representative understanding of the challenges and opportunities related to DTT adoption, enabling more comprehensive and inclusive solutions for the construction industry.

Keywords: Digital Tracking Technologies (DTT), Adoption, Circular Economy (CE), Prefabricated Concrete, Socio-Technical Transition (STT), Multi-Level Perspectives (MLP)

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INNOVATIVE PEDAGOGY IN K-12 EDUCATION: A COMPREHENSIVE STUDY OF COMPUTATIONAL AND DESIGN THINKING WITH EMERGING TECHNOLOGIES THROUGH THE EXTEN(DT)² PROJECT.

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Abstract

Introduction: In the dynamic landscape of education, innovation plays a crucial role in driving progress. Supported by Horizon Europe and Innovate UK, the Exten $(DT)^2$ project emerges as a transformative initiative aiming to propel Design Thinking into the digital age (Extendt2, n.d.). This integration enhances pedagogy, promotes sustainable digitization, and encourages broader adoption of Design Thinking (DT). It also seeks to reshape interdisciplinary learning and foster essential 21st-century skills (Milrad et al., 2023). Computational Thinking (CT) equips learners with adaptability and innovative thinking abilities (Yadav et al., 2011; Oh et al., 2018). Design and Computational Thinking are increasingly acknowledged as effective pedagogical approaches (Bocconi et al., 2016), valuable for skill development and problem-solving (National Research Council, 2010; Panke, 2019). Incorporating these adaptable activities into classroom projects aligns with the objectives of twenty-first-century education, bridging student learning with digital fabrication (Iwata et al., 2020). The project also leverages emerging technologies (ET) to enhance these methodologies (Veletsianos, 2016), as DT and CT are recognized for developing 21st-century skills (Li and Zhan, 2022).

Study gap and Motivation: The integration of DT, CT, and ET holds promise in enhancing the feasibility, accessibility, and inclusivity of K-12 education for students, teachers, and administrators. However, gaps persist in understanding the specific challenges, opportunities, and potential impacts of this integration (Samberg, 2018).

While each approach—DT, CT, and ET—is increasingly recognized for its individual merits, comprehensive studies on their combined application in K-12 education remain limited. There is a critical need to explore the feasibility, accessibility, and inclusivity of these pedagogical methods, as well as how data-driven insights can inform educational practices. This study aims to address these gaps by investigating

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effective strategies for integrating DT, CT, and ET to create a more accessible and inclusive educational experience. Such efforts are crucial for advancing sustainable methodologies in K-12 settings. Through the lens of the Exten (D.T) ² project—leveraging technologies like ChoiCO, SoBert, MalT2, and GearsBox—this study embarks on a multifaceted exploration. Its goal is to inspire transformative pedagogical practices that cater to diverse learner needs across the educational spectrum. The study's motivation is to foster robust skill development, promote innovation, and motivate students, teachers, and administrators to unlock new opportunities for educational advancement.

Research Questions: The following research questions were identified for assessing the overall investigating aim of this study:

RQ 1a: How can the combined use of CT and DT, with ET, enhance the educational experience of teachers and students in K-12 settings as reflected in existing literature?

RQ 1b: What is the current state of CT and DT with ET in K-12 education, as reflected in social media opinion with a focus on identified gaps, trends, and areas for further exploration?

RQ 2: How can the data obtained from questionnaires with text analytical approach be utilized to understand factors that impact the feasibility, accessibility, and inclusivity of these pedagogical approaches in Exten (D.T) ²?

RQ 3: How can the findings obtained from the study serve as a catalyst to inform useful decisions when implementing CT, DT with ET in K-12 education?

Methods: Data related to DT, CT, and ET in K-12 education was collected from Facebook, Web of Science, Google Scholar, Research Rabbit, and other reliable scholarly repositories. Additionally, the study analyzed data collected through questionnaires, which gathered experts' opinions on the integration of the Exten (D.T)^2 project in educational settings. The study utilized both programming and non-programming techniques to achieve its objectives. Formal scholarly datasets were prioritized to publications from the past 12 years and studies worldwide published in English. These datasets were analyzed using VOSviewer, along with machine learning (ML) and deep learning (DL) techniques, to explore trends and gaps in academic literature. Facebook posts, specifically focused on opinions and reviews related to the intersection of DT, CT, and ET in K-12 education, were scraped with Bardeen, a web extension tool and analyzed using Orange BioLab, ML, and DL. In ML, topic modeling and sentiment analysis are employed, and network graphs used for visualization. While in the DL techniques, on the other hand, utilized the BERT model and Naive Bayes for performance evaluation. Orange BioLab facilitates sentiment analysis, presenting results through intuitive bar plots. Additionally, topic modeling techniques such as MDS and LDAVis are utilized to provide comprehensive insights and visual representations of the data. Expert opinions collected through questionnaires were examined with NVivo and MS Excel to gather insights on feasibility, accessibility, and inclusivity. Together, the insights from these analyses aim to provide a comprehensive understanding of the combined use of CT, DT, and ET in K-12 education and inform future implementations.

Outcomes: The study from formal scholarly dataset underscored the importance of interdisciplinary approaches, innovative teaching methodologies, and the necessity for further research to effectively integrate these concepts. It also highlighted the significance of CT skills, coding practices, AI and DT for enhancing problem-solving abilities and improving creativity among students. However, it also revealed challenges such as the scarcity of studies focused on design thinking and the need for more exploration with computational thinking and emerging technologies.

The study from social media data highlighted the importance of skill development, innovation, and enhancing learning outcomes. However, challenges such as privacy concerns, disparities in access to technology, and ethical considerations emerge, underscoring the importance of addressing these issues to ensure ethical implementation of CT, DT and ET in K-12 education. Additionally, the analysis suggests a pressing need for teacher training and support programs to equip educators with the necessary skills and knowledge to integrate these tools into their teaching practices. Furthermore, the social media analysis highlighted the issues and challenges that need attention in translating theoretical concepts into real-world applications and the development of practical solutions that bridge the gap between theory and practice within educational settings.

The study from the questionnaire revealed the importance of continuous professional development opportunities, adequate resource allocation, seamless technological integration, supportive educational policies, inclusive teaching practices, comprehensive support systems, and accommodations for diverse student and educator needs to enhance feasibility, accessibility, and inclusivity.

Conclusion: In conclusion, the findings of this study reveal the critical importance of a multifaceted approach to integrating CT, DT and ET within K-12 education. The analysis has identified significant gaps in understanding the specific challenges, opportunities, and potential impacts of this integration, emphasizing the urgent need for research to bridge these divides. A comprehensive curriculum design framework that incorporates these elements can significantly enhance students' critical thinking, problem-solving, creativity, and collaboration skills.

The study faced several limitations. Due to time constraints, data scraping was performed only on the Facebook platform, excluding others like LinkedIn and Twitter. The questionnaire-based data collection method may have missed in-depth insights that could be obtained from direct interviews or voice mining. Additionally, the analysis focused solely on textual posts, overlooking the emotional value of images and emojis in comments. Moreover, advanced DL techniques for data analysis were not utilized, which could have enhanced the accuracy and depth of insights. Considering these limitations, future research should adopt a more comprehensive approach by incorporating multiple platforms and diverse data collection methods to gain a deeper understanding.

Keywords: Computational Thinking, Design Thinking, Emerging Technologies, K-12 education, 21st century skills, Exten (D.T) [2]

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CONSTRUCTING DIGITAL COMPETENCE IN SMALL AND MEDIUM-SIZED ENTERPRISES – CHALLENGES AND OPPORTUNITIES

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ABSTRACT
Today, there is an increased demand for both digital competence and specialized skills across various industries and job markets. While Sweden is considered at the forefront, international competition remains fierce, necessitating different initiatives to maintain the position. Digital competence can be described as a strategic factor for economic growth, yet limited digital skills and competencies pose obstacles, especially in the context of digital transformation.

This paper aims to introduce a conceptual book that describes and analyzes how companies in different sectors are impacted by digitalization. The focus lies on perceived digital competence needs, the challenges and opportunities companies encounter with digitalization. The book draws from data collected in the project "Digital Competence and Cutting Edge Skills in Kronoberg," which includes 181 brief telephone interviews and 34 in-depth interviews. These interviews were conducted with SMEs across six different industries in the Kronoberg region. The in-depth interviews provide insights into underlying reasons for competency needs and offer a clearer understanding of unique competencies and strategies to digitalize. Additionally, the analysis explores how organizations approach competency supply in general.

