The Importance of Digital and Computer Science Education in Primary Schools: Perspectives from Educators

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Abstract: Education is at a crossroads, where traditional methods meet the growing demand for innovation in teaching. As the nature of knowledge and skills evolves, educators are challenged to rethink how foundational subjects are taught and how emerging competencies are introduced to young learners. This study examines the integration of computer science and digital education in Austrian primary schools, identifying the main obstacles, relevant topics as well as teachers' professional development requirements. Data was collected through a survey distributed to 202 teachers who participated with their pupils in a creative, unplugged circus workshop at the COOL Lab, Johannes Kepler University's innovative teaching laboratory for all ages specializing in computer science and digital education. The survey included both qualitative and quantitative components to gain in-depth understanding. The results indicate a significant gap between the implementation of computer science and digital education as well as teachers' confidence in these areas. Key barriers affecting the implementation of these topics include lack of resources and time, limited teacher knowledge and confidence as well as the prioritization of core subjects. The findings of this study highlight the need for targeted professional development and increased support to effectively integrate digital and computing literacy into primary education.

1 INTRODUCTION

The rapid digitalization of our daily lives has made digital literacy essential for individuals to actively participate in modern societies. Globally, there has been a concerted push to integrate digital literacy and computer science education into school curricula, with the aim of equipping young learners with the tools they need to thrive in a technology-driven future. The European Commission's Digital Education Action Plan (2021–2027) underscores this urgency by emphasizing the need to prepare learners for a digital economy and to achieve EU-wide digital literacy targets, such as ensuring that at least 80% of the population has basic digital skills by 2030 (Eurydice, 2022). Starting digital education and computer science at the primary level offers an opportunity to foster computational thinking, problem solving abilities, and digital literacy early in life. These skills not only lay the foundation for academic and professional success, but also empower children to become informed and engaged citizens. The value of introducing computer science at this stage is further highlighted by research that links early exposure to programming and digital concepts with enhanced cognitive abilities such as reasoning, creativity, and metacognition. However, the integration of digital and computer science education into primary school curricula remains uneven across Europe. While some countries, such as Greece and Poland, have long recognized computer science as a compulsory subject, others have yet to adopt systematic approaches to teaching this discipline. Challenges such as lack of teacher training, insufficient resources, and competing curricular priorities often hinder progress (Eurydice, 2022). This study aims to address these gaps by investigating the integration of computer science and digital education in Austrian primary schools. Specifically, it seeks to identify key barriers to implementation, relevant topics for early learners, and the professional development needs for teachers. Through a mixed-methods survey involving 202 teachers who participated in a creative, unplugged workshop at the COOL Lab, the research

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provides insights into the current state of digital education in Austrian primary schools and offers recommendations for improvement. The significance of this research lies in its potential to inform policy and practice, contributing to the advancement of primary education in Austria. By addressing existing challenges and highlighting effective strategies, this study supports the broader European vision of fostering high quality, inclusive, and effective digital education from the earliest stages of learning.

The paper is organized as follows: After the introduction, the background chapter provides an overview of the global and European context for digital education and computer science in schools. The methodology section describes the research design, participants, data collection, and analysis methods. The findings section presents the key results, followed by a discussion of their implications in relation to existing literature and practice. Finally, the paper concludes with a summary of key insights, limitations, and directions for future research.

2 THEORETICAL FRAMEWORK

In response to the accelerated global digitalization driven by the COVID-19 pandemic, the European Commission launched the "Digital Education Action Plan (DEAP)" in September 2020. This strategic initiative is founded upon two pillars: the enhancement digital infrastructure and the provision of essential equipment, and the advancement of digital education content, with a particular emphasis on equipping learners with emerging technological skills. The overarching objective is to align educational systems with the rapid pace of digital transformation in the modern world (Kask and Feller, 2021).

In the majority of European school systems, digital competence education starts at the primary school level (ISCED level 1), with 21 systems initiating this instruction as early as grade one. In some countries, such as the Czech Republic and Bulgaria, this starts at a later stage, typically around grades three or four. In a few nations, the introduction of digital education is postponed until lower secondary school (ISCED level 24), with Croatia and Romania introducing it in grade five and Cyprus, Malta, and Albania in grade seven. Approaches to teaching digital competence vary. It can be integrated across all subjects, taught as a standalone course (mandatory or optional), or embedded within other subject curricula (see Figure 1).

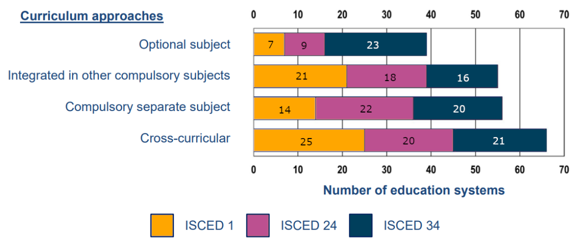

Figure 1: Curriculum approaches to teaching digital competence (EACEA, 2023) (adapted by the authors).

