

Generative AI and the Croatian Educational System

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This chapter explores the transformative potential of Generative AI (GEN-AI) in education, focusing on its integration into the Croatian educational system. It examines the historical evolution of AI, the rapid emergence of GEN-AI tools, and their implications for teaching and learning. GEN-AI's multimodal capabilities offer opportunities to enhance creativity, problem-solving, and personalised learning. However, challenges such as overreliance, transparency, and ethical considerations require special attention. Croatia has made significant efforts in addressing these challenges through initiatives like the BrAln project, CARNET's AI curriculum, and the Digital Croatia Strategy 2032, which emphasise AI literacy, teacher empowerment, and equitable access. Pedagogical approaches for teaching with and about GEN-AI are discussed, emphasising active learning, ethical awareness, and the importance of maintaining human oversight. This chapter advocates for a balanced, human-centric approach to integrating GEN-AI, ensuring its use aligns with educational values of creativity and intellectual growth while addressing the evolving demands of a digital future.

Keywords: Croatian education, AI in education, AI curriculum, AI ethics, digital transformation, AI literacy



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Introduction

AI traces its origins to the mid-20th century when researchers began exploring the possibility of creating machines capable of performing tasks traditionally associated with human intelligence (Rojas, 2024). Alan Turing, one of the most influential pioneers in AI (Teuscher, 2004), posed the question of whether machines could think and introduced the famous Turing Test as a way to evaluate whether a machine could demonstrate behaviour indistinguishable from that of a human. Turing suggested that a computer could be considered intelligent if it could mimic human responses under specific conditions, laying the foundation for the idea of machines »thinking« like humans and igniting decades of research and discussions in the field (French, 2000). In 1956, John McCarthy formally coined the term »Artificial Intelligen-

ce« (Rajaraman, 2014), marking the establishment of AI as a distinct field of study. Today, one of the most advanced applications of AI is Generative AI, a technique designed to mimic human communication by creating text, images, or other content based on patterns learned from vast datasets (Gatla et al., 2024).

The rapid emergence of artificial intelligence (AI) tools in the educational landscape presents both opportunities and challenges that demand critical exploration (Rizvi, 2023). Among these advancements, Generative AI (GEN-AI) tools have gained significant traction due to their multimodal capabilities, enabling both students and teachers to generate diverse forms of content. This technological evolution promises to transform traditional pedagogical methods, yet its implications on teaching, learning, and the broader education ecosystem remain underexplored (McGrath et al., 2024).

While AI conversational models and generative tools offer unprecedented support in educational settings, their widespread adoption also raises critical concerns. From a teacher's perspective, the omnipresent capability of generative AI to provide extensive, immediate knowledge can foster feelings of inadequacy—leading educators to question their role in a landscape where AI seems omniscient. Similarly, from a student's perspective, there is a growing perception that learning might become obsolete, as GEN-AI tools appear to offer instant solutions to any problem or answer to any question. These attitudes risk undermining the core values of education: fostering creativity, curiosity, and a deep understanding of knowledge through effort and engagement.

The danger of a purely consumer-based education system, where knowledge is readily available without the rigour of critical thinking and problem-solving, is another pressing concern. While regulatory frameworks for AI in education are being developed, they often fail to address the underlying pedagogical shifts necessary to integrate AI effectively into teaching and learning. Without a new approach to teaching about, for, and with GEN-AI, such regulations may ultimately prove insufficient.

This paper adopts a critical perspective on the role of GEN-AI in education, emphasising the importance of recognising these tools as aids, not substitutes, in the learning process. It argues for a balanced approach that integrates GEN-AI into education while maintaining a human-centric focus on creativity and intellectual growth. To this end, this study examines current regulations and best practices, with a particular focus on the Croatian context, and proposes a framework for addressing the evolving trends in generative AI education.

Regulations and Governmental Initiatives on Generative AI in Education in Croatia

The Republic of Croatia has recognised the importance of the development of artificial intelligence and is, at the same time, one of the signatories of the Declaration on Artificial Intelligence Cooperation (signed in July 2018). The current guidelines, policies, and standards governing the use of Generative Artificial Intelligence (GAI) in education within Croatia and the European Union (EU) rely on existing legislative frameworks, ethical guidelines, and available technological solutions.