From a general perspective, the responses indicate that most companies experience a high pace of digitalization, emphasizing the importance of digital-related issues. Furthermore, a significant number of companies actively develop their digital competence on an ongoing basis. Challenges consist of knowing what, how and when to invest in digital competence. Looking ahead, continued digitalization is seen as essential, particularly to prepare employees for the ongoing transition.

Keywords: Digital Competence, Cutting Edge Competence, Digital Strategies, Inhabited Institutions and Communication Small and Medium sized Companies.

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CULTURAL INSTITUTIONS AND THE CULTURE WAR: THE DIGITAL THREAT TO THE PROMOTION OF DEMOCRACY (CICUW)

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ABSTRACT
The pervasiveness of far-right discourse has irrevocably affected the ability of cultural institutions to promote pluralism and democracy. In Sweden, the growing influence of the far-right has turned cultural institutions, such as museums and public libraries, into political symbols in an escalating 'culture war' (Harding 2022; Hanell *et al.* 2023). Librarians are urged by politicians and the public to cancel LGBTQI-themed or multicultural events, and cultural institutions have undertaken such measures to mitigate the risk of encountering hate speech and harassment from far-right sympathizers. This presents a democratic challenge.

The purpose of CiCuW is to produce new knowledge about far-right attacks on public cultural institutions and their democratic consequences. Existing research shows how the pervasiveness of far-right discourse is facilitated by the capabilities afforded by digital technologies. The aim of the project is thus to understand the interplay between the far right's antagonistic information activities online and on-site attacks on cultural institutions. While existing research has often studied these aspects separately, cultural institutions and the online culture war discourse offer a ompelling starting point for exploring the interrelatedness of on-site experiences and hostile online information activities. To this end we apply an innovative interdisciplinary approach that draws on perspectives from Library and Information Science, Digital Humanities and Linguistics, combining data-driven methods and the text analytical capabilities of large language models with qualitative approaches. Through this novel mixed methods approach, a key component of the project is to further methodological development necessary for understanding the interplay between online discourse and offline events. This contribution presents tentative results from a pilot study and the design of the proposed project.

The pilot study explored user comments on online news websites as instances of digital interaction (Landert 2014), applying a data-driven approach informed by sentiment analysis and topic modelling testing both conventional lexicon-based sentiment scoring and Latent Dirichlet Allocation (LDA) topic modelling, and more recent Bidirectional Encoder Representations from Transformers (BERT) modelling. An ongoing analysis suggests that the frequency and temporality of comments and

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upvotes provide a window into the processes shaping far-right digital discourses (Ihrmark et al. 2023). The main pattern of interest is whether the connection between certain topics and expressed sentiment can lead to, or reinforce, negative engagement with said topic over time. The combination of these techniques will also allow for exploration of the connection between online and offline interactions by answering questions such as whether a topic which is connected to more frequent expressions of negative sentiment will lead to real-life incidents in which said sentiments are echoed. In order for this to be established, recurring topics and their distribution within the dataset will be identified using topic modelling, and the sentiment of user engagement using sentiment analysis. The ability of sentiment analysis to quantify sentiment in the engagement will also allow for insights regarding the level of expressed sentiment before an incident occurs offline, if such a connection exists, and the development of sentiment regarding a topic in the discourse. In the proposed project, we leverage the insights derived from this study to advance methodological development by combining qualitative and quantitative methods.

Methodologically, the project is underpinned by an interdisciplinary approach, clearly articulated in the project objectives, and realized through three interconnected project parts. The interdisciplinary endeavor is theoretically unified through the adoption of a joint theoretical framework: practice theory (Shove *et al*. 2012). This framework is suitable for the proposed project as it provides an analytical tool for approaching discourse and action, as well as knowledge, meaning and material artefacts, as a composite analytical unit of interconnected elements: practice. By analytically framing public cultural workers' experiences of hate and threats and the online information activities of the far-right as distinct yet interconnected manifestations of a singular practice, we can elucidate the various forms of interconnectedness between online discourses and physical events within cultural institutions. The project is divided into three subprojects, each structured to address one research question respectively.

The first subproject consists of three ethnographic case studies, focusing on-site experiences, designed to produce in-depth knowledge of public cultural workers experiences of hate and threat. The second subproject is focused on exploring and classifying far-right interactions online to explore the connection to real-world events. Through collecting online interactions, categorized according to the expressed sentiment and the topic of said sentiment, connections between sentiment, topic and any physical space mentioned within the digital interaction can be made. In the third subproject, results, and insights from the two previous sub studies will be further explored and synthesized in a series of workshops. The workshops will focus on producing recommendations for interdisciplinary methodological advancement with regards to studying the entangled processes of online and offline interactions, based on the project's findings.

The project will move beyond the state of the art by providing a systematic and interdisciplinary investigation into democratic implications of the pervasiveness of far-right discourse, focusing on a previously neglected empirical field: public cultural

institutions. Besides furthering our knowledge on democratic implications of farright influence, this new knowledge will feed a valuable knowledge exchange with the public cultural sector on how to preserve and foster their democratic leverage in politically turbulent times. To this end, a reference group with experts from cultural institutions will be formed as part of the project. Through the development and implementation of an innovative mixed methods approach this project will contribute to the ongoing efforts in methodological advancement aimed at understanding the relations between online discourse and offline occurrences. Last but not least, the project will provide new knowledge essential for scholarly endeavors that aims to safeguard democratic governance.

Keywords: cultural institutions, democracy, far-right discourse, digital methods

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FACSIMILES FOR FUTURE ARCHIVES: FADING FAXES AND DIGITAL DIFFICULTIES

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ABSTRACT
This project investigates the numerous challenges surrounding the preservation andpotential digitization of faxes in the Birgitta Stenberg manuscript collection (KvinnSam, University of Gothenburg Library), while suggesting ways in which this case study may be instructive for other cultural heritage archives containing thermal paper documents or other similarly challenging materials. Thermal paper documents, which include faxes, are well-known to be physically unstable, with inevitable fading, discoloration, and embrittlement posing challenges for long-term content and material preservation. Thermal paper faxes, copies, and prints are widespread in KvinnSam manuscript collections dating from the 1980s, 1990s, and early 2000s. While most fax and printing processes now use more stable paper and printing techniques, thermal papers continue to be widely used for the printing of receipts, labels, and tickets. Archival guidelines for thermal paper documents, typically developed by governmental archives in the early 1990s, recommended creating archival copies on acid free paper—a process called preservation photocopying—and discarding the original unstable thermal paper documents. Yet these recommendations may not always be feasible when dealing with large quantities of faxes in archival collections, nor may they always be appropriate for cultural heritage materials which may seek to preserve not only the content of documents but also their material forms. With newer technologies, newer recommendations for thermal paper content preservation may include digitization, but digitization may bring additional challenges for an archival collection such as the one investigated here.

In Fall 2023, KvinnSam received project funding to begin to address the unstable faxes in their collections. While KvinnSam was aware of many of these thermal paper documents within their in their archival collections, existing staffing and funding limitations coupled with the sheer size of their ever-growing archival collections have meant that a full inventory of these documents as well as possible strategies for remediating them had not been previously investigated. The project funding enabled the fixed-term employment (January-March 2024) of a supplementary staff member (this author) to comprehensively inventory and create condition assessments of thermal paper documents within the Birgitta Stenberg collection (known to contain large quantities of faxes) and to develop actionable guidelines for handling thermal paper documents within KvinnSam's existing collections and future archival

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accessions. These guidelines were developed following an extensive literature review focusing on thermal paper history, composition, and preservation, as well as engaging in collaborative dialogue with KvinnSam's archivists, the Gothenburg University conservator, and, to a lesser extent, the University Library Digitization Division.