2.1 Digital Education and Computer Science in Primary Schools

Digital education and computer science are related but distinct fields that are very important in education today. Digital education, on the one hand, focuses on the use of digital tools, media and technologies to support the teaching and learning process. A core element of digital education is the set of digital competencies, as outlined in the DigComp framework. These skills are essential for individuals to use digital technologies effectively and responsibly in educational, professional, and personal settings.

The latest DigComp model, DigiComp 2.2, includes five main areas: (1) information and data literacy, (2) communication and collaboration, (3) digital content creation, (4) safety, and (5) problem solving (European Commission, 2022). By addressing these dimensions, digital education aims to equip students with the skills they need to thrive in an increasingly digital world.

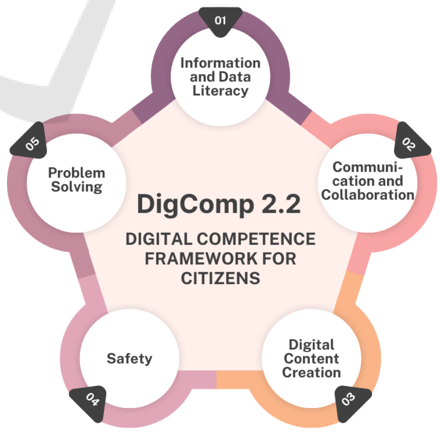

Figure 2: Digital Competence Framework for Citizens (European Commission, 2022) (adapted by the authors).

As defined in the European Eurydice report, computer science education is the discipline that shapes the digital landscape and encompasses the fundamental principles of "computational structures, processes, artifacts and systems, and their software designs, applications and impact on society." From a comparative analysis of informatics education in Europe, ten critical areas have been identified: (1) data and information, (2) algorithms, (3) programming, (4) computing systems, (5) networks, (6) people-system interface, (7) design and development, (8) modelling and simulation, (9) awareness and empowerment, and (10) safety and security (Eurydice, 2022).

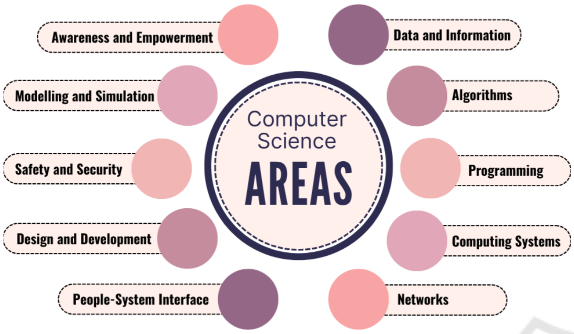

Figure 3: Crucial Computer Science Areas identified by Eurydice (Eurydice, 2022) (adapted by the authors).

In summary, while computer science emphasizes the teaching of basic computing concepts (Brinda, 2018) and centers learning on the technology itself (Flerlage et al., 2023), digital education focuses on developing the ability to interact effectively with technology and use it to enhance teaching and learning (Sadiku et al., 2017).

To prepare students for a technology-driven world, early exposure to both, computer science and digital literacy is essential. Research shows that computer science education in K-12 settings not only improves computational thinking abilities, creativity and critical thinking (Lee et al., 2022), but also addresses disparities in exposure between genders (Webb et al., 2017; Prottsman, 2014). Furthermore, early exposure to computer science helps reduce performance gaps and improves perceptions of the discipline (El-Hamamsy et al., 2023). Research has also shown that the integration of computer science education into other subjects increases students' enthusiasm, active involvement, and curiosity about the content (Lee et al., 2022).

The benefits of early exposure to computer science are mirrored in Austria's ongoing commitment to refine its educational policies and integrate digital literacy across all levels of schooling.

In Austria, computer science education has a long tradition, beginning with its introduction in 1985 for students in 9^{th} grade for two hours per week (Reiter, 2005). Another significant development was the introduction of the subject "Digital Education" (German: Digitale Grundbildung) in lower secondary schools in 2018 (Bundesministerium, 2018). In primary education, digital literacy is integrated into the curriculum as an overarching theme. With the introduction of a new curriculum for primary schools in the 2023/24 academic year, the use of digital media and devices has been integrated into overarching didactic principles. Although computer science and digital education are not separate subjects, they are treated as an overarching theme throughout the curriculum. The curriculum includes thirteen such themes, two of which are computer science education (German: Informatische Bildung) and media education (German: Medienbildung). These themes are to be addressed and implemented in designated subjects rather than in isolated lessons (Bundesministerium, 2024). Moreover, "Education Innovation Studios" have been established at university colleges for teacher education in all federal states and in 100 primary schools. Here, children acquire a playful understanding of robotics and coding. Guided by the motto "Learning to think. Problem-solving", programs and projects are designed to help students in primary schools build their digital literacy (BMBWF, 2023). The recent shift towards an early exposure to computer science is one of the reasons why professional development has not yet fully caught up, as educators and training programs are still adapting to this fundamental change in curriculum approach. The following chapter discusses the teacher's role in more detail.

