Integrating Digital and AI Literacy with Digital Citizenship across the Curriculum in Italian Schools

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Abstract

The paper outlines future directions for collaborative curriculum design in the Italian educational context, where Artificial Intelligence (AI) serves not only as a content generator but also as a catalyst for bridging disciplinary boundaries. The future of AI is inherently unpredictable, presenting both benefits and threats that impact reality more significantly than other technologies. Nevertheless, we can learn to adapt our choices and organize our behaviors to influence the future. This is especially crucial in the educational sector, where a new literacy is necessary to affirm human intentionality as a key factor in interactions with technologies like AI. The proposed case study relates to the experimental introduction of the AI discipline at the Marconi-Pieralisi upper secondary school in Jesi (IT). This initiative, along with two other important recent reforms, represents a significant curricular innovation in the Italian educational landscape: the introduction of civic education as a compulsory subject in all schools in the country, and the reorganization of technical institutes. By reframing the case study, the paper proposes a pathway toward AI-mediated interdisciplinary curriculum integration.

Keywords

artificial intelligence, interdisciplinary curriculum, digital citizenship,

1. Introduction

The digital technological revolution, which includes disruptive AI, significantly impacts all aspects of social and political life [1]. To educate for democracy, active citizenship grounded in conscience and critical spirit must be strengthened [2]. In this context, the role of the school becomes crucial in designing learning experiences, beginning with the acquisition of digital skills to promote critical and conscious active citizenship [3]. This paper explores how AI and generative AI, are catalyzing interdisciplinary shifts in educational design. Drawing on qualitative data from an Italian upper secondary school curriculum initiative, it examines how educators at the Marconi-Pieralisi Institute in Jesi are integrating AI into Computer Science and Civic Education courses, fostering interdisciplinary connections and rethinking traditional subject boundaries. The use of AI reveals emerging opportunities for designing curricula that foster transferable skills—such as critical thinking, ethical reasoning, and data literacy—across diverse academic domains, ultimately nurturing active citizenship in a digital world. The preliminary phase of this research, which focused on the same case study at the Marconi-Pieralisi Technical Institute in Jesi, was previously presented at the Third Sustainable Development Conference (SDC 2024) [4]. This article builds on that initial contribution while offering a significantly new perspective by addressing several research questions, employing a distinct analytical framework, and focussing on the interdisciplinary integration of digital and artificial intelligence skills into curriculum design.

2. Evolving digital and AI literacy in the European policy landscape

Digital literacy is a critical educational issue for the development of knowledge society [5]. It translates into the ability to use new media and new technologies to actively participate in a now largely digitised

society [6], as well as to critically analyse the production and fruition of digital content, acting as consciously on the Web [7]. It overlaps with various related concepts, such as digital skills, digital competencies, computer literacy, information literacy, media literacy [8]. The European Commission identifies digital competence as one of the Key Competences for Lifelong Learning, initially defined in 2006 and later updated by the Council Recommendation in 2018 [9]. Several European policy initiatives underscore the importance of digital competence, such as the updated DigComp Framework (now DigComp 2.2) [10] as well as the Digital Education Action Plan (2021-2027) [11] and the Digital Decade Policy Programme 2030 [12]. Consequently, the European Union is actively working to develop both basic and advanced digital skills to facilitate digital transformation and social inclusion. Digital literacy forms the foundation of AI literacy, encompassing not only technical skills but also critical thinking, ethical awareness, and inclusivity in an AI-driven world. Ng et al. [13] emphasise the lack of a clear definition of AI literacy and call for effective teaching strategies that make its technical aspects more accessible. Yi [14] underlines the role of metacognition—reflecting on one's own thinking—as crucial for engaging critically with AI. A comprehensive approach to AI literacy should include understanding fundamental concepts, interacting with intelligent systems, and assessing their societal implications. In this context, the European Union has launched initiatives to enhance awareness of AI and data in education, starting with the Ethical Guidelines for Educators on Using AI and Data in Teaching and Learning [15], aiming to increase awareness of AI and data in education. Digital literacy must be redefined as a dynamic, future-oriented construct that integrates data fluency, ethical reasoning, and the ability to navigate AI environments—moving beyond basic ICT skills. Schools and community learning centers play a key role in developing these competencies by using digital technologies as tools for creativity and active learning [16]. They also help foster critical thinking, resilience, and support families in guiding children's use of technology. Expanding school access and investing in teacher training can better connect internet use with educational opportunities, helping address the significant digital skill gaps among younger students [17] As early as 2014, the UN Committee on the Rights of the Child recommended that member governments incorporate digital literacy into their national school curricula [18]. Today, this literacy must also encompass sustainability—such as energy-efficient computing, awareness of cloud computing's carbon footprint, and AI's potential to support the UN Sustainable Development Goals. Empowering students in this way enables them to understand their role in promoting a socially and ecologically responsible use of technology. Altogether, these discussions underscore the urgency of prioritizing digital and AI education to equip future generations with the skills needed in a rapidly evolving digital society [19].