Initially, the assumption of KvinnSam was that digitization might prove the best means by which the archival content of these documents could be preserved. However, a number of difficulties arose which called for the creation of guidelines that included digitization only as one possible approach among others, one that might be used in conjunction with more analog solutions such as preservation photocopying, for example. The difficulties of digitizing these documents include institutional financial limitations; the heterogeneous conditions and physical realities of these documents; the sheer quantity of these documents (7000+ pages) within a single collection; the need to balance the archival responsibility to preserve original documents as long as possible with the destructiveness of digitization (light exposure is particularly damaging to thermal paper documents); and the desire to maintain archival order (as these documents are often interspersed with nonthermal paper records). One of the most compelling arguments for digitization, that of access, is not currently applicable to this collection. While accessible for researchers on site, this collection has some access restrictions meaning that any digitized resources created could not be open access, conflicting with the common digitization drive to create such resources. Further, a number of issues external to this collection and to KvinnSam also arose when considering digitization. The Digitization Division at the Gothenburg University Library was attempting to manage a silverfish infestation during the period of this project, which made KvinnSam archivists somewhat disinclined to send archival materials to them until this issue was handled. The British Library cyberattack, which occurred in October 2023, made the Gothenburg University Library and KvinnSam concerned about the digital security and stability of its own digitized cultural heritage, particularly in the case of a collection with access restrictions which would require even more layers of digital security. Despite these difficulties, in the cases of some of the thermal paper documents in KvinnSam's collections, digitization may often prove invaluable for improving ethe readability of faded thermal paper documents. The high quality of digital images may also be better able to communicate the materiality of the original documents than may be possible with preservation photocopying, as in the case of uncut faxes which are not possible to reproduce physically without page breaks, for example. The guidelines developed thus recommended digital-analog approaches which can better support KvinnSam's archival imperatives.

While these guidelines and recommendations concerning archival faxes and thermal paper documents were developed specifically for KvinnSam's collections and archival realities, they may prove useful for other archival collections. The literature review undertaken for this project demonstrated a serious lacuna in research; the recommendations made, primarily by governmental archives in the 1990s, have not been updated. The assumption seems to be that, since fax communications have

largely given way to fully digital technologies like email, thermal no longer being generated and so are no longer a concern for archives. Yet cultural heritage manuscript collections rarely arrive to archives immediately after their creation, meaning that institutions may have received—and may continue to receive—these documents, sometimes in large quantities, many years and even decades after their creation. Undertaking new research in this area and collaborating with archives can assist in the development of actionable guidelines to help archives best leverage analog and digital solutions for the long-term preservation of these cultural heritage materials.

Keywords: Archival materials—Deterioration, Archival materials—Digitization, Facsimile transmission, Preservation of materials, Preservation photocopying

LEVERAGING POPULATION MOBILITY INSIGHTS FROM MOBILE OPERATOR DATA FOR DEVELOPMENT AND HUMANITARIAN ACTION: FROM SETTING UP MOBILE DATA PARTNERSHIPS AND SECURE PROCESSING AND DATA IN USE

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ABSTRACT

Introduction

Exploring the potential for digital transformation globally, through the use of data initiatives, Flowminder works to promote positive change in both global learning and big data applications, with a strong focus on mobile operator data analytics. Enabling decision makers to access the data needed to transform the lives of vulnerable people, Flowminder focusses on providing valuable insights and capacity strengthening to governments, mobile network operators (MNOs), national/international agencies and researchers, in low- and middle- income countries, to improve decision-making for development and humanitarian purposes.

Currently, understanding and awareness of the value of mobile operator data (and specifically Call Detail Records (CDRs), a dataset automatically generated by MNOs for billing purposes) is significantly increasing; however, the effort required to set up sustainable & impactful CDR data initiatives is not necessarily widely appreciated. Flowminder has been active in assisting governments (as well as development and humanitarian actors) in responding to the need to adopt new data sources in order to fill 'data gaps' and meet their development goals or programme objectives.

Significant during the COVID-19 pandemic, Flowminder proactively supported the global response to the outbreak by working with MNOs, and/or governments to provide, in many countries, mobility insights derived from CDRs, to support decision-making. This proved useful in monitoring the restricted population's mobility through high spatial and temporal resolution, providing near-real time insights which estimated the impact on mobility of imposed restrictions, such as lockdowns, which were implemented to reduce transmission and control the spread of the disease.

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Data and Methods

To provide decision makers with precise and accurate mobility estimates, and support interventions in many sectors, from health to disaster management or official statistics, for example, Flowminder has developed state-of-the-art methods for estimating population distribution and mobility, alongside different models for setting up public-private big data initiatives.

Extracting the population mobility information contained in CDRs is of critical importance in data poor contexts such as in low- and middle-income countries (LMICs), where it can support humanitarian and human development efforts. Flowminder has specialised in addressing such challenges through the development of robust live systems, from ingestion and automated quality assurance (QA) checks of pseudonymised CDR data and cell data, to the extraction of mobility information from CDRs and bias correction using survey data, resulting in the semi-automated production of a set of standard indicators, ready to be disseminated to decision makers in LMICs through dashboards, standard reports or as data sheets.

Flowminder made the choice to conduct all CDR data processing within the firewall of the MNOs. While this comes with constraints on compute power and memory, it is essential to protect subscribers' data privacy. The organisation has also developed and is testing different models for setting up mobile data initiatives to overcome these challenges, bearing in mind that every operator, context and needs are unique. In Haiti for example, Flowminder is enabling the increased access to and use of mobile operator data in ways that are ethically sound, financially viable, and sustainable, while providing the MNO with CSR and revenue generation opportunities. In Ghana, Flowminder has entered a long-standing partnership with Ghana Statistical Service and Telecel Ghana (previously Vodafone Ghana) to integrate CDR-derived estimates into official statistics, and support branches of the government in using these data for improved decision-making.

To handle all data processing, from ingesting the pseudonymised CDRs to outputting mobility and population estimates, Flowminder built “FlowKit”. FlowKit is an open-source CDR data processing toolkit, consisting of various databases and tools for automating data ingestion and QA, implementations of our methods for extracting mobility information from CDRs, scaling, combining and formatting the mobility estimates for end usage. Pseudonymised CDR data are received from the operator daily, and are automatically ingested into the FlowKit database, ready for processing. The team has also set up a monitoring system that tracks the status of the at-MNO servers, FlowKit installations and automated QA checks, and sends alerts so that any detected problem can be addressed quickly. This is important particularly for crisis preparedness so that CDRs are available and specific processing can begin promptly if a crisis occurs or is forecast.

Results/ Findings

Flowminder provides analytical reports and data (via datasheets or dashboards) to inform a range of applications, from disaster management, to official migration statistics and immunisation planning, and is working towards further automating the production of these end products for each application. Currently, they produce scaled and adjusted mobility and population estimates for Haiti, Ghana and the Democratic Republic of the Congo (DRC), and the work is backed-up by capacity building activities with key actors for sustainable use.

In response to the COVID-19 pandemic for example, Flowminder provided analyses in seven different countries, utilising anonymised CDR aggregates. They were able to generate insights into the changes of mobility and population distributions, in comparison to a pre-pandemic baseline. Findings from the data research shows a substantial, sharp reduction in mobility immediately following government restrictions in all seven countries, which may have helped control the spread of the disease as intended. However, the data also portrayed that the lifting of restrictions consequently resulted in slow recovery of mobility towards the pre-pandemic baseline, further suggesting a longer term impact of mobility on the economy.

Research Implications/ Contributions

Through understanding that every operator, context and needs are unique, and through the development of innovative and robust methods for analysing such data, Flowminder is efficient in supporting decision makers with useful insights into both routine and crisis mobility in a country. However, several challenges are currently preventing operators from routinely providing access to their data for development/humanitarian purposes, including, among others, the lack of resources or financial incentives to process, share and manage data releases over the long term. Therefore, Flowminder aims to openly share the lessons learnt and the knowledge acquired to forge a long-lasting CDR data partnership, from partnership building stage to processing, analysis and applications development.

Keywords: public-private partnerships; collaborations; mobile operator data; big data applications

ARTIFICIAL INTELLIGENCE AND THE CYBER UTOPIANISM OF JUSTICE. WHY AI IS NOT INTELLIGENCE AND MAN'S STRUGGLE TO SURVIVE HIMSELF

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ABSTRACT
Objective: to show the ontological differences between human and artificial intelligence and address structural divergences at the definitional level.

This work integrates a more detailed and specific panel of articles and researches conducted as CrossMediaLabs which covered the following topics in 2023 and 2024

- Copyrights and artificial intelligence systems. Legal principles and requirements underlying law in a globalised world
- From the European Court of Justice ruling of 4 July 2023 (Case C252/21) to paid social profiles. The intervention of ex-post justice does not solve the problem of citizens' data management.
- AI and human emotions: definition, regulation and possible implications.
- Artificial intelligence at the service of criminal justice? AI and criminal law: benefits and dangers of a de-humanisation of justice
- From clarity of the act to legal design. A realist commentary on new trends in cyber-utopianism.
- The Supreme Court decision 43638/2023 and the competent court for the crime committed by means of computer operations: the crossroads of the choice between the place of human action and the technological place.
- Legislative Decree 107/2023: the new rules to combat the dissemination of terrorist material on the network. An initial reading of the limits and risks to constitutional rights.
- AI-generated images: for a Chinese court they can be protected by copyright
- The legal protection of neural rights

Methods: dialectical approach to cognition of social phenomena, allowing to analyze them in historical development and functioning in the context of the totality of objective and subjective factors, which predetermined the following research methods: formal-logical and sociological.