2.2 Teachers, Technology & Transformation

Teachers are central to the successful implementation of digital education initiatives, and self-efficacy plays a critical role in determining their effectiveness (McInerney et al., 2020; Zhou et al., 2020). Self-efficacy, as described by Bandura's theory, refers to an individual's belief in his or her ability to perform certain tasks, and for teachers, this translates into confidence in delivering curriculum content (McInerney et al., 2020; Zhou et al., 2020). Research has consistently shown that teachers with higher self-efficacy are more likely to adopt innovative teaching practices and positively influence student outcomes. In computer science education, where many teachers may lack prior training, increasing self-efficacy is particularly important. Professional development (PD) programs have proven effective in building teacher confidence and equipping educators with tools and knowledge necessary to successfully integrate new curricula (McInerney et al., 2020; Zhou et al., 2020). However, educational reforms can sometimes undermine self-efficacy, particularly when they introduce unfamiliar methods or assessment practices that leave teachers feeling unprepared or overwhelmed. This underscores the importance of ongoing, well-structured PD initiatives that not only focus on skill building but also provide continuous support to teachers as they navigate these changes (Hodges et al., 2014).

While teacher self-efficacy is a critical factor, the successful integration of digital education also depends on addressing systemic barriers that hinder innovation. These barriers can be categorized into intrinsic, extrinsic, and institutional challenges, each of which presents unique obstacles. Intrinsic barriers, such as fear of change, resistance to new methods, and a lack of confidence in technological competence, are often cited as the most significant obstacles, particularly in STEM (Science, Technology, Engineering, and Mathematics) education (Hasanah and Tsutaoka, 2019; Shi, 2016). Extrinsic barriers, including insufficient access to infrastructure, unreliable technology, and limited resources, further complicate the adoption of digital education initiatives (Shi, 2016). Institutional factors, such as time constraints, competing curricular demands, and inadequate opportunities for collaboration, create additional challenges for teachers striving to implement these changes (Lanford et al., 2019). Overcoming these barriers requires a multi-pronged approach. Schools must foster a culture of collaboration and innovation, and provide platforms for teachers to share ideas and best practices. Additionally, empowering teachers with strategies such as design thinking can help them effectively adapt to and overcome these challenges (Shi, 2016; Lanford et al., 2019).

Estonia is an example of how a strategic, well-supported approach to digital education can transform teaching and learning. Since the mid-1990s, Estonia has prioritized the integration of ICT in education, focusing on developing robust infrastructure, providing access to digital tools, and ensuring high-quality teacher training (Põldoja, 2020). Estonia's success is rooted in strong government support, a highly developed IT sector, and a culture that values innovation and digital literacy (Andronic, 2023). This comprehensive strategy has made computer science a compulsory subject in primary schools and an elective in secondary schools, embedding digital skills into the education system at an early stage (Heintz et al., 2016). Teacher training has been a cornerstone of this transformation, with online programs tailored to educators' needs, including both short- and long-term courses that have significantly increased digital literacy (Põldoja, 2020; Leoste et al., 2022). By integrating digital culture into everyday learning and addressing both infrastructural and pedagogical needs, Estonia has established itself as a leader in digital education. This model offers valuable lessons for other countries, illustrating how targeted investments in infrastructure, training, and teacher support can overcome barriers and foster educational innovation.

2.3 Creative & Unplugged Approaches to Digital Education and Computer Science

The idea of "unplugged" learning revolves around teaching computational concepts through interactive, hands-on activities without relying on technology. It focuses on creating engaging and accessible experiences to simplify complex ideas for a wide range of learners. Even when devices are available, they can pose challenges, such as distracting students or requiring complex software installations and configurations that may disrupt classroom activities, particularly in environments with limited technological access. CS Unplugged leverages this approach, offering a wide range of educational benefits that make it an effective and versatile method for teaching computer science concepts (Bell, 2018).