International Legislative and Regulatory Framework

The EU has established several key regulations that impact the deployment of AI technologies in education:

- Artificial Intelligence Act (AI Act) (Regulation, 2024): Enforced from 1 August 2024, the AI Act classifies AI applications based on risk levels—unacceptable, high, limited, and minimal. Educational applications often fall under ‘high-risk’ due to their significant impact on individuals’ rights and well-being. These applications must adhere to strict requirements concerning transparency, safety, and human oversight.
- General Data Protection Regulation (GDPR) (Regulation, 2016) : This regulation ensures the protection of personal data within the EU, mandating that AI systems processing personal data in educational contexts comply with data privacy and security standards.

Croatia, as an EU member state, aligns its national legislation with these EU directives, ensuring that AI applications in education conform to both EU and national legal requirements.

Several organisations have developed ethical guidelines to support the responsible use of AI in education:

- UNESCO’s Guidance for Generative AI in Education and Research (UNESCO, 2023): This framework assists countries in implementing immediate actions and formulating long-term policies to ensure a human-centred approach to GAI in education.
- European Data Protection Supervisor (EDPS) Guidelines on Generative AI (European Data Protection Supervisor, 2024): These guidelines help EU institutions comply with data protection obligations when using or developing GAI tools, emphasising the importance of safeguarding personal data.

Croatian Legislative and Regulatory Framework

Strategic directions for Gen AI in education as part of digital education are defined by The Digital Croatia Strategy for the period until 2032 (Republic of Croatia, 2022), which outlines a comprehensive vision for Croatia's transition into a digitally advanced society.

By fostering a regulatory, investment, and tax environment conducive to technological innovation, the strategy aims to position Croatia as a competitive digital economy with personalised public services and technologically proficient industries. A critical pillar of this vision is the continued development of digital competencies across all educational levels, ensuring that future generations are equipped to thrive in a digitalised world.

To prepare students and educators for the demands of a digital future, the strategy emphasises the need for a dynamic and adaptable education system. This system must continuously align with advancements in digital technologies, including AI and evolving workforce requirements. The strategy identifies four essential areas for the digital transformation of education:

1. Digitally Mature Environments - establishing infrastructure and digital ecosystems in schools that support seamless integration of information and communication technologies (ICT) into teaching and learning.
2. Digitally Skilled and Confident Educators - providing continuous formal, informal, and lifelong training for teachers to build their ICT competencies and confidence in using advanced technologies, including AI, as integral tools in the classroom.
3. ICT as Support for Learning and Teaching - promoting ICT as an enabler for innovative teaching practices and personalised learning experiences, empowering students to engage actively with digital tools.
4. Digital Leadership - encouraging data-driven decision-making and fostering digital literacy among school administrators to support strategic planning and implementation of ICT initiatives.

The strategy highlights the need to integrate digital technologies and competencies into both subject-specific and cross-curricular programs in primary and secondary education. This approach aims to ensure that students not only use digital tools effectively but also develop a deeper understanding of their potential and limitations. Additionally, the strategy calls for a focus on higher education by promoting the digital transformation of universities and investing in research and technological infrastructure, particularly in STEM and ICT fields.

To sustain momentum in building digital skills across the population, the strategy includes several supportive measures:

1. Promoting Lifelong Education in ICT - expanding access to formal and informal education programs that enhance digital skills at all life stages.
2. Reducing Administrative and Tax Barriers - creating incentives to attract and retain foreign ICT professionals to strengthen the workforce.
3. Establishing Specialized Programs for ICT-Interested Students - developing tailored programs for students passionate about ICT topics to foster early engagement and expertise.

The Digital Croatia Strategy 2032 positions education as a cornerstone of the nation's digital future. By embedding digital competencies into curricula, fostering ICT innovation, and investing in educators and infrastructure, Croatia aims to create an inclusive and forward-looking education system. These initiatives ensure not only workforce readiness but also broader societal adaptation to the demands of an increasingly digitalised world.

The Digital Croatia Strategy serves as a foundational framework for The National Plan for the Development of the Education System for the Period Until 2027 that outlines Croatia's strategic priorities for integrating advanced technologies, including artificial intelligence (AI), into its educational framework (European Commission, 2024). Recognising AI as a pivotal element in transforming education, the plan emphasises both the opportunities and challenges associated with the adoption of AI and generative AI (GEN-AI) in schools. The document underscores the need for a systematic approach to aligning the education system with technological advancements while fostering equitable access and inclusivity.

To address the growing demand for highly qualified professionals in science and technology, the plan places special emphasis on reforming secondary education, particularly gymnasium curricula. This reform aims to prepare students for continued education and equip them with foundational knowledge in critical scientific domains, including AI, which is highlighted as essential for Croatia's and the European Union's future development. AI education is envisioned as a means to enhance innovation, workforce readiness, and societal transformation while promoting an understanding of its risks, such as bias, discrimination, and misuse.