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Results: a cross-cutting analysis was applied to the phenomenon of AI between cyber utopianism and cyber realism. Starting from a quote by Max Tegmark, the theory of artificial intelligence is reconstructed by the theorists who founded the discipline (Turing, Minsky, Bernstein, von Neumann) and it is discussed why – in light of the discoveries and assumptions of neuroscience – it is not possible to define it as intelligence according to human criteria. Three short notes are included in the appendix that complete the discussion: 1. on the consciousness of machines 2. on the theory of utopian cyber employment and remuneration 3. "The hungry judge is more cruel" (discussion on an Israeli study).

Scientific novelty: through the examination of multiple types of intelligence (Gardner) and social intelligence (Thorndike, Goleman), a more complex definition of intelligence is proposed than that which can be replicated by artificial neural networks, especially in relation to the interaction between animal and environment. Three short messages highlight the uncertainty and risks that may arise from the rampant use of artificial intelligence as judges.

Practical significance: starting from a correct definition of human intelligence, the author comes to the definition of artificial intelligence. Beyond the myth of AI, we discover its limits and the objective limitations we must provide for in order to save the most precious asset we have: mankind.

Keywords: artificial intelligence, justice, criminal law, neuroscience, computational theory

ARTIFICIAL 'EMOTIONAL' INTELLIGENCE FOR OPERA THEATRE: INNOVATING AUDIENCE ENGAGEMENT IN CONTEMPORARY SCIENCE-FICTION OPERA

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ABSTRACT
The surge in Artificial Intelligence (AI) has sparked debates about its impact on human expression and connection in the creative arts. This paper builds on my pilot study that explores how AI may complement and augment embodied dimensions of human artistic creativity in live music performance settings. It uses 'science-fiction opera' – an operatic subgenre that integrates sci-fi narratives with speculative technologies – as a pivotal case study to examine AI's potential and challenges in enhancing **audience engagement** in a digitally-mediated theatre. Leveraging opera's capacity for conveying nuanced emotions across artistic mediums, this study evaluates the dynamics of **human–machine affective and emotional interaction** (i.e., the ways in which performers or audiences engage, interact, and connect with intelligent machines) in contemporary sci-fi opera performances. By employing **critical media theories** to analyse sci-fi opera's performance designs, I aim to identify strategies that utilise AI & data-driven technologies to enable real-time, multimodal emotional exchange between the audience and on-stage action at opera events. Based on theoretical insights, I will then develop a **conceptual framework** to integrate audience-centric emotional feedback into performance settings, thereby pioneering interactive & immersive designs in an 'emotionally responsive' opera theatre.

Building on the state-of-the-art in opera studies, intermediality, digital performance, and AI ethics, this study offers interdisciplinary methodologies in exploring AI & musical creativity, advancing these fields by:

1) It develops an AI-driven opera theatre framework that meets contemporary digital cultures' demands for audience engagement and accessibility. This framework, integrating **participatory design** in multimedia arts with **intermediality theories**, pioneers AI-mediated emotional feedback mechanisms for future opera. It addresses the gap of **limited audience agency** in digital theatre studies, while transitioning the traditional art form of opera into an economically viable, increasingly AI-led future.

2) It highlights **human–artificial co-creativity** to advance AI-based opera. It synthesises traditional Humanities' ethnographical & theory-based approaches with innovative digital methods to explore AI's links with human emotions through the lens of opera. It demonstrates how 'emotion AI' and 'affective robotics' can foster new **performative processes** and enrich **creative outputs** in opera theatre, presenting

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their use in operatic settings as a novel form of **computational creativity** for the performing arts, thus highlighting the symbiosis between artificial and human creativity.

3) This study not only analyses AI's potential benefits for the performing arts, but also exemplifies **how humanistic & artistic research can deepen our understanding of AI**. The case studies probe into other forms of intelligence (e.g., emotional, sensory, creative) via sci-fi operas' experimental practices, broadening discourses in posthumanism and AI ethics that traditionally prioritise AI's 'computational intelligence' and 'scientific objectivity'. It illustrates how opera studies can uncover AI's opportunities and implications that have never been considered before.

Overall, this study will prototype new critical perspectives for using AI in enhancing audience emotional engagement, making opera more *accessible* and *desirable* for 21st-century audiences. It is a crucial step towards gathering and analysing the essential data necessary for my broader future endeavour—developing an 'opera metaverse' that *implements* the technical & artistic concepts from this study. It will also address ethical considerations to ensure that integrating technology in the arts enables us to reimagine creativity and the ethics of creative work in a progressively AI-driven society.

Keywords: science-fiction opera, audience engagement, audience agency, human–machine affective or emotional interaction, human–artificial co-creativity, artificial emotional intelligence

ETHICAL ISSUES IN THE DIGITIZATION OF INDIGENOUS COLLECTIONS: THE CASE OF VÄRLDSKULTURMUSEET

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ABSTRACT

The Swedish National Museums of World Culture (Världskulturmuseet) have recently published a report explaining the situation of the museum collection currently available on Carlotta, along with some actions they have been taking as part of decolonizing practices to enhance access to the Latin American indigenous collections. As part of these actions, the museum decided to migrate the Brazilian indigenous collections of the *WaiWai* to a new platform called *Tainacan*, a Brazilian platform created in 2014 to consider the indigenous perspective and involve their participation in describing the objects (Muñoz et al., 2022) (Martins et al. 2021). The project "Digital Repatriation of Amazonian Cultural Heritage" conducted by Lana (2022) also demonstrates the gaps in the museum's digitization project. Through collaboration with indigenous groups, the project has been working on digital repatriation. This allows these groups to have digital access to their objects and describe them according to their own perspectives.

However, materials from *WaiWais* and many other communities remain available on Carlotta, showing misrepresentation, problems with accessibility, and other metadata issues (Sundström, 2023) (Muñoz et al., 2022). Among these numerous problems, the presence of digitized collections itself presents a point to be analyzed, considering that different indigenous communities have different ways of representing and conserving their knowledge. In many cases, access is restricted or even completely prohibited, depending on the community's point of view (Morphy, 1991).

When considering cultural particularities, it is essential to understand the regulations Brazilian indigenous communities have concerning their intellectual properties regarding their own material. *The Fundação Nacional dos Povos Indígenas* (National Indigenous Peoples Foundation) is responsible for protecting the interests of indigenous people in Brazil. The organization ensures respect related to the access, reproduction, and display of indigenous artifacts in different institutions.

In Sweden, the National Strategy for Digital Cultural Heritage aims to connect cultural heritage with today's and future users, emphasizing democracy. The document highlights several benefits of digitization, such as online access and the security of materials. It also outlines guidelines that direct the digitization process. Although these documents are not the primary focus of our investigation, they offer possibilities for further analysis.

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The goal of this seed project is to engage in theoretical discussion and document analysis aimed at identifying the ethical conflicts, based on Brazilian policy statements, of displaying Brazilian indigenous material in a Swedish cultural heritage online institution. Consequently, this highlights the issues of digitization that prioritizes metadata and documents available online, while ignoring cultural specificities and ethical concerns in displaying objects from different cultures. Our central questions are: What ethical issues can be raised in digitizing indigenous material? What conflicts can be found between Swedish digitization practices and Brazilian indigenous policies?

The method used was document analysis and interviews. The documents analyzed were from the *Fundação Nacional dos Povos Indígenas* (National Foundation of Indigenous Peoples), specifically focusing on the PORTARIA n. 177/PRES, dated February 16, 2006. This document outlines rules about how "to respect indigenous peoples, the protection of their material and immaterial heritage related to image, artistic, and cultural creations." An analysis was conducted on Carlotta to identify what the digitization rules guide regarding materials from other cultures. The interviews were semi-structured and gathered information about the ongoing decolonization project, Carlotta management, and future projects related to the collections.