3. Framing Digital Citizenship in education: legal and conceptual foundations in Italy

A common definition of digital citizenship is the promotion of responsible online behaviour as well as civic and social justice engagement, which includes definitions that emphasise technological aspects and digital skills [20]. As a result, digital citizenship education seeks to promote healthy and safe behaviours while also encouraging proactive, reflective, and respectful attitudes towards online content creation and self-expression [21]. As discussed above, the importance of responsible technology use was acknowledged in 2006 and again in 2018 by the European Parliament [9]. In Italy, the Ministry of Education, Universities, and Research (MIUR) published a syllabus in 2018 to develop a Digital Civic Education Curriculum. This syllabus emphasizes rethinking how people find and use information and communication resources privately and publicly [21]. Another important contribution to the development of digital citizenship education paths was made by Law 92/2019, which reintroduced civic education into school curricula [22]. This legal framework integrates the teaching of digital literacy with broader democratic competencies and aligns with European directives such as DigComp 2.2 [23]. For readers less familiar with the Italian school system, it is important to note that civic education has recently become a transversal discipline, supported by national mandates and local experimentation. The Guidelines for Teaching Civic Education [24] define digital citizenship as the need for all citizens

to develop media literacy skills in order to face the complexity and challenges of a constantly changing society in which technology plays a critical role. Article 5 of Law No. 92/2019 [22] introduces digital citizenship education, understood as the ability of an individual to consciously and responsibly use virtual means of communication, and lists seven key areas of focus that align closely with DigComp 2.2 [23]. Legislative Decree No. 45/2025 [25], introduces another significant legislative innovation in the Italian school system: the reform of technical upper secondary schools in Italy. This reform, which will take effect in the 2026-27 school year, aims to align curricula with the demand for skills in the manufacturing sector, with a focus on innovation related to Industry 4.0 and the profound digital transformation that is taking place. The reorganisation, which will impact institutions like the I.I.S. Marconi Pieralisi, the case study discussed in the paper, calls for the creation of a new technical institute curriculum that will be split into two primary areas: a flexible address area devoted to acquisition and a national general education area that will be shared by all paths and work to create a fundamental culture that incorporates humanistic and scientific-technological elements. Law 92/2019 [22] on the introduction of civic education and Legislative Decree No. 45/2025 [25], which reformed technical institutes, are two essential and complementary pillars for the spread of comprehensive and responsible digital and AI literacy. With an emphasis on digital innovation and Industry 4.0, as well as on preparing students for STEM careers and professional degrees, the goal of technical institute reform is to match training programmes with the demands of the productive enterprises. In addition, Law 92/2019 [22] on civic education adds digital citizenship as one of its core thematic focal points, encouraging critical media comprehension, thoughtful and responsible technology use, and knowledge of the dangers of misinformation and data security. In this context, the two regulations intersect: while technician reform provides the technical skills required to understand, develop, and implement digital technologies and artificial intelligence, civic education provides the ethical, critical, and social framework for their responsible use. The combination of these two legislative perspectives is critical for training students who not only know how to use artificial intelligence and digital technologies, but also understand their social, ethical, and legal implications, thus contributing to digital and AI literacy that truly empower individuals to assert their rights and access equal opportunities in both digital and physical spaces, fostering personal growth and addressing the issue of digital education [26].