The strategic framework identifies four primary areas and two horizontal themes for digital transformation:

1. Digitally mature environments – Enhancing school infrastructure to support digital learning.
2. Digitally competent and confident teachers – Providing professional development to build educators' digital and AI literacy.
3. Support for learning and teaching with ICT – Integrating digital tools and technologies into teaching practices.
4. Data-driven decision-making – Utilizing analytics and predictive models to improve educational outcomes.

The horizontal themes focus on culture, sustainability, and research and development, which further emphasise the importance of AI in shaping future educational practices.

The plan acknowledges several challenges that impede the full integration of digital and AI technologies in education, including:

1. Uneven access to resources and digital tools across schools, resulting in disparities in the quality of education.
2. Inadequate digital competencies among teachers, limiting the effective use of AI in teaching and learning.
3. A lack of curricula tailored to new technologies such as AI, 3D printing, and IoT hinders students' preparedness for the future workforce.
4. Insufficient research and experimentation in applying digital technologies in pedagogical settings.

To overcome these challenges, the plan proposes a range of measures:

1. Equipping schools uniformly to ensure all students and teachers have access to advanced digital tools.
2. Developing AI-focused curricula for both mandatory and extracurricular activities, enabling students to understand AI's potential and risks and fostering their ability to apply AI in innovative ways.
3. Professional development for educators to teach AI effectively, including its safe and ethical applications.
4. Promoting innovation through AI, such as hosting school competitions and creating AI-based educational resources.
5. Establishing an AI-driven educational portal for detecting and recommending digital content, tools, and services tailored to specific learning needs.
6. Leveraging data analytics and predictive models to improve decision-making, enhance administrative processes, and support personalised learning.

The plan also emphasises the importance of educating the school community about the ethical principles governing AI applications in education. This includes raising awareness about potential biases, privacy concerns, and the responsible use of AI tools. Moreover, it calls for the development of materials to teach about AI and its societal implications, ensuring that students become informed users and potential innovators of AI technologies.

The National Plan for the Development of the Education System demonstrates Croatia's commitment to integrating AI into education as a strategic priority. By addressing infrastructure, professional development, curriculum innovation, and ethical considerations, the plan aims to create an education system that is not only technologically advanced but also equitable and future-focused. These initiatives are vital for positioning Croatia as a leader in AI literacy and ensuring that its students and teachers are well-prepared to navigate and shape the digital age.

Implementation of measures defined in the strategic documents

In Croatia, several initiatives like the development of the virtual assistant system in teaching as part of the "Support for the Application of Digital Technologies in Education (BrAIIn)" project, which involves several components contributing to the development of a sophisticated AI system for educational purposes (Sabic et al., 2024) and have emerged to promote AI literacy and align educational practices with global standards.

Croatia is making significant strides in integrating artificial intelligence (AI) education into its elementary and high schools, positioning itself as a leader within the EU. Key initiatives include:

CARNET's AI Curriculum Initiative

Supported by the e-Schools project, which has equipped schools nationwide and digitally trained educators, the curriculum »Artificial Intelligence: From Concept to Application« was implemented in the 2023/24 academic year as part of the BrAIIn project (Fiore, 2024). Currently, 293 teachers from 248 schools actively teach this curriculum through extracurricular activities and elective courses, reaching over 1,000 students. This initiative ensures that both teachers and students are equipped with foundational AI knowledge.

CroAI AI educate program

The AI educate program, organised by the CroAI association, represents an initiative aimed at empowering educators to integrate artificial intelligence (AI) into classrooms effectively (<https://www.croai.org/education>). As part

of the broader initiative Thematic Systemic Support for Artificial Intelligence and Social Development, the program has introduced over 2,700 teaching and non-teaching staff across 13 Croatian counties to the fundamentals of AI and its potential applications in education. This program focuses on equipping educators with the foundational knowledge and skills necessary to understand and utilise AI tools, including generative AI (GEN-AI), in teaching and administrative tasks.

School of the Future

A collaborative project by STEMI and Infobip, with A1 Croatia as the main partner, introduces over 1,000 students from 60+ schools to AI through hands-on engineering activities. This project focuses on engaging students with practical applications of AI, fostering interest in cutting-edge technologies (Pajtak, 2024).

EDIT CodeSchool program

Since 2020, Split-Dalmatia County, via the ICT County activity, has supported the EDIT CodeSchool program, offering students in Split-Dalmatia County the opportunity to learn programming and applied AI. Through courses like »Development of Intelligent Web Applications (RIWA)« (Slobodna Dalmacija, 2024), students are introduced to AI concepts such as neural networks and computer vision. Participants create intelligent web applications, gaining practical experience in AI and machine learning.