By eliminating the challenge of learning to program—often perceived as a barrier—students can explore foundational ideas in computer science without prior programming knowledge (Bell et al., 2011). This enables meaningful engagement with broader computer science topics (Hromkovič and Lacher, 2017) and helps dispel the misconception that the field is solely about programming (Prieto-Rodriguez and Berretta, 2014). Originally culminating in the 1998 book Computer Science Unplugged: Off-line Activities and Games for All Ages (Bell et al., 1998), the CS Unplugged approach has since evolved into more than just a collection of materials—it has become synonymous with making computer science accessible. Key principles include avoiding the use of computers, incorporating kinesthetic learning, fostering a sense of play or challenge, adopting a constructivist approach, providing short and simple explanations, and embedding concepts within a narrative framework (Nishida et al., 2009).

Furthermore, its ease of implementation and independence from specialized equipment make it particularly effective for large groups, brief learning sessions, and interdisciplinary integration. For instance, CS Unplugged exercises are highly effective in short presentations, academic settings, or interactive demonstrations at science centers, where programming activities may be impractical (Bell, 2018).

Additionally, Lau and Yuen (2010) identify CS Unplugged as one of three approaches to fostering a more inclusive and gender-sensitive CS classroom (Lau and Yuen, 2010).

2.3.1 The COOL Lab & "let IT Dance!"

The COOL Lab, located at Johannes Kepler University (JKU) Linz, is an innovative teaching, learning, creative, and research facility dedicated to digital education and computational thinking. It serves a diverse audience, including school students, educators, and university students, and offers a range of programs designed to facilitate the exploration and integration of modern technologies into educational practices. The lab offers a variety of workshops designed to meet the needs of learners at different educational levels. For instance, school workshops for the 2024/2025 academic year cover topics like programming robots, the construction of electronic musical instruments using the Makey Makey device, and the comprehension of algorithms through hands-on activities with devices like the micro:bit. In recognition of the importance of digital literacy in modern education, the COOL Lab offers professional development opportunities for educators across all disciplines and grade levels. Furthermore, the COOL Lab engages in collaborative initiatives with educational institutions to enhance digital competencies and foster a deeper understanding of technological advancements.

One such initiative is the "Let IT dance!" project, which addresses issues like cybercrime in music and dance apps, and aims to promote awareness and effective prevention strategies. The "Let IT dance!" project from the Johannes Kepler University was conducted between November 1, 2022, and December 31, 2023 and was funded under the "Frauenprojektförderung 2022/2023", a program from the Federal Chancellery aimed at strengthening the role of women and girls in the digital world and diversifying their career paths, with a focus on STEM fields. The project's objective was to cultivate interest among girls and young women in IT, computer science, and related fields by employing dance and music as a means of making these subjects more appealing (see Figure 4). Moreover, the project aimed to facilitate comprehension of complex concepts such as algorithms, coding, loops, and conditional logic through creative methods. Another main objective of "Let IT dance!" was to educate about cyber risks (e.g., grooming, sexting, and scamming) associated with popular platforms like TikTok and YouTube.

The project employed an interdisciplinary and innovative implementation strategy designed to effectively engage the target audience. At the project's core were interactive workshops, during which participants explored programming concepts by animating robots and virtual characters to "dance". The workshops not only made coding accessible and enjoyable but also allowed participants to connect abstract computer science concepts with creative outcomes. Simultaneously, cybercrime awareness workshops addressed digital safety concerns by highlighting risks associated with popular platforms such as TikTok and YouTube. These workshops were adapted for various educational levels, from kindergarten to secondary school, and were incorporated into teacher training programs. To further enhance learning, the project developed educational materials, including learning packages, instructional videos, and a learning analytics platform. This platform enabled educators to analyze participants' errors in coding, identify specific learning challenges, and create tailored paths to improve understanding. Moreover, all activities underwent iterative evaluation through the incorporation of participant feedback and quality assurance cycles.

Figure 4: Dancing during the circus show from the "Let IT dance!" project.

The "Circus of Knowledge" (German: Zirkus des Wissens) is an innovative educational and cultural initiative hosted at the Johannes Kepler University Linz (see Figure 5). It serves as a creative space where learning, research, and artistic expression converge. It played a significant role in the "Let IT dance" project by serving as an engaging venue for outreach and educational activities. The Circus is designed with the objective of making knowledge and education appealing to diverse audiences, with a particular focus on children and young people. Its unconventional approach blends academic content with artistic and theatrical methods, such as incorporating music, dance, storytelling, and hands-on activities. This facilitates the demystification of subjects such as science, technology, and mathematics, sparking curiosity and a love for learning. In the context of the "Let IT dance!" project, the Circus of Knowledge provided a venue for workshops and activities where programming, IT concepts, and digital safety were explored creatively through music and dance. Its unique atmosphere complemented the project's goal of making computer science approachable and engaging, particularly for girls and young women.

Figure 5: Circus show from the "Let IT dance!" project.