4. Institutional Practices and Frameworks for Digital Citizenship in Italian Schools

Alongside the creation of the Italian civic education regulatory framework, schools in Italy have taken independent steps to create their own digital curricula that integrate the principles of digital citizenship. During the 2017/2018 school year, school leaders from lower and upper secondary schools in Val di Non and Val di Sole [27] formed a collaborative network to develop a shared digital citizenship curriculum. Based on the DigComp 2.1 framework, the initiative aligns with best practices in ICT integration and reflects the evolving nature of digital education. The curriculum follows a vertically integrated structure from primary school to the first and second years of upper secondary school (which in Italy determines the end of compulsory schooling). It is grounded in the belief that digital competence is as essential as traditional academic skills, forming the foundation for responsible citizenship in a connected world. This holistic approach underscores the relevance of digital literacy for students' personal growth and professional futures. Finalized in May 2022, the curriculum was validated by experts from the Provincial Institute for Educational Research and Experimentation (IPRASE), confirming its educational quality and alignment with regional and European standards. In a parallel initiative, educators from Valle d'Aosta developed an alternative digital curriculum inspired by IPRASE's work. Grounded in the latest DigComp 2.2 framework, the project offers a structured approach to digital education with clear guidelines and best practices tailored to different educational levels [28]. Also the "Vertical Digital Curriculum" covers five "two-year" periods, from primary school to the first and second years of upper secondary school (which in Italy determines the end of compulsory schooling), and is organized around the five DigComp competence areas. Each area is divided into three components: competence development, learning

activities, and supporting resources. This flexible design provides an indicative progression path to help schools shape inclusive and effective digital curricula. Both the Valle d'Aosta and Trentino-Alto Adige projects promote digital competence not only as technical skill, but as essential to the ethical and informed use of technology, including AI. These initiatives aim to equip students with the ability to navigate the digital world with confidence, responsibility, and critical awareness, preparing them to be active, socially responsible citizens. Finally, the paper presents a case study of the Marconi-Pieralisi upper high school in Jesi, Marche region, where the AI discipline has been introduced into the curriculum for fourth- and fifth-year students majoring in Computer Science and Telecommunications [29]. This innovation was made possible by the Institute's use of its school autonomy quota, which allows Italian schools to integrate existing subject curricula while also introducing new subjects in response to local needs and ongoing social transformations. The new teaching has many touching points with civic education curriculum, which for fourth and fifth year students investigates the thematic core of digital citizenship [29]. Through the combination of the two programmes, students are guided to meet learning objectives pertaining to the development of basic skills, including: critically, responsibly, and consciously accessing information, sources, and digital content; managing digital identities and data online; safeguarding one's own and others' safety in digital environments, avoiding risks to one's physical and mental health; and analysing the issues surrounding the management of digital identities, the right way. Both the digital citizenship core and the AI programme seek to equip students with critical, responsible, and aware digital skills so they can successfully and safely navigate the digital world. Although the Marconi Pieralisi Institute experience developed independently of the Trentino school network's and Valle d'Aosta educators' digital curricula, the initiatives share some similarities. All of the projects presented are dedicated to promoting digital competence, not only as a set of technical skills, but also as an important orientation tool for the responsible and informed use of modern technologies. By cultivating these skills, the initiatives hope to prepare students to navigate the complexities of the digital landscape with confidence and integrity, resulting in a generation of technologically proficient and socially responsible citizens. However, the Marconi Pieralisi Institute's AI programme curriculum has the added benefit of providing students with comprehensive and practical AI training, preparing them to become competent and knowledgeable technology professionals (Appendix 1).