CARNET User Conference - best practice exchange activity

The CARNET User Conference (CARNET, n.d.) is a flagship project supporting Croatia's systematic approach to integrating technology, including Generative AI, into education. Held annually since 1999 and supported by the Ministry of Science, Education, and Sports, the conference now gathers over 1,000 participants, including educators, school leaders, researchers, and ICT professionals. It serves as a platform for exchanging best practices, knowledge, and experiences in applying advanced technologies in education, with a focus on modern pedagogical approaches and internet-based innovations. By promoting the responsible and effective use of tools like Generative AI, the conference reinforces Croatia's commitment to fostering innovation and collaboration in education.

Artificial Intelligence in Education - manual

The educational manual »Artificial Intelligence in Education« (Kralj et al., 2024) is designed for teachers, school counsellors, principals, and other profession-

als within the educational system. Developed by experts from the “Partners in Learning” Association, the manual provides an introduction to fundamental AI concepts, their applications in education, and the ethical challenges associated with their integration into the teaching process. It includes explanations, examples, reflection questions, and activity suggestions for teachers to use with students.

The manual is divided into three main sections. The theoretical part introduces AI concepts and encourages educators to consider the ethical dilemmas related to its use in education. This is followed by activity proposals aimed at students aged 13 and older, promoting interactive, creative, and collaborative learning experiences while raising awareness of the potential risks and challenges associated with AI. The final section offers resources and strategies for teachers to integrate AI responsibly into their pedagogical practices, ensuring a safe and effective approach to teaching with these technologies.

This manual serves as a foundational resource for education professionals looking to deepen their understanding of AI, explore its possibilities and challenges, and apply it in a pedagogically appropriate way that prioritises students’ best interests.

Even without systematic implementation of generative AI (GEN-AI) tools in elementary and secondary schools in Croatia, some teachers and administrative staff have independently adopted tools like ChatGPT to facilitate administrative tasks and enhance the teaching process. For example, the secretary of XV. gimnazija in Zagreb uses ChatGPT to streamline administrative workflows, demonstrating the potential of such tools to improve efficiency in everyday school operations. This ad-hoc usage highlights the growing recognition of GAI’s practical applications in educational settings outside of teaching.

The research Artificial Intelligence and Critical Thinking in High Schools (Čižmar, 2024), conducted as part of the project Digital Literacy in the Age of AI by ODRAZ and Telecentar with support from The European Citizen Action Service, offers valuable insights into the perception and literacy of artificial intelligence (AI) in Croatia. The study revealed that 42% of Croatians have experimented with or currently use AI tools, yet only 19.3% of respondents demonstrate high AI literacy, while 26.3% exhibit a low understanding of AI concepts. Public sentiment towards AI reflects a mix of apprehension and optimism, with 60% associating AI with uncertainty or concern and 30% linking it to utility and excitement. Additionally, 49% of respondents fear job displacement within the next 5 to 10 years due to AI, and 72% believe AI will negatively impact interpersonal relationships.

These findings underscore the urgent need for improved AI education and literacy to address societal concerns and foster a balanced understanding of AI's opportunities and challenges. While education efforts in introducing GEN-AI are promising, the long-term impact of such activities on the educational system requires further evaluation. Given the rapidly evolving landscape of AI technologies, it is crucial to regularly assess and refine regulations and best practices to ensure their alignment with pedagogical and ethical principles.

GEN-AI in Education: The Croatian Approach

As Generative AI becomes more prevalent in education, it is essential that teachers remain informed, empowered, and actively involved in shaping its use. While some applications of Generative AI may continue to operate as black-box systems, the importance of transparency and interpretability cannot be overstated (Farrow, 2023). Just as educators strive to understand how their students think, it is equally important to understand how Generative AI arrives at its outputs to ensure ethical and effective use. In Croatia, the integration of Generative AI into education is supported by several aforementioned projects, reflecting a multifaceted approach to utilising this technology in the classroom. These initiatives highlight the importance of policies and best practices that emphasise transparency, accountability, and trust, while fostering collaboration among stakeholders in the educational community.

Some of the projects focus on using Generative AI as a tool for both students and teachers to enhance teaching and learning. These initiatives encourage educators to integrate AI into their practices to support creativity, problem-solving, and personalised learning experiences. Other projects are designed to develop AI literacy, using GEN-AI as a motivational tool to engage students by connecting their learning with the AI technologies that are increasingly omnipresent in everyday life. For example, existing programming curricula in Croatian elementary and high schools are being adapted to include modules where students learn to program applications with AI functionalities, providing a hands-on introduction to Generative AI concepts.