By linking CS education with creative arts like dance and music, the project "Let IT dance!" demonstrated a unique approach to fostering interest in IT among girls and young women.

3 METHODOLOGY

3.1 Participants

The study included 272 primary school teachers who attended a circus workshop at the JKU COOL Lab in 2022 and 2023, and accompanied a total of 3,226 children. Following their participation in the workshop, the teachers were invited to take part in the subsequent survey. The response rate for the survey was 74.3%, with 202 out of the 272 teachers participating. Of the respondents, 14 were male, representing 6.9% of the sample, and 186 were female, representing 92.1% of the participants. Two respondents did not indicate their gender. The mean number of years of service among the participants was 16.03 years, with a standard deviation of 11.72 years, indicating a wide range of teaching experience among the respondents.

3.2 Research Design

The objective of this study is to explore the current state of computer science and digital education in primary education. Furthermore, it illuminates the main barriers, teachers' needs and key issues. To achieve this, a survey was administered to the participating teachers. The survey instrument used a mixed-methods approach, integrating both quantitative and qualitative components. Quantitative data were collected using dichotomous questions (yes/no) and five-point Likert items, with response options ranging from (1) "does not apply" to (5) "completely applies", allowing respondents to express varying degrees of agreement. In addition to the quantitative items, optional open-ended questions were included to gain deeper insight into teaching barriers as well as the main issues that teachers consider as important. Additionally, demographic information, including gender and years of service, was collected. The paper-based survey was completed anonymously, with each participant using a unique identifier to ensure confidentiality. The questionnaire was originally in German and was translated into English for the purposes of this paper. It also included additional items, such as feedback on the circus workshop. However, this paper presents only a subset of items from the full questionnaire that are relevant for the research questions.

3.3 Data Analysis

The quantitative data were analyzed with the software IBM SPSS Statistics, version 23, employing both descriptive and inferential methods. For the items on the 5-point Likert scale, descriptive statistics were employed to calculate frequencies, means and standard deviations. The responses were assigned numerical values on a scale of one to five. To determine the proportion of teachers who had already implemented digital education or computer science, descriptive statistics were applied. To evaluate the perceived importance of computer science and digital education, a paired-sample t-test was utilized, whereas Pearson correlation analysis examined the correlation between teachers' confidence and teaching readiness. A thematic analysis based on the method of Braun and Clarke (Clarke and Braun, 2017) was conducted for the qualitative data obtained from the open-ended questions.

3.4 Research Questions

This study sought to explore the following research questions which are addressed and discussed in the following sections.

1. What is the current state of digital education and computer science in primary schools, and what factors influence teachers' readiness to implement these subjects?
2. What are the main barriers to implementing digital education and computer science?
3. What topics do teachers consider most relevant for digital education?

4. What are teachers' professional development needs in digital education and computer science?

4 FINDINGS

4.1 Digital Education and Computer Science in Primary Schools

The participants of the survey were asked whether computer science and digital education had already been integrated into their lessons. The results show a significant implementation gap. A total of 179 individuals responded to the question regarding digital education, with 74.9% indicating that they have incorporated it into their lessons. In contrast, computer science has been integrated into the lessons by only 24.6% of the 183 teachers who responded to this question. These results show a clear under-representation of computer science in comparison to digital education. When it comes to perceived importance, a paired-sampled t-test shows that teachers rate digital education significantly higher ($M = 3.85$) than computer science ($M = 3.26$), $t(190) = -10.30$, $p < .001$. Similarly, teachers feel significantly more confident in teaching digital education ($M = 3.54$) than computer science ($M = 2.05$), $t(193) = -18.13$, $p < .001$. A Pearson correlation test revealed a moderate positive relationship between teachers' confidence in computer science and their readiness to implement it in their lessons ($r = .400$, $p < .001$). In the case of digital education, on the other hand, there is a stronger positive relationship between confidence and readiness ($r = .470$, $p < .001$).

The results show that higher confidence has an influence on the readiness, however, also other factors may influence the willingness to implement it in the classroom.

4.2 Implementation Barriers

In order to respond to the second research question regarding the primary obstacles to the implementation of digital education and computer science, a thematic analysis based on the principles of Braun and Clarke (Clarke and Braun, 2017) was conducted. In total, 74 of 202 teachers mentioned that barriers were preventing them from integrating computer science or digital education into their teaching. Following this approach, these responses were coded (n=74) and categorized in four main themes that present the key obstacles: a lack of resources (n=40), a lack of teacher knowledge and confidence (n=17), time constraints (n=12), and the prioritization of core subjects (n=5).