5. Designing Digital and AI curricula: insigts from teachers involved in the AI teaching

The study took a qualitative approach, with semi-structured interviews with three teachers involved in AI and civic education programmes, as well as the school leader. The interviews sought to delve deeply into the teachers' perceptions, experiences, and visions about the significance and efficacy of incorporating AI into teaching. The analysis sought to uncover shared meanings, perceived critical issues, and future potential in order to gain a more in-depth understanding of the observed phenomena.

5.1. Methodology

The study included four unstructured narrative interviews conducted in May 2024 with teachers of Civic Education and Computer Science, as well as the school leader. Participants were asked to reflect on the rationale behind introducing AI, the design choices made, and the pedagogical challenges encountered. The collected data were coded using a thematic analysis approach, focusing on emergent categories such as interdisciplinarity, ethical concerns, assessment, and student engagement. Interviews were audio-recorded and transcribed for qualitative synthesis. The qualitative data collection utilized unstructured narrative interviews [15] to explore the methods employed by teachers and management to integrate AI within the educational context. The analysis focused on identifying recurring themes and interrelated connections through key terminology. The interview covers a wide range of topics related to integrating AI into the school curriculum, including teacher training and inclusiveness, as well as the use of AI-based technologies, evaluation of their effectiveness, and documentation of work done.

The primary goal of the questions formulated and contained in Appendix 2) was to gain a thorough and nuanced understanding of how AI is integrated into a technical institute's curriculum.

5.2. Results and Insights

Analysis of the interviews revealed five major themes: (1) The perceived need to align AI education with civic values; (2) The challenge of balancing technical skills with ethical reflection; (3) Enthusiasm for interdisciplinary teaching formats; (4) Concern about the lack of assessment tools for AI literacy. Teachers emphasized the importance of collaboration across departments and proposed a progressive path beginning with conceptual foundations in Civic Education and leading to hands-on data literacy labs in Computer Science. These insights directly informed the design of a modular curriculum outlined below. The ethical aspects of AI were also addressed in civic education classes to ensure that students understood the technology's potential and the ethical responsibilities that come with its application. The experience with IA didactics resulted in an innovative operational suggestion for improving cooperative and lab dynamics. The interviewees emphasised that inclusive design required teachers to recognise and accommodate diversity in learning in order to fully develop students' specific abilities and potential. AI literacy entails raising students' awareness of issues concerning the ownership and protection of data contained in information collected and reused by artificial intelligence applications. According to the philosophy teacher, taking a collaborative and practical approach to teaching AI involves mutually enriching the student-teacher dialogue relationship. The narrative fragments emphasise the digital curriculum's interdisciplinary nature, highlighting its interactions with various fields of study while also addressing the ethical and legal implications of acquiring digital skills and promoting collaboration among teachers across all disciplines.

6. Conclusions

This contribution provides an overview of the implementation of digital citizenship education, focussing on the Italian initiative to emphasise civic education's interdisciplinary nature and AI teaching. This approach is consistent with European and international frameworks for citizenship education, encouraging the integration of digital technologies into various discipline syllabi. This prepares students to face modern challenges and become informed, competent citizens in the digital age. Digital citizenship education emphasises the importance of both technical and critical reading skills, allowing students to understand information processes and interact with technology in an ethical and responsible way. This encourages active social participation and enables students to make meaningful contributions to society. This educational approach relies heavily on interdisciplinary curriculum integration, which connects content, methods, and language from various academic disciplines around common themes, challenges, or experiences. This method goes beyond the traditional separation of subjects—such as math, science, and literature—to demonstrate how they influence and complement one another. A thematic or problem-based approach promotes meaningful and contextualised learning by connecting subjects through central themes or real-world problems. Furthermore, this integration promotes collaboration among teachers from various disciplines, resulting in a cohesive curriculum that overcomes the traditional separation of subjects. Incorporating data analysis and artificial intelligence (AI) into this interdisciplinary framework promotes transversal learning by serving as a bridge between disciplines such as statistics, computer science, economics, and biology. This integrated approach allows students to collaborate on complex problems while also developing critical thinking and problem-solving skills. Furthermore, AI and data analysis promote innovation and creativity by allowing students to discover new connections between disciplines and inspiring the creation of novel models, solutions, and knowledge. In summary, interdisciplinary curriculum integration provides an educational model that extends beyond traditional subject boundaries to create more meaningful and relevant learning experiences. The incorporation of data analytics and AI expands on this potential, forging connections between disciplines and preparing students to effectively address the complex challenges of the modern world.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly and Quillbot for grammar and spelling checks. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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A. Appendix 1