The main findings indicate that the *Fundação Nacional dos Povos Indígenas* also has a database of images, which display all the pictures authorized for exhibition in other institutions. To be part of the database, the images must meet all the requirements, including a set of signed contracts and regulations, as mentioned above. Regarding public information, an institution can use the images as long as they "respect the limits of privacy, honor, and intimacy of those portrayed" (PORTARIA, p. 4, translated from Portuguese). This is not the case with Carlotta, as their webpage has a warning sign informing users that they will maintain information online, even if it does not meet the requirements of the people portrayed, as they prioritize access to materials.

> "When searching our database, it is worth knowing that some people regard the information and pictures of objects and ceremonies available as sacred and hence, do not want these in the public domain. Nevertheless, it is our decision to make these available on the public domain as we feel it is important for individuals and groups to know what collections the Museums of World Culture manage" (SMVK, 2023, Carlotta. Sundström, 2023).

There is a conflict between what Brazilian regulations say and how Carlotta represents Brazilian indigenous information. However, as previously stated, it is also necessary to analyze the existing digitization policies in Sweden, to understand the origins of such practices applied in the museum. It is essential to highlight that Membrilla (2024) analyzed the guidelines for digitization and found nothing that specified indigenous materials. In the document "*Världskulturmuseerna i en digital tid,"* the institution's strategy for digitization is explained; however, no specific points related to image rights or information on conflicts of interest in different countries were identified. The interviewer stated that even after contact with the indigenous group, when they shared their worldview, the museum's documentation practices remained the same due to some administrative

challenges reported, also addressed in Sundström (2023). Membrilla (2024) also discussed this issue and referred to such practices as a colonial footprint. Based on these outdated practices in museum documentation and the lack of significant changes surrounding them, the interviewer believes that the only solution is to continue migrating to *Tainacan*.

In conclusion, we assert that access to documents through massive digitization, even when based on democratic principles, should not take precedence over the rights of minority groups, specially those from other countries with different languages, culture, and regulations. The formation of such collections carries a colonial past, and making this past available online without the necessary cultural restrictions may harm these groups by reinforcing stereotypes, which may not be a democratic decision for the portrayed groups.

The consequences of mass digitization and the colonial past can also be observed when assessing the metadata available on Carlotta. Including an assessment of terms, descriptors, and all metadata that describe the images may represent a high cost for the museum, often remaining in the background within digitization projects. However, not changing the metadata may result in many other ethical conflicts that must be investigated. For that reason, the metadata used to describe Brazilian indigenous collections will be the next step in this research, as the metadata used to represent indigenous collections needs to be created considering the particularities of a community, as the literature review showed Sundström (2023).

Keywords: Digitization, Brazilian indigenous collections, Swedish National Museums of World Culture

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DIGITAL EXCAVATIONS: TEXT MINING APPROACHES FOR A BETTER ARCHAEOLOGY

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ABSTRACT
Archaeology and associated disciplines from the social sciences stands much to gain from collaboration with experts in the digital humanities. Likewise, digital technologies and experts in computer science are able to benefit through their association with disciplines like archaeology, as these collaborations lead to the asking of diverse questions, thereby encouraging technological innovation. In recognition of this, the preliminary stages of our work together have focused on identifying a number of exciting research areas that will directly benefit from such a cross-disciplinary collaboration, guided by our key overarching research question: how can the application of digital methodologies within archaeology facilitate research that encourages a more critical understanding of the past? In this paper, we will discuss the further research questions our collaboration has targeted, the methods we have used, and how these research initiatives have the potential to impact widely beyond our individual disciplines.

Recent research within archaeology has identified the need to use techniques like text mining to improve our knowledge of the history of archaeology as a discipline and uncover the ways nationalist discourse developed and remains influential (Plets et al. 2021). Our collaboration targets a significant body of published works of *Antiquity*, a journal of world archaeology that has been publishing continuously since 1927, with circa. 7000 articles in its records. The corpus of Antiquity comprises a substantial record of the development of archaeological discourse and is ideal for a historiographical study. We will present the initial results of a data-driven discourse analysis on how archaeological thought has evolved, specifically regarding concepts of ethnic and cultural identity of peoples in the past, drawing on a detailed analysis of term frequency and word concordancing. We also explore increasing diversity of

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geographic areas of focus over a period of 1920 until 2020; e.g. what is meant by 'World Archaeology'? Which regions are actually being studied, and how does this change over time?

The history of archaeological research has implications beyond academic interest. Archaeology as a discipline has been intimately tied with the nation-state since its origins in the late nineteenth and early twentieth centuries; archaeology both creates and sustains the nation, providing material evidence to support established national narratives and to facilitate the creation of new ones as required by socio-political circumstances. Although there have been a number of critical responses to this relationship, especially over the past three decades, as Plets *et al* (and others) argue, uncritical nationalist dialogue remains embedded in a significant portion of archaeological discourse. Our contribution to the history of archaeology not only reveals the results of our analysis of the development and continued prevalence of banal nationalism within archaeological publications but also demonstrates the value of such cross-disciplinary collaborations and highlights the unique expertise at Linnaeus University, in collaboration with Utrecht and Durham, that has led to this project.

The potential impact within archaeology will be considerable, especially if we are able to transform our results into pedagogical and research tools such as an interactive database or discourse maps. Archaeological research ranges widely both geographically and temporally, and the discipline currently lacks resources which enable the visualization of the history of archaeological thought in the twentieth and twenty-first centuries. We have the ability to deliver these tools, and through our planned collaboration we can achieve a much better understanding of the continued impact of nationalistic thought on our perception of the past.

Keywords: archaeology, text mining, nationalism, discourse analysis

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RE-EXAMINING THE DESIGN OF ONLINE DOCUMENTATION: PLATFORM FOR DISPLACED OBJECTS

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ABSTRACT
There has been exacerbated discussions in recent years about the future of objects that were obtained from other cultures under contexts of disempowerments in history. While digital technologies are being increasingly used as interim measures of display for virtual restoration, potential improvements on the narratives been adopted in telling the cultural representations and values of this group of objects deserves meticulous examination. Although technically digital documentation systems ensure a spectrum of object information from multiple sources can be captured, entered into the database and provide the public with online access to the objects data, the sociotechnical nature of their underlaying data schemes constrains them from traversing a single ontology. This creates potential hindrances in reclaiming a more comprehensive cultural identity of the displaced object. Under such context, this presentation focuses on exploring the potential of adopting biographical approach to create digital online documentation platform to exhibit displaced objects more dialogically, in ways that extend the debates on virtual repatriation and restoration. This research employs qualitative methods including semi-structured interviews, observations, and archival studies to collect contextual information about the object's social life to create its biography and to better understand the collection management system adopted by the museum that shaped the narration of the object's story online.

This presentation is based on my research that examined how information of a piece of mural fragment, originally from China, is currently depicted on the V&A 's website. My findings suggest that narratives shaped around the object is confined by the museum's overall mission, its database structure and the limited object records it possessed. This limitation is further evidenced when comparing with how the custodian agency of the heritage site where the object originated collect, manage and preserve data about the fragment driven by a different intention of "bringing the object home" as the nation's cultural heritage. The lack of detailed information of the object's provenance and the different intention of managing and displaying the fragment's information prevented the presentation of alternative versions of the object's identity. This makes it hard to read the fragment's meanings and values from multiple cultural perspectives and to retrieve the object's multi-layered cultural identities accumulated throughout its social life.

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Facing this conundrum, I will examine how the approach of creating object biography informs the construction and evaluation of a more culturally inclusive online database. I will illustrate the polysemic nature of displaced object by highlighting the cultural representations of the same historical object as well as its diasporic journey are portrayed differently from different perspectives. Guided by an aim to restore the object's social life, a platform whose design complies with this approach would empower voices from various agents that played a key role in shaping the object 's identity and value. I will demonstrate the effectiveness of the conceptual design of such platform is evidenced by its ability to support the creation of culturally inclusive online platforms that allow different taxonomies and interpretations of an object to be exposed in parallel, while making transparent the multiple cultural and knowledge structures within which these interpretations and taxonomies are embedded. Adopting this design mindset to evaluate the effectiveness of current platforms in enriching and enhancing the accessibility of displaced object data, I will also briefly analyze the contents of two existing online platforms-- the Digital Benin and the Reciprocal Research Network that function as online data repositories and as facilitators of communication between the communities of origin and the holding institutions. By reviewing these two cases, the presentation would reach a conclusion that the online databases that cover the objects' biographical information can contribute to the enrichment of the displaced object's cultural representations. It does so by allowing different taxonomies and interpretations of the object to be exposed in parallel, while making transparent the multiple cultural and knowledge structures within which they are embedded.