Beyond the classroom, Croatia emphasises educating all stakeholders—administrators, policymakers, and teachers—about the potential applications of Generative AI in their respective roles. These initiatives aim to ensure that AI is not only a tool for teaching and learning but also a resource for improving efficiency and innovation in education management and policy development. To promote the exchange of best practices, the annual CARNET User Conference has served as a cornerstone for professional development for 26 years, bringing together over 1,000 participants from the Croatian education

sector each year. This conference provides a platform for teachers to share innovative methods and experiences with integrating Generative AI and other advanced technologies into their teaching practices.

The exchange of best practices, supported by initiatives like the CARNET conference, is crucial for addressing the challenges posed by Generative AI. Whether these systems function as black-box, grey-box, or transparent models (Adadi & Berrada, 2018), the emphasis remains on equipping educators with the tools and knowledge to critically evaluate AI-generated outputs. This empowers teachers to integrate GEN-AI in ways that enhance learning without undermining the human elements of education, such as creativity, empathy, and individualised support.

As Generative AI technologies continue to evolve, Croatia's proactive approach demonstrates the value of shared policies, ethical guidelines, and community collaboration. By fostering these principles and supporting education through pilot projects, programming curricula, and best practice exchanges, Croatia positions itself as a leader in integrating Generative AI into education. Ultimately, this collective commitment ensures that Generative AI serves as a valuable partner in education, enhancing rather than replacing the uniquely human aspects of teaching and learning.

Pedagogical Approaches for Teaching With, About and For GEN-AI

The integration of Generative AI into education is not merely a technological advancement but a fundamental shift that challenges traditional notions of teaching and learning. To understand its impact, it is essential to connect its use with established educational theories. The works of Jean Piaget, Lev Vygotsky, Jerome Bruner, and Seymour Papert offer critical frameworks for examining how students learn and how tools like Generative AI can either support or hinder the learning process.

Jean Piaget's constructivist theory (Waite-Stupiansky, 2022) emphasises the active role of students in constructing their own knowledge through experiences and interactions with their environment. Generative AI, while capable of providing answers to questions, risks undermining this active process if used solely as a source of direct answers without encouraging deeper exploration or critical thinking. Unlike a teacher or a peer, who can adapt their responses to the learner's developmental stage and cognitive needs, Generative AI lacks the nuanced understanding required to scaffold learning effectively in line with Piaget's principles without prior user profiling.

Lev Vygotsky's sociocultural theory, particularly his concept of the Zone of Proximal Development (ZPD) (Doolittle, 1995; Verenikina, 2003), highlights

the importance of guided interaction between the learner and a more knowledgeable other—traditionally a teacher or peer. While Generative AI can act as a tool to extend the ZPD by providing timely assistance, it cannot fully replace the dynamic and responsive interaction that characterises effective scaffolding. Teachers and peers bring context, empathy, and the ability to challenge misconceptions, elements that Generative AI still cannot replicate. Furthermore, the inaccuracies in Generative AI's responses, stemming from its misunderstanding or limitations, pose a significant risk of misleading students if these errors go unchecked.

Jerome Bruner's theory of discovery learning (Ozdem-Yilmaz & Bilican, 2020) advocates for teaching methods that encourage students to construct new ideas based on their existing knowledge. Generative AI has the potential to facilitate discovery learning by generating examples, explanations, or alternative perspectives. However, the risk lies in students passively accepting the AI's outputs as authoritative answers, bypassing the critical thinking and inquiry essential for deep learning. Unlike a teacher or peer, Generative AI cannot discern whether a student has fully grasped a concept or is simply replicating its outputs without understanding. We are experiencing the Chinese room argument (Cole, 2024).

Seymour Papert's constructionism (Papert, 1984, 2020; Stager, 2005) builds on Piaget's ideas, emphasising learning through making and hands-on activities. Generative AI can support constructionist approaches by helping students brainstorm, simulate, or design creative projects. However, its lack of awareness about individual learners' contexts or objectives means it cannot offer the kind of meaningful feedback or encouragement that a teacher or peer might provide during project-based learning.