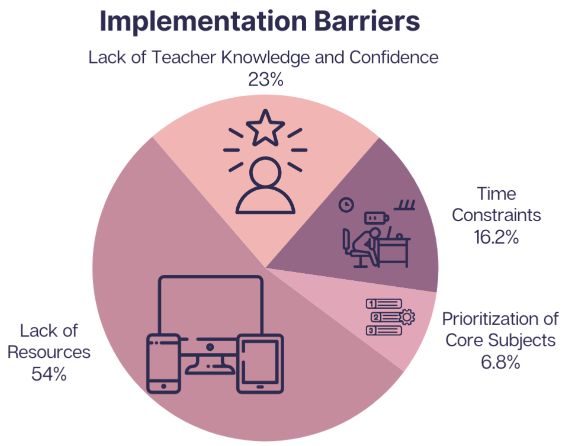

Figure 6: Barriers to Digital Education Implementation.

1. **Lack of Resources.** The most significant factor impeding the implementation of computer science and digital education in the classroom is the lack of basic infrastructure and resources that educators believe are necessary to integrate these topics into their lessons. This issue was mentioned 40 times. Examples of responses include: "No devices, no internet!" ("Keine Geräte, kein Internet!"), "The technical requirements at the school are lacking" ("Es fehlen die technischen Voraussetzungen an der Schule") or "We are unfortunately very sparsely equipped; only one computer per class" ("Sind leider sehr spärlich ausgestattet; nur ein Computer pro Klasse"). This result shows that many teachers view technical equipment as a necessary precondition that prevents them from making even initial attempts to start digital education initiatives.
2. **Lack of Teacher Knowledge & Confidence.** The second significant implementation barrier is the issue of professional competency concerns, which was mentioned seventeen times (23%). The concerns mainly refer to the implementation of computer science, as one teacher noted: "I have no idea about computer science myself" ("Ich habe selbst keine Ahnung von Informatik"). Another participant stated: "Computer science: no, because too little own knowledge" ("Informatik: nein, weil zu wenig eigenes Wissen"). These illustrative quotes show a significant need for professional development, especially when it comes to computer science.
3. **Time Constraints.** The third major factor that prevent teachers from implementing computer science and digital education in their lessons is time. This was mentioned by twelve participants (16.2%). Similar comments, such as "Lack of

time" ("Fehlende Zeit"), "No – because there is no time" ("Nein – weil es zeitlich kein Platz hat") or "No: No time, 'learning material' has to be worked on!" ("Nein: Keine Zeit, 'Stoff' muss erarbeitet werden!") were made. This demonstrates that there is often little room for additional content besides basic educational requirements.

4. **Prioritization of Core Subjects.** A minority of teachers (n= 5, 6.8%) explicitly stated that core subjects are being prioritized over computer science and digital education. An emphasis was placed on fundamental skills, as for example one teacher stated: "Because my class focuses on other things → learning German ..." ("Weil in meiner Klasse andere Punkte im Vordergrund stehen → Deutsch lernen ..."). Another teacher commented "No: Did not match the subjects" ("Nein: Hat nicht zu den Fächern gepasst").

4.3 Key Topics and Challenges

The third research question tried to determine what topics teachers consider most relevant for digital education and how these align with their perceived needs and implementation challenges. To receive answers to this question, again, a thematic analysis based on the method of Braun and Clarke (Clarke and Braun, 2017), was done. In total, 110 teachers listed multiple key topics that were then coded (n=204) and categorized into eight main themes:

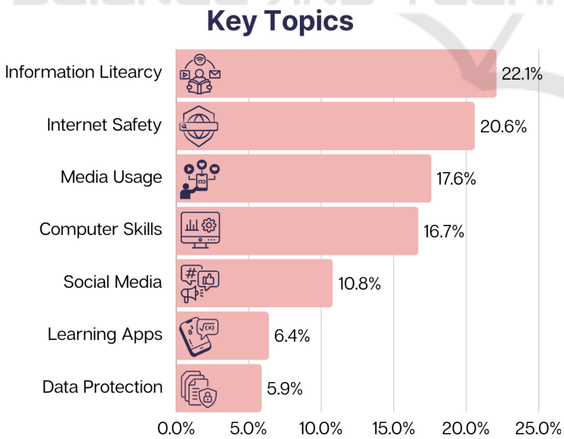

Figure 7: Digital Education: Key Topics.

1. **Information Litearcy (n=45, 22.1%).** This theme includes skills, such as online research, critical evaluation of information, usage of age appropriate platforms and search-engines and the ability to distinguish between real and fake news. Examples are "Critical questioning of content" ("Kritisches Hinterfragen von Inhalten"), "Access to knowledge → Being able to search; finding solutions" ("Zugang zu Wissen → Suchen können; Lösungen finden"), or "Fake news – filtering out correct information" ("Fake News – Herausfiltern von richtigen Informationen").