https://docs.google.com/document/d/1mThyzLSHEe5TsRoU3D4JzIWg28nKkLPPiay4vurxL5E/edit?tab=t.0

B. Appendix 2

1. Could you retrace the steps that led to the integration of AI into your school's ITd telecommunications technical programme?

2. How were the teachers and classes that participated in the experiment identified?

3. Was training offered and, if applicable, given to the teachers involved? If so, what were the methods and timeframe? What inclusive learning communication methods were implemented? And is there any additional refresher or follow-up training planned?

4. What about the types of diversity in the classroom, such as age, background, internal dynamics, and relationships with teachers?

5. How do teachers' commitment and presence change in response to the opportunities presented by the use of AI-based technologies?

6. What criteria are used to assess the impact of AI implementation on the vertical curriculum of the school's technical specialisation in IT and telecommunications?

7. According to the school's PTOF, the cross-curricular civic education curriculum for fourth and fifth grades focusses on the thematic cores of digital citizenship and the Constitution, law (national and international), legality, and solidarity for fifth graders, which include topics such as profiling and cybersecurity.

What are your thoughts on raising awareness among students and teachers about issues concerning data ownership and protection in information collected and reused by AI applications? 8. What do you believe are the most important steps towards new literacy to address digital educational poverty, which is defined as a lack of digital skill acquisition?

B List of segments

The following segments were translated from Italian into English.

1. The Computer Science department proposed introducing AI as a subject to better prepare students for university and meet external needs. Approval from the Teachers' Board was required, emphasizing teamwork and management consensus.

2. Discipline planning focused on standard content, despite no specific guidelines. In-house training was crucial for teachers to understand both the historical and technical aspects of AI.

3. The Institute plans to introduce AI as a separate subject in its three-year computer science curriculum, leveraging the expertise of teachers who studied AI extensively. [. . .] Recognizing the importance of preparing students for future challenges, the Institute has noted a demand for AI skills from local companies, highlighting its role as a regional educational resource.

4. The goal is not to train experts in AI, but rather to provide students with the skills to debunk clichés and understand AI as a useful technological tool.

5. Introducing AI in the curriculum requires structured practical and lab activities to foster experiential learning and enhance student understanding.

6. Lessons are structured to alternate practical applications with theoretical aspects, focusing on developing students' ability to independently research and complete work within a set timeframe.

7. For students with special educational needs, the lab offers significant advantages, as computers often serve as a compensatory tool. However, some students may struggle, so we've implemented cooperative work in pairs to support classmates with fragile needs through tutoring. 8. The teaching of the IA discipline in classrooms primarily focuses on workshop activities to enhance communication and promote inclusiveness.

9. AI has also been integrated into the civic education curriculum where the ethical aspects of the application of technology are mainly addressed. It is important that students understand the ethical and social implications of AI, not only as a technological tool, but also as something that can influence everyday life and social dynamics.

10. The students were unfamiliar with philosophy, which allowed them to freely express their views. This led to an interesting mutual learning experience between us. We engaged in a philosophical dialogue about the ethical rules and principles that should guide the development of artificial intelligence systems for lawful purposes.