A critical challenge with GEN-AI lies in its tendency to occasionally produce incorrect or misleading information due to its reliance on probabilistic models rather than genuine understanding (Garry et al., 2024). Teachers and peers, while not infallible, are better equipped to acknowledge the limits of their knowledge and collaboratively seek accurate answers. Generative AI, on the other hand, can present inaccuracies with unwarranted confidence, potentially leading students astray if they lack the skills to critically evaluate its outputs.

In summary, while Generative AI has the potential to enrich the learning experience, it cannot substitute the nuanced, responsive, and context-aware roles of teachers and peers. Its integration into education must be carefully guided by pedagogical principles that emphasise critical thinking, discovery, and active participation, ensuring that students engage with Generative AI

as a tool to enhance their learning rather than a source of unquestionable authority (Dwivedi et al., 2023).

Pedagogical approach to teaching about Generative AI

Teaching about Generative AI to elementary school students requires a pedagogical approach that simplifies complex concepts while fostering curiosity, critical thinking, and ethical awareness. The approach should be hands-on and interactive, using age-appropriate analogies and activities to introduce students to the basics of AI, its applications, and its limitations. It should also promote active engagement through exploration, discussion, and reflection.

At the foundation of this approach is experiential learning, where students interact with simple AI tools to understand how they work. For example, they could use platforms like Teachable Machine (n.d.) to create basic image or sound classification models, helping them grasp the concept of training AI with data. This aligns with constructivist principles (Piaget), enabling students to build knowledge through hands-on experimentation.

Next, scaffolded exploration should guide students in understanding Generative AI's role as a creative assistant (Sætra, 2022). Teachers can demonstrate how AI generates stories, drawings, or music, emphasising that the AI relies on patterns learned from large datasets and does not »think« like a human. Activities could include comparing AI-generated outputs with student-created work to identify similarities, differences, and errors, fostering critical analysis and reflection.

Storytelling and analogies (Chadwick & Muilenburg, 2011) play a vital role in simplifying abstract concepts. For example, explaining AI as a »very smart copycat« that learns from examples and tries to predict what comes next can help students grasp the idea of generative models. Discussions can explore questions like, »How does the AI know what to draw?« or »Why might it make mistakes?« These discussions should also introduce the idea that AI can only work with the data it has seen and may not always provide correct or ethical results.

A focus on collaborative learning helps students explore AI's ethical implications. Small group activities could include role-playing scenarios where students act as AI trainers or users, decide what data to include in training and discuss the consequences of biases or misinformation. This aligns with Vygotsky's sociocultural theory, emphasising learning through interaction and dialogue.

Additionally, ethical literacy is integral to teaching about Generative AI, even for younger students. Through age-appropriate discussions, students can reflect on questions such as, »Is it okay for AI to make art or stories for

us?» or »How should we use AI responsibly?« Simple exercises, like identifying AI-generated content versus human-created work, can teach students to critically evaluate digital information.

Finally, the approach should include creative problem-solving tasks, encouraging students to use AI tools to solve challenges or complete projects while emphasising human creativity's unique role. For instance, students could use AI to generate ideas for a class story but take ownership of editing and completing the narrative themselves.

This pedagogical approach combines interactive learning, critical thinking, and ethical awareness, ensuring that elementary school students develop a foundational understanding of Generative AI as a tool, its potential benefits, and the responsibilities that come with its use. By fostering curiosity and reflection, this approach prepares young learners to navigate the evolving digital landscape thoughtfully and responsibly.

Conclusion and Future Directions

Generative AI offers transformative opportunities to enhance teaching and learning by complementing human cognition, empowering educators, and ensuring equitable access to quality education.

To fully leverage its potential, it is essential to design and implement interventions that prioritise key principles.

Generative AI should be used as a tool to enhance students' critical thinking, creativity, and problem-solving skills rather than merely serving as an »answer engine.« By aligning AI tools with the goal of boosting human abilities, educators can promote active learning and foster deeper engagement.

Teachers must be empowered as central figures in the successful integration of AI into classrooms. This requires comprehensive training, ongoing coaching, and dedicated support to help them confidently adopt AI tools in their teaching practices. Additionally, teachers need sufficient time and incentives to explore and experiment with these tools in diverse educational settings.

Building AI literacy across all stakeholders, including educators, students, and decision-makers, is crucial. Such literacy should be rooted in competency frameworks and emphasise the responsible and ethical use of AI, focusing on understanding when and how to use these tools effectively.

Establishing robust ethical guidelines is imperative to address challenges such as privacy, bias, and equity. These guidelines must be dynamic, evolving alongside technological advancements, and serve as opportunities for teaching ethical decision-making and digital citizenship.