2. **Internet Safety (n=42, 20.6%).** The second most important theme is the constant emphasis on the need to teach content related to "safer internet", which was mentioned nine times. Other comments were "Safe, age-appropriate use of the internet" ("Sichere, altersgemäße Nutzung des Internets") or "What is useful – important – what do I have to consider on the www, what should I/should I not do" ("Was ist sinvoll – wichtig – was muss ich im www beachten, was soll ich/soll ich nicht tun").

3. **Media Usage (n=36, 17.6%).** This is the third area that teachers find particularly important. This theme includes the meaningful use of digital media. Teachers made comments such as "Rules for using digital media" ("Regeln im Umgang mit digitalen Medien"), "Competent use of digital media" ("Kompetenter Umgang mit digitalen Medien"), or "Media Skills" ("Medienkompetenz").

4. **Computer Skills & Concepts (n=34, 16.7%).** The fourth category includes basic digital competencies such as text processing, basic programming skills, as well as basic hardware operations.

5. **Social Media (n=22, 10.8%).** Twenty-two responses focused on the responsible use of social media platforms, especially popular platforms, such as TikTok, Snapchat, and WhatsApp.

6. **Learning Applications & Robotics (n=13, 6.4%).** This theme was only mentioned thirteen times, with the focus on educational software and platforms and basic robotics education using Bee-Bots or learning apps.

7. **Privacy & Data Protection (n=12, 5.9%).** This category is like the second major category, internet safety, but with a specific focus on personal data management and digital footprints.

8. **Other (n=3, 1.5%):** A miscellaneous category captures three comments, including "creativity" or "use in daily life".

4.4 Teachers' Professional Development Needs

The fourth question dealt with teachers' professional development needs and how the implementation gaps can be met by professional development. In summary, the participants of this study highlighted a strong demand for professional development. In total, 191 teachers answered the questions whether they need additional support in the implementation of computer science topics and/or digital education. The mean score for computer science related professional development was higher with a mean score of 3.91 (SD= 0.99), whereas the need for digital education training resulted in a mean score of 3.54 with a standard derivation of 1.08.

4.5 Bridging the Gap with Professional Development

The findings demonstrate that a number of factors impact the integration of digital education and computer science into educators' pedagogical practices. Targeted professional development for teachers can play a significant role in enabling them to overcome these challenges. Based on the insights gained, four key areas for impactful professional development have been identified:

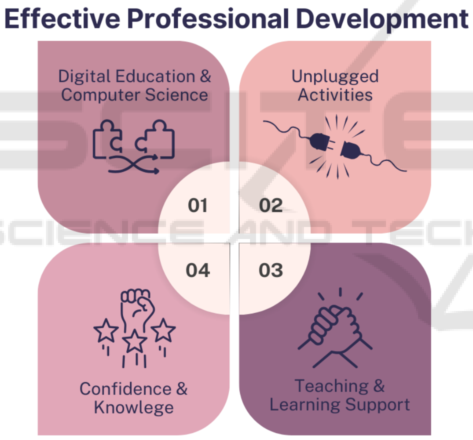

Figure 8: Effective Professional Development.

1. **Combining Digital Education & Computer Science.**
   As revealed by the findings of this study, there is a significant disparity in teachers' confidence and implementation rates between digital education and computer science. Only 24.6% of teachers reported engaging with computer science topics. The combination of these two areas in training programs could encourage more teachers to participate and reduce their fear of computing. In addition, the inclusion of both topics can also clarify the differences between the fields and promote a broader understanding of their complementary roles. This may motivate more teachers to embrace computer science education.

2. **Provision of Unplugged Activities.**
   A considerable obstacle to incorporating computer science and digital education is the lack of resources, as reported by numerous teachers. For this reason, professional development should include practical, low-cost teaching methods, such as unplugged activities, which do not require technological devices. Hands-on activities do not need expertise in using technology and provide an easy way to teach the fundamental concepts of computer science, such as computational thinking. The implementation of unplugged activities not only overcomes the obstacle of resource limitations but also provides an alternative perspective on the field of computer science. This is achieved by demonstrating the versatility of computer science in various classroom settings.

3. **Increase Knowledge & Confidence.**
   The findings indicate that many teaches may hold misconceptions about what computer science entails. A common belief is that teaching it requires advanced technological skills. However, a fundamental part of computer science focuses on thinking strategies and problem-solving techniques rather than technology itself. This area is called computational thinking and has already found its way in many school curricula and gained considerable attention in the last few years (Wing, 2006). The teaching of computational thinking equips students with the essential skills such as abstraction, decomposition, pattern recognition and algorithmic thinking. These skills are not only important in the field of computer science, but also in everyday live and across many academic disciplines. By addressing the misconceptions, teachers can learn about the importance of computational thinking and recognize that it is a crucial strategy that promotes critical thinking and problem-solving. In addition to the benefit that teaching core concepts does not require any technology, teachers learn about the benefit of fostering these skills and the positive impact on their own subjects.