The major contribution of this research is that it enriches our understandings of the social affordances of digital technology in addressing the under/misrepresentation of the originating culture, the past conflicts and power-imbalances between nations. On the one hand, by unpacking the predigital world as a social construct, the research foregrounds a different motive to utilize the object to connect narrators from different cultures by initiating their intercultural dialogues about the value of the object and its life story. On the other hand, I explore the capacity of digital technology to construct ideal environments for the exchange of views that emplace the displaced object within diverse socio-historical contexts and knowledge management schemes. This would make it possible to encode multi-layered meanings and values to the object, to connect the museum professionals with the originating culture across time and space, and to extend their imagination of the object within relational cultural and knowledge frameworks.

Keywords: object interpretation, digital documentation, object biography, displaced object, cultural inclusion

WORK EXPERIENCES AND TRAINING NEEDS IN THE IMPLEMENTATION OF DIGITAL CHAT-BASED CARE ASSESSMENTS IN PRIMARY CARE

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ABSTRACT
The digital transformation of society affects healthcare to the greatest extent. Despite the increasing knowledge on implementation of telemedicine in healthcare systems, the current state of research on text-based care assessments conducted by nurses in primary care is naught. To ensure smooth transition and adoption of this new working method, it is essential to map out nurses´ working experiences and training needs. Currently the training of future clinicians on the use of telemedicine is only in its earliest stages. Proper educational training for nurses is essential to empower them with telemedicine knowledge and hands-on skills, so that they can be a creative force for innovations within their practice. Hence, this study aims to describe nurses´ training and working experiences with text-based care assessments in primary care.

Qualitative study design using semi structured in-depth interviews was conducted among seven health professionals (nurses and pharmacist) from four different regions in Southeast Sweden. Data was inductively analyzed using reflexive thematic analysis.

Three preliminary themes were generated to describe nurses training and working experiences with text-based care assessments, namely Learning the art of digital interaction, Prolonged assessment process, and Anticipated facilitating features in the system. According to the participants the conversational process in the chat can be difficult to work with. It can also inhibit the creation of therapeutic relationship with the patient. The training in chat technique was expressed to be well needed skill for creating a clarity in the conversation and obtaining an accurate anamnesis in a timely manner. Overall, conduction of text-based care assessments was associated with prolonged care assessments process. Difficulties in conducting a good medical

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assessment was mostly due to fact that text-based conversations were more prone to misinterpretation and misunderstanding. Hence informing, confirming, and summarizing were seen as good chat practices which facilitated effective communication. Nevertheless, prolonged care assessment had also some benefits, such as it enabled clinicians to think through their answers and consult with colleagues, which can lead to more thorough medical assessment. Other positive aspects of this new working method included the availability of chat history, the ability to send information links in the chat, varying work environment and professional development. Lastly, anticipated facilitating features in the system including auto anamnesis and auto triage can be enhanced to better meet nurses´ needs.

The findings of this study may offer insights for global community, health professionals, technology designers, and policy makers to better understand nurses´ text-based encounters with care seekers in their everyday practice. This study also reveals opportunities for appropriate educational design for clinicians working with telemedicine. The participants appreciated a chance to practice non-technical skills such as chat technique and effective communication before clinical practice. Development of soft skills such as interpersonal skills and empathy can be critical to master the person-centered communication in text based medical assessments among nurses. Hence combination of different forms of education techniques including self-reflection approaches can benefit nurses´ provision of patient-centered care in telemedicine. Since all respondents in current study were female, further research may aim to include male´s perspectives on text-based care assessments.

Keywords: nurse, person-centered care, primary care, telemedicine, thematic analysis, text-based care assessments

AI-SUPPORTED METHODS FOR ANALYSIS OF UNSTRUCTURED TEXT RESPONSES IN PATIENT SURVEYS IN PRIMARY HEALTHCARE

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ABSTRACT

Health data is essential for the digital transformation in healthcare services to happen. Health data informs policymakers and practitioners and provide evidence for reform processes and organizational development. Even though our health systems produce large amount of data, usage is often limited by a lack of access to appropriate analytical tools or skills needed to appropriately assess and interpret complex health data. The national patient survey (NPE) in Sweden collects approximately 100 000 responses annually from patients visiting primary healthcare facilities. The last question in the survey is an open-ended free text question allowing patient to describe their experiences with the health services in their own words. Despite the fact that these unstructured text responses have been regularly collected since 2017 no systematic analysis has been conducted to explore and understand patterns of sentiments among the patients or the content of these responses at aggregate level. This lack of analysis is unfortunate, as these responses are likely to contain valuable feedback for understanding health care seeking behavior among the population and efficiency challenges in service delivery.

The overall goal with this research project is to use artificial intelligence (AI) technology to analyze the unstructured text responses from the free-text question in NPE. This data, provided by patients in primary healthcare over the course of the past seven years, has so far never systematically been analyzed. The aim is to test and develop a tool for analysis which can be used to improve service delivery and provide access to a large dataset for further research.

The research questions:

i. How can advanced AI-based analytical tools and techniques be leveraged to systematically analyze unstructured text responses from NPE data?

ii. What aspects and sentiments are identified in unstructured text responses in the NPE and how are these changing over time?

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Methods

Aspect-based sentiment analysis (ABSA) will be employed to analyze the data. Specifically, it involves (i) identifying the various aspects mentioned by patients in their responses (such as staff behavior, waiting time, etc.) and (ii) assessing the sentiments expressed towards these aspects. For example, expressing dissatisfaction with the waiting time or being happy about treatment by the staff. Unlike standard sentiment analysis, which only classifies overall sentiment, aspect-based sentiment analysis identifies sentiment directed toward specific entities, topics, or aspects within the text.

After completing the textual analysis, temporal changes in opinions regarding various aspects will be examined. To accomplish this, we will employ statistical methods and visual analytics. By harnessing advanced natural language processing techniques alongside statistical methods, we aim to understand patterns and changes in patients' experiences and perceptions of healthcare services.

Findings

So far in our project we have carried out two national surveys aimed at the users of the results from the NPE. The first group of users (n=18) is a sample of operational staff managing NPE and the results from NPE at the central level in each of the 21 Regions. The second group of users is a sample of managers at operational level for example a health center or a clinic (n=51) in five of the 21 Regions. The findings indicate a lack of appropriate tools to analyze the free-text responses, that there is no systematic analysis of the results, and 45 percent of the respondents report that they have never used the results from the free-text question for organizational development or improvement.

Research implication

By developing an AI tool for text analysis of open-ended free text patient responses, a systematic analysis of this data can be carried out benefiting both policymakers and practitioners in health care services. An AI tool could also create opportunities for additional research opening an important dataset for a larger group of researchers to look at. Areas of interest could for example include differences in patterns of sentiment depending on geographical area or socio-economic indicators among the respondents.

Keywords: AI technology, sentiment analysis, opinion mining, primary healthcare, service delivery

HEALTH INEQUALITIES AND DIGITAL TOOLS: A QUALITATIVE STUDY IN KRONOBERG REGION[1]

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ABSTRACT
Health inequalities persist as a significant societal problem [1]. The COVID-19 pandemic highlighted their impact on morbidity and mortality. Health inequalities arise from various factors, including social determinants of health [2]. Mitigating these inequalities is crucial to improve human health and align with the UN Sustainable Development Goal 3.

The rapid adoption of digital technologies is helping health care services to enhance efficiency, reduce costs, and make data-driven decisions, however, it has also unintended consequence and has been reported to result in new kind of inequities [5]. Previous findings emphasize the digital divide of vulnerable groups and the need to increase their digital inclusion to improve their access to healthcare and guarantee their right to health [3].

In Sweden, health inequalities not only persist but have increased in some regions [4]. Sweden's 21 regions and 290 municipalities are responsible for providing health and welfare services. In 2018, the Swedish Parliament enacted a new national public health policy that aims to abolish avoidable health inequalities. The policy sets out specific targets and emphasizes that public health is a shared responsibility of all, at all levels, including academic researchers and practitioners in the field.