Finally, AI solutions must be accessible and inclusive, designed for use in diverse socioeconomic and geographic contexts. Priority should be given to creating low-cost, user-friendly tools that function in environments with limited connectivity, ensuring that students in underserved areas can also benefit.

By integrating these considerations, generative AI can be a powerful catalyst for innovation, enhancing learning outcomes, fostering creativity, and preparing students for the complexities of the digital age.

References

- Adadi, A., & Berrada, M. (2018). Peeking inside the black-box: A survey on explainable artificial intelligence (XAI). *IEEE Access*, 6, 52138–52160.
- CARNET. (n.d.). *CARNET Users Conference CUC*. <https://www.carnet.hr/en/uslugu/carnet-users-conference-cuc/>
- Chadwick, C., & Muilenburg, L. (2011). Digital storytelling in the science classroom: Using analogies to improve understanding. In M. Koehler & P. Mishra (Eds.), *Proceedings of SITE 2011: Society for information technology and teacher education international conference* (pp. 1087–1092). Association for the Advancement of Computing in Education.
- Čižmar, Ž. (2024). *Umjetna inteligencija i kritičko mišljenje u srednjim školama*. Digcomp. <https://digcomp.info/umjetna-inteligencija-i-kriticko-misljenje-u-srednjim-skolama/>
- Cole, D. (2024, 23 October). The Chinese room argument. In *Stanford Encyclopedia Of Philosophy*. <https://plato.stanford.edu/archives/win2024/entries/chinese-room/>
- Doolittle, P. E. (1995). *Understanding cooperative learning through Vygotsky's zone of proximal development*. Institute of Education Sciences.
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., ... Wright, R. (2023). Opinion paper: 'So what if ChatGPT wrote it?' Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, 71, 102642.
- European Commission. (2024). *Ongoing reforms and policy developments*. <https://eurydice.eacea.ec.europa.eu/national-education-systems/croatia/ongoing-reforms-and-policy-developments>
- European Data Protection Supervisor. (2024, 3 June). *Generative AI and the EUDPR: First EDPS orientations for ensuring data protection compliance when using generative AI systems*.

- Farrow, R. (2023). The possibilities and limits of explicable artificial intelligence (XAI) in education: A socio-technical perspective. *Learning, Media and Technology*, 48(2), 266–279.
- Fiore, S. (2024, 5 April). *CARNET's cutting-edge projects: Empowering education for all and building a secure communication infrastructure*. Géant Connect. <https://connect.geant.org/2024/04/05/carnets-cutting-edge-projects-empowering-education-for-all-and-building-a-secure-communication-infrastructure>
- French, R. M. (2000). The turing test: The first 50 years. *Trends in Cognitive Sciences*, 4(3), 115–122.
- Garry, M., Chan, W. M., Foster, J., & Henkel, L. A. (2024). Large Language Models (LLMs) and the institutionalization of misinformation. *Trends in Cognitive Sciences*, 28(12), 1078–1088.
- Gatla, R. K., Gatla, A., Sridhar, P., Kumar, D. G., & Rao, D. S. N. M. (2024, 2–3 May). *Advancements in generative AI: Exploring fundamentals and evolution* [Conference presentation]. 2024 International Conference on Electronics, Computing, Communication and Control Technology (ICECCC), Bengaluru, India. <https://doi.org/10.1109/ICECCC61767.2024.10594003>
- Kralj, L., Blažić, A., Valenčić, H., Janeš, S., & Blašković, V. (2024). *Edukativni priručnik za učitelje o primjeni umjetne inteligencije u učenju i poučavanju: medijska pismenost*. Agencija za elektroničke medije.
- McGrath, C., Farazouli, A., & Cerratto-Pargman, T. (2024). Generative AI chatbots in higher education: A review of an emerging research area. *Higher Education*. <https://doi.org/10.1007/s10734-024-01288-w>
- Ozdem-Yilmaz, Y., & Bilican, K. (2020). Discovery learning: Jerome Bruner. In B. Akpan & T. J. Kennedy (Eds.), *Science education in theory and practice: An introductory guide to learning theory* (pp. 177–190). Springer.
- Pajtak, M. (2024, 5 March). *Projekt Škola budućnosti širi se izvan Hrvatske: 'Do 2027. želimo educirati pola milijuna ljudi'*. Srednja.hr. <https://www.srednja.hr/novosti/projekt-skola-buducnosti-siri-se-izvan-hrvatske-do-2027-zelimo-educirati-pola-milijuna-ljudi/>
- Papert, S. (1984). New theories for new learnings. *School Psychology Review*, 13(4), 422–428.
- Rajaraman, V. (2014). John McCarthy: Father of artificial intelligence. *Resonance*, 19, 198–207.
- Regulation (EU) of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulation (Artificial Intelligence Act). (2024). *Official Journal of the European Union*, (1689). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401689
- Regulation (EU) of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (Gen-