4. **Introduction of Teaching & Learning Support.**
   A common misunderstanding among educators is the assumption that incorporating digital education and computer science into their teaching always means additional content delivery. The training program should demonstrate how these subjects can enhance existing content. This can be achieved by showing how computational thinking and elements of digital education can support rather than compete with the core subject. Inte-

grating these novel approaches ensures that these disciplines are regarded as crucial components of contemporary education, rather than optional extras.

By addressing the needs of teachers, professional development can help overcome the main barriers teachers face and help them effectively integrate computing and digital education into classroom practice.

5 DISCUSSION

This paper investigates the current state of digital education and computer science implementation in Austrian primary schools. The results of the survey revealed a significant implementation gap between digital education and computer science, the latter being underrepresented. Moreover, the findings demonstrate that teachers are more confident in teaching digital education than computer science, which correlates with its higher implementation rates. Previous studies have also highlighted that teacher confidence has a direct positive impact on the integration of technology in their pedagogical practice (Gomez et al., 2022; Stringer et al., 2022; Mustafına, 2015). Stringer et al. especially emphasized the critical role of professional development in enhancing teachers' confidence (Stringer et al., 2022).

Even though the results of this survey show that higher confidence influences readiness, other factors also influence classroom implementation. Main reasons that prevent teachers from implementing the one or the other are lack of resources, low confidence as well as a need for professional development, and time constraints. The identified barriers are consistent with previous studies (Nolan et al., 2024; Loudova, 2021; Stringer et al., 2022). Findings of another study revealed a disconnect between ICT policy goals, teachers' understanding, and actual classroom technology integration at the primary school level (Drenoyianni and Bekos, 2023). Similarly, Jutaite et al. mention the lack of teacher training as well as technical issues as one of the key barriers to implementing digital training (Jutaite et al., 2021).

These findings highlight the importance of targeted professional development to minimize implementation barriers and improve teachers' skills (Bowman et al., 2022). Effective teacher training could address the misconceptions about teaching computer science and demonstrate new concepts and methods, such as computational thinking and unplugged activities. Furthermore, it is vital to emphasize the benefits of including it, as also previous studies have demonstrated (Li et al., 2019). With this new skill set, teachers may feel more confident about integrating computer science and digital education in their classrooms.

6 LIMITATIONS

While the results provide valuable insights into the current state of computer science and digital education implementation in primary schools, several limitations must be considered in their interpretation.

First, the study was geographically limited to Austria and the participants were exclusively teachers who attended a workshop with their students at the COOL Lab. This may have implications for the generalizability of the findings to other contexts or different regional and international educational settings. Furthermore, the study is characterized by a notable gender imbalance, with male teachers representing only 6.9% of the participants and female participants representing 92.1%. It is possible that gender may exert an influence on skills and attitudes, and thus a more balanced sample may yield more balanced results. Another limitation to consider is that the study relied on self-reported data, which has the potential for bias. Responses may be influenced by over- or underestimation of teachers' approaches and skills.

While these findings offer significant insights, a more comprehensive understanding of this topic would be gained through further in-depth studies, such as interviews and observational measurements.

7 CONCLUSION & OUTLOOK

This study provides insights into the implementation of digital education and computer science in Austrian primary schools. While progress has been made by integrating both areas as overarching themes in the new primary school curriculum, which was first implemented in the school year 2023/24, significant challenges remain, particularly in the domain of computer science. In addition to low teaching confidence, the survey results revealed a number of obstacles to the integration of digital education and computer science. These include limited resources, inadequate teacher knowledge, time constraints, and the prioritization of core subjects. In light of the survey results, a strategic framework for addressing the challenges through professional development has been proposed. Key elements include training that focuses on the implementation of both digital education and computer science, providing unplugged activities, building teacher confidence and skills, including addressing misconceptions, and finally, demonstrating the interdisciplinary applicability of the disciplines.

In conclusion, this study highlights the critical need for teacher support in order to meet the revised curriculum requirements. Although the survey incorporates both qualitative and quantitative elements and offers valuable insights, further studies, such as in-depth interviews or observations, are essential for a more comprehensive understanding of the contextual factors. Additionally, future research should be conducted to assess the effectiveness of the proposed professional training and to monitor its impact. By prioritizing these efforts, teachers can be empowered to equip young learners with the essential skills required for success in the digital age.

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