In 2021, the Public Health Agency, *Folkhälsomyndigheten*, presented a framework which implies coordinated efforts at national and regional levels to realize the new health policy. In line with the Public Health Agency's idea of coordinated effort, a transdisciplinary team of researchers with expertise in *health, social, computing*, and *information* sciences has been formed to develop a study in the Kronoberg Region, with the aim of exploring the factors, barriers, and other such elements that lead to health inequalities in the region and the use of digital tools in the provision of primary healthcare services.

[1] Study developed in the framework of the Seed Project "Mitigating health inequalities in the Kronoberg Region: A transdisciplinary System Thinking approach"

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To that end, we used a qualitative inductive design. To align with limited resources we restricted the scope to the Araby area in the city of Växjö, which is considered by the Municipality as one of the priority areas for its socio-economic challenges [6]. We conducted nine semi-structured interviews with stakeholders from Region Kronoberg, primary healthcare professionals and organizations supporting vulnerable people in the selected area, to get their perspectives and experiences towards health inequalities and the use of digital tools. The interviews specifically focused on identifying the factors leading to health inequalities in the region, exploring the use of digital tools in the primary healthcare services and understand the strengths and challenges in their implementation. We also investigated stakeholders' requirements and needs in relation to the mitigation of health inequalities. The interview data is analyzed using manifest content analysis.

Preliminary findings of the analysis are as follows. Language and cultural barriers and lack of knowledge about the health system represent the main factors leading to challenges in the access to primary health care services. Elderly people and people with different ethnic background (mostly immigrants) represent the most vulnerable groups for health inequalities. They also suffer from digital divide and require both health and digital literacy for use of digital solutions. The Poor layout and design of digital solutions (e.g. 1177 web and app) that contains a consistent amount of health information and offer health services, negatively impact user experience, satisfaction, and trust towards the healthcare services. Regardless of such challenges, a large majority of interviewees also appreciated the advantages of using digital solutions in healthcare and suggested improvements to address the specific needs and challenges of vulnerable groups.

The results of this study are largely in favor of use of digital tools in agreement with the findings reported by WHO [3]. This study suggests further research on solutions to improve digital tools' usability and vulnerable groups' digital literacy. Moreover, it will be used to provide recommendations for how existing digital solutions can be better addressed to eliminate avoidable and mitigate types of health inequalities.

Keywords: health inequalities, health inequities, digital tools, digital divide, Sweden

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ADVANCEMENTS IN EEG ANALYSIS FOR ENHANCED DIAGNOSIS AND TREATMENT OF EPILEPSY: A COMPREHENSIVE PLATFORM APPROACH

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ABSTRACT
The diagnosis and treatment of epilepsy, a complex neurological disorder affecting millions worldwide, has undergone significant advancements with the integration of cutting-edge technology and innovative methodologies. Electroencephalography (EEG) stands as a cornerstone in this domain, offering invaluable insights into brain activity and facilitating the identification of epileptic patterns. This abstract delves into the multifaceted landscape of epilepsy management, focusing on the development and implementation of a Comprehensive Platform for Visualizing and Analyzing Electroencephalograms (EEG).

From a clinical perspective, EEG is indispensable in diagnosing neurological disorders, particularly epilepsy. Specific patterns in EEG signals can indicate epileptic activity and help determine its type and origin. Additionally, EEG is fundamental in sleep disorder research, offering valuable insights into different sleep phases and their possible disturbances. In patients in comatose or altered consciousness states, this technique provides crucial data regarding brain activity levels (Apicella, Isgrò, Pollastro, & Prevete, 2023).

In research, EEG is an essential tool for analyzing how the brain processes information and responds to different stimuli. The study of brain waves during various cognitive tasks and mental states provides key insights into understanding processes such as cognition, emotion, and consciousness. Frequency and amplitude parameters of brain waves are crucial in EEG analysis, enabling physicians and neuroscientists to identify specific patterns associated with various neurological conditions, such as epilepsy, where spikes and sharp waves are key diagnostic markers. In the emerging field of brain-computer interfaces (BCI), detailed analysis of brain wave frequency and amplitude opens new possibilities for developing communication and control systems based on brain activity. Understanding these parameters is vital not only for clinical diagnosis and neurological research but also for advancing innovative technologies that seek to integrate brain activity with external devices more effectively (García-Hernández et al., 2023).

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Epilepsy is a complex neurological disorder affecting millions of people worldwide, manifesting in a wide range of forms and severities. Characterized by a predisposition to recurrent seizures, this condition results from abnormal and excessive electrical activity in groups of brain cells, triggering various physical and cognitive symptoms. Triggers include brain injuries, infections, tumors, genetic anomalies, and other neurological diseases. The episodic and unpredictable nature of seizures poses a significant challenge for those affected (Fisher et al., 2014).

Pre-diagnosis algorithms for detecting and classifying epilepsy using EEG have become fundamental tools in neurology, especially with the advent of advanced signal processing and machine learning techniques. These algorithms not only promise faster and more accurate diagnoses but also facilitate a deeper understanding of the complexity of neurological disorders like epilepsy.

The Discrete Wavelet Transform (DWT) is a powerful and versatile technique employed in signal and image processing, established as a standard tool for analyzing non-stationary signals across various research and industrial disciplines. DWT offers a multi-resolution representation of a signal, allowing its decomposition into components of different frequencies, each temporally localized (Murungi, Pham, Dai, & Qu, 2023).

Pre-diagnosis using EEG is a diagnostic tool for early detection of epilepsy, leveraging abnormal patterns in brain electrical activity to identify potential disorders. This preliminary phase is crucial for deciding whether deeper analysis or treatment options are needed. This is especially vital in epilepsy, where EEG is essential for early detection of abnormalities such as spikes and generalized discharges, pinpointing the origin of seizures, and differentiating between different types of epilepsy, thereby facilitating appropriate treatment selection and clinical management.

Pre-diagnosis helps identify possible cognitive deficiencies associated with epilepsy, brain wave behaviors to detect epileptiform spikes, and determine the need for a more detailed and specific evaluation. This can help professionals design an appropriate intervention plan to address the individual's needs.

The proposed solution is a Comprehensive EEG Visualization and Analysis System, focused on improving classification capabilities in neurology and psychology through advanced technology for EEG analysis and visualization. By combining data analysis, processing infrastructure, and visualization tools, the proposed system addresses current limitations in EEG analysis and establishes an intuitive and robust platform for future research and advances in diagnosing and treating neurological conditions.

The objective is to integrate and apply an algorithm in the web application to process EEG signals and extract relevant features. These features will be used to classify brain activity in terms of adverse elements present in the signal. Specifically, the aim is to classify brain activity into five distinct categories: epileptiform spikes, periodic

lateralized discharges, generalized periodic discharges, lateralized rhythmic delta activity, and generalized rhythmic delta activity.

The ultimate purpose of this classification is to assist physicians in evaluating the effectiveness of therapies applied to their epilepsy patients and to improve the ability to pre-diagnose the patient's condition. The platform implements data analysis techniques to evaluate signals collected by EEG nodes. This approach will enable the detection of epileptiform spikes, providing professionals with reliable pre-diagnosis based on objective data and recognizable patterns. The combination of these technologies provides a complete and cohesive ecosystem for developing prediagnosis systems. From data collection and processing to visualization and user interaction, each component has been selected to optimize the system's performance, scalability, and efficiency. This architecture not only handles large volumes of data and performs complex analyses efficiently but also ensures a smooth and modern user experience, making it an excellent choice for big data analysis projects.

In conclusion, this software development and applied research project highlights the transformative potential of the Comprehensive EEG Visualization and Analysis Platform in advancing the pre-diagnosis and treatment of epilepsy. By integrating cutting-edge technology with clinical expertise, this platform, developed as a final project for the Computer Systems Engineering degree at the University of Monterrey, represents a significant step forward in improving pre-diagnosis outcomes for epilepsy patients and advancing neurological research.

Keywords: eHealth, EGG, Analytics, ML, Cloud, Processing Epilepsy

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DIGITAL SOLUTIONS TO MITIGATE HEALTH INEQUALITIES – PRELIMINARY RESULTS OF A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Health inequalities refer to *differences, variations, and disparities in the health achievements of individuals and groups* [1]. These disparities are influenced by various social, economic, and environmental determinants, and manifest as differences in health status, life expectancy, and access to healthcare services. Addressing health inequalities is a global problem. In the European Union (EU), health inequalities cost approximately one trillion euro (9.4% of EU GDP) per year [2].