- eral Data Protection Regulation). (2016). *Official Journal of European Union*, (679). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679>
- Republic of Croatia. (2022). *Digital Croatia strategy for the period until 2032*. https://mpudt.gov.hr/UserDocImages//RDD/SDURDD-dokumenti//Strategija_Digitalne_Hrvatske_final_v1_EN.pdf
- Rizvi, M. (2023, 8–10 June). *Exploring the landscape of artificial intelligence in education: Challenges and opportunities* [Conference presentation]. 2023 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), Istanbul, Turkiye. <https://doi.org/10.1109/HORA58378.2023.10156773>
- Rojas, R. V. B. (2024). Artificial intelligence: Genesis, development, and future. In R. V. Benítez Rojas & F.-J. Martínez-Cano (Eds.), *Revolutionizing communication* (pp. 1–15). CRC.
- Sabic, I., Puljiz, H., & Smoljo, A. (2024). Personalized learning in the Croatian national education system: A study of AI implementation in the e-class register. *SN Computer Science*, 5, 1145.
- Sætra, H. S. (2022). Scaffolding human champions: AI as a more competent other. *Human Arenas*, 8(1), 56–78.
- Slobodna Dalmacija. (2024, 10 September). *EDIT CodeSchool digitalne Dalmacije: zakoraci besplatno u svijet programiranja!* <https://slobodnadalmacija.hr/promo/edit-codeschool-digitalne-dalmacije-zakoraci-besplatno-u-svijet-programiranja-1417412>
- Stager, G. (2005). Papertian constructionism and the design of productive contexts for learning. In *Digital tools for lifelong learning: Proceedings of the Tenth European Logo Conference* (pp. 1–11). Centre for Informatics and Technology in Education.
- Papert, S. A. (2020). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.
- Teachable Machine. (n.d.). *Teachable Machine: Train a computer to recognize your own images, sounds, and poses*. <https://teachablemachine.withgoogle.com/>
- Teuscher, C. (2004). *Alan Turing: Life and legacy of a great thinker*. Springer.
- UNESCO. (2023). *Guidance for generative AI in education and research*. <https://doi.org/10.54675/EWZM9535>
- Verenikina, I. (2003). *Understanding scaffolding and the ZPD in educational research*. <https://core.ac.uk/download/pdf/36994249.pdf>
- Waite-Stupiansky, S. (2022). Jean Piaget's constructivist theory of learning. In L. E. Cohen & S. Waite-Stupiansky (Eds.), *Theories of early childhood education* (2nd ed., pp. 3–17). Routledge.

Generativna umetna inteligencija in hrvaški izobraževalni sistem

Poglavje raziskuje transformativni potencial generativne umetne inteligence (GUI) v izobraževanju, pri čemer se osredotoča na vključevanje te tehnologije v hrvaški izobraževalni sistem. Preučuje zgodovinski razvoj umetne inteligence (UI), hiter porast

orodij GEN-U ter posledice za poučevanje in učenje. Multimodalne zmožnosti GUI ponujajo priložnosti za krepitev ustvarjalnosti, reševanje problemov in personalizirano učenje. Vendar je treba posebno pozornost nameniti tudi izzivom, kot so pretirano zanašanje na GUI, preglednost in etični vidiki. Hrvaška si je precej prizadevala za reševanje teh izzivov s pobudami, kot so projekt BrAIIn, učni načrt za UI CARNET in strategija Digitalna Hrvaška 2032, ki poudarjajo opismenjevanje na področju UI, opolnomočenje učiteljev in pravičen dostop. Obravnavani so pedagoški pristopi za poučevanje z GUI in o GUI, pri čemer so poudarjeni aktivno učenje, etična ozaveščenost in pomen ohranjanja človeškega nadzora. To poglavje zagovarja uravnotežen, na človeka osredotočen pristop k vključevanju GUI, ki zagotavlja, da je njena uporaba skladna z izobraževalnimi vrednotami ustvarjalnosti in intelektualne rasti, hkrati pa obravnava spreminjajoče se zahteve digitalne prihodnosti.

Ključne besede: izobraževanje na Hrvaškem, umetna inteligenca v izobraževanju, učni načrt za umetno inteligenco, etika umetne inteligence, digitalna preobrazba, pismenost na področju umetne inteligence