Public health in Sweden, one of the key EU nations, is highly ranked. However, health disparities and inequities in social determinants persist [3]. Swedish Parliament introduced a new national public health policy in 2018 to eliminate avoidable health inequalities. To implement the policy, the Public Health Agency of Sweden (Folkhälsomyndigheten) proposed a framework, The framework requires coordinated efforts at all levels, regional and national, involving researchers and practitioners in the field. To support realization of the framework, researchers at Linnaeus University, with expertise in social, health, computing and information sciences, formed a transdisciplinary team. The team aims to investigate use of digital solutions to address the problem of health inequalities. They tasked the first two authors of this abstract, under the supervision of the third author, to do a Systematic Literature Review (SLR).

The SLR aims to identify *what has been already reported and should be considered* for the design and development of the digital solution(s). More specifically, the SLR targets following three research questions: *RQ1) What are the various factors, barriers, or other such elements that lead to health inequalities? RQ2) What digital solutions have been reported in the literature to mitigate health inequalities? RQ3) What are the trends in last 5 year for the use of digital solutions to mitigate health inequalities?* For all the three questions, we limited the scope of our search to countries of EU, EEA, United Kingdom, and Switzerland. These countries were selected based on their proximity to Sweden and other EU nations.

The SLR was conducted in accordance with PRISMA [4] and guidelines given by Kitchenham et al. [5]. We defined a review protocol document, available online[1], to

[1] https://lnu.box.com/s/5ktlfepvd6zycarogv3tuqnd8tcq20tp

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systematically guide and perform the review process. The protocol document specifies the goals, research questions (RQs), and strategies for performing the search, extracting and analyzing data, and report findings of the SLR. The goals and RQs are already specified above. The search strategy is mainly based on automatic search combined with manual search and snowballing. The automatic search was performed using PubMed [2]and Scopus [3]search tools with inclusion of studies written in English between 2020 and 2024. For this, we defined two search strings (SS), SS1 for the RQ1 and SS2 for the RQ2 and RQ3; both search strings are documented in the review protocol. Both search strings were tested for their accuracy and precision using quasi-gold standard method [6]. Execution of the search strings on PubMed and Scopus jointly resulted in 700 studies for SS1 and 756 studies for SS2.

We conducted a manual review of automatically searched studies using inclusion and exclusion criteria to eliminate irrelevant ones. The filtering process was done in two steps: first by reading titles and abstracts, and then by reading the full articles. After the first step, we identified 129 studies for RQ1, and 83 studies for RQ2 and RQ3. Following the second step, these numbers were further reduced to 32 for RQ1, and 17 for RQ2 and RQ3. In total, we selected 49 primary studies for analysis. We plan to use mixed analysis methods, primarily qualitative content analysis, to analyze the data from these primary studies and answer the research questions.

The analysis is ongoing, with preliminary results available. For RQ1, initial findings suggest that health inequalities are driven by factors such as unequal social, economic, and environmental conditions (social determinants of health), age, gender, ethnicity, migration, geographical locations, and systems and forces shaping life conditions, including political systems, economic policies, development agendas, and social norms. For RQ2, the main digital solutions identified to address health inequalities include eHealth, mHealth, Telehealth, Telemedicine, Artificial Intelligence, Big Data, and Digital Health Literacy programs. The analysis for RQ3 is not yet complete, but it is expected that mobile phone applications and other telecommunication-based digital solutions, along with Big Data-based AI and machine learning solutions, will be more prevalent and widely reported.

Designing digital tools and solutions to enhance health equality require to carefully consider challenges, for instance digital divide and digital health literacy. Our conjecture is that complete results of the review, which we plan to publish as future work, will be helpful to design new or extend exiting digital solutions that are easy to access, understand, and use by all, including elderly and people with special needs.

Keywords: health, health inequalities, digital, digital solutions, digital transformation, socioeconomic factors, digital divide, systematic review.

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MOBILE HOMECARE TEAMS – HOW TO LEAD AND ORGANIZE?

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ABSTRACT
The societal development of an ageing population in Sweden poses significant challenges to maintaining high-quality healthcare. As the population ages, there is an increased incidence of multiple illnesses, necessitating increased medical and health-promoting interventions without a corresponding growth of resources. These health conditions require comprehensive and continuous care, which places significant challenges on existing healthcare systems which are already stretched thin.

To meet these challenges the ambition is to transform the healthcare structure to what is defined as person-centered and integrated care. This concept emphasizes the importance of bringing healthcare services closer to where patients live. This not only enhances accessibility, but also ensures that care is more personalized and responsive to the immediate needs of patients.

Home care allows patients to remain in a familiar and comfortable environment, which can significantly improve their quality of life. It also enables them to maintain a higher degree of independence and control over their daily lives. People who are cared for at home are often more satisfied and experience greater well-being compared to those who are cared for in hospitals. By shifting the locus of care from hospitals to community settings or patients' homes, there are expectations to improve patient satisfaction and quality of life.

However, conducting assessments of the condition of older patients in a home setting is challenging. It requires healthcare workers to make accurate and timely decisions based on limited information and often without the immediate support of a hospital infrastructure.

To succeed in this shift in the locus of care, there are expectations for the digital transformation of healthcare and the implementation of e-health solutions to improve healthcare for providers and patients. Digital transformation involves the integration of digital technologies into all areas of healthcare, fundamentally changing how care is delivered and managed. E-health solutions, such as telemedicine, electronic health records, collaboration tools, and mobile health

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applications, can streamline processes, improve communication, and enhance the quality of care.

One core challenge is when healthcare that is traditionally performed in hospitals is moved to patients' homes, more advanced care must also move out. This care must be performed by medically competent personnel who can handle the complexities of home care. Following this, when personnel to a varying extent move out, the conditions for leading this personnel group change. Hence, leadership in this context involves managing remote teams, ensuring quality and consistency of care, and providing ongoing training and support for dispersed team members.

The project's purpose was to develop strategies and guidelines for the operational management and governance of digital transformation. This facilitated person-centered and integrated care for those in need, using mobile teams supported by digital tools in their work. By leveraging technology, there were expectations to improve the efficiency and effectiveness of home care, ensuring that patients received the right care at the right time.

The study was designed as a qualitative case study in two organizations, Vårdbolaget Tiohundra and Region Kronoberg, and performed by two research partners, Linnaeus University and Lund University. The empirical data collection consisted of in total five workshops with stakeholders from both Vårdbolaget Tiohundra and Region Kronoberg. Two one-hour rich picture workshops with stakeholders from Region Kronoberg such as managers, physicians and ambulance staff plus one one-hour rich picture workshops with an experienced home health care team from Vårdbolaget Tiohundra, all three workshops with the aim of creating a problematization of mobile home care. Followed by document studies of guidelines and policy documents and 17 qualitative semi structured interviews guided by themes from the rich picture workshops and policy documents. The duration of the was interviews approximately 50-60 minutes, all recorded, transcribed and uploaded to a team based QDA-tool. Data was analyzed through qualitative data analysis based on the organization's problems and possible solutions, as well as various theoretical perspectives and current research. After the analysis of workshops and interviews one workshop each was held with Vårdbolaget Tiohundra and Region Kronoberg to present, validate and challenge the findings. These two workshops were used as a member check and filter when doing the last round of analysis of the empirical data.

The findings showed that the core issue at hand is that the care of the older and frail patients cuts across organizational boundaries in the health care system. Challenges were identified in the form of different views on what good and integrated care means among actors in different organizational units. Another significant challenge was deficiencies in accessibility and communication between the actors. To meet these challenges, guidelines have been drawn up based on the specific conditions of the owners of the needs.

The collaboration of multiple stakeholders is considered crucial for success. Collaborative care models, where different healthcare professionals work together as a team, have been shown in prior studies and confirmed in this study, to improve patient outcomes and satisfaction. These models require robust systems for communication, coordination, and management to ensure that all team members are aligned and working towards common goals.

The findings from the study reveal that coordination of activities as well as self-managing and autonomous work teams were identified as success factors for the governance and management of mobile teams in home healthcare. This was possible by A; a thorough operationalization of the vision of "person-centered and integrated care" into measurable objectives that can be anchored jointly by the actors involved in the care of the elderly and frail patient, B; improved accessibility and communication between the actors and improved communication between digital information systems, and C: self-organizing and autonomous mobile teams.

Expected effects: A self-organizing and flexible adaptable organization with clear strategies and improved communication between organizational units.

Keywords: person-centered and integrated care, mobile home care team, eHealth