

Exten.(D.T.)² Executive Summary on Key Policy Recommendations

As part of the core theoretical ideas that form the Exten.(D.T.)² framework, and based on comprehensive evaluation results collected from the first two years of school and professional development interventions, we present the following policy recommendations. These aim to support the effective integration of Emerging Technologies (Artificial Intelligence (AI)/Learning Analytics, 3D Printing, Augmented Reality and Virtual Robotics) in European school contexts and contribute to the broader digital transformation of K-12 education.

The proposed recommendations focus on six key areas and are grounded on rigorous, evidence-based scientific methods for data collection and educational assessment. These will be further refined based on the ongoing evaluation of the project's third year of implementations.

1. **Enhancing digital and AI literacy** among teachers and educational stakeholders
2. **Upgrading technological infrastructures** in schools to support Emerging Technologies
3. **Developing ethical guidelines** for the use of AI and Learning Analytics
4. **Expanding professional development** opportunities for educators
5. **Transforming curricula** to foster multidisciplinary collaboration and competence development
6. **Encouraging research and innovation** to ensure the ethical and efficient use of AI and other Emerging Technologies in education

R1: Increase digital and AI literacy of teachers and other educational stakeholders

Although many teachers are enthusiastic and willing to integrate emerging technologies and AI (e.g., Learning Analytics) into their classrooms they frequently lack the necessary AI literacies and skills to do so effectively. Furthermore, where they do possess the know-how to use the technology, they lack the pedagogical knowledge on how to put the technology to use so that their students achieve better understandings of the subject at hand. This can lead to confusion, frustration, disappointment and in some cases abandonment of efforts to implement these technologies. Therefore, there is a clear need to enhance educators' knowledge, skills, and attitudes toward emerging technologies and AI and how they can be employed to achieve better teaching and learning. This can be achieved through open-access initiatives and resources such as distributing free educational materials, offering open courses, hosting hands-on workshops and seminars, and providing online forums for teachers to share their experiences and challenges related to AI and Emerging Technologies in the classroom. Relevant competencies related to AI and Emerging Technologies (such as Augmented/Virtual Reality and 3D Printing), including information and data literacy, should be integrated into the European Digital Competence Framework to enhance digital transformation efforts

R2: Improve the technological infrastructures of all schools to enable the use of ET by all students

Many EU schools lack the technological infrastructure necessary for implementing innovative pedagogies such as Design Thinking with Emerging Technologies. It is essential to equip all schools with adequate technology to support the large-scale integration of Augmented Reality, Learning Analytics and Virtual Reality in secondary education. In addition to Emerging Technology itself (e.g., AR components, VR headsets, or 3D printers) schools need supporting infrastructure such as computers with capable graphics cards, stable and fast internet connections, dedicated spaces for VR/AR applications, rooms for 3D printers, and tablets for AR applications. Furthermore, training school staff in the proper use of these technologies (e.g., 3D printers) is crucial to prevent misuse, errors, and potential safety risks. Ensuring the security of these technologies in school buildings is also essential. To achieve an inclusive and equitable digital transformation of EU education it is imperative to provide these infrastructures in all schools. To address these challenges, policymakers should prioritize investments in technological infrastructure, provide funding for equipment and connectivity, and implement targeted professional development programs to ensure educators can effectively integrate Emerging Technologies into their teaching practices.

R3: Develop guidelines for the secure and ethical usage of LA/AI by students and teachers in school settings

The use of Learning Analytics in secondary education is sensitive concerning children's digital safety. Therefore, specific guidelines must be developed to ensure their secure and ethical use by students and teachers. These guidelines should address, inter alia:

- **Data security:** Ensuring student data collected for Learning Analytics remains anonymous
- **Data access:** Defining who can access classroom data and what is permitted to be done with it
- **Ethical use:** Establishing guidelines on how teachers or other stakeholders may use analytics data responsibly
- **Transparency:** Providing clear and understandable information to students about data collection, processing and their rights
- **Informed consent:** Obtaining consent for different types of data collected

Where Learning Analytics or AI are used in mixed-reality technologies (e.g., AR-based games) it is crucial to specify whether sensitive data, such as students' voice commands or geolocation, are being collected and how AI algorithms process them. These guidelines must align with current legislation, including the "EU's AI Act" and the "Ethical Guidelines on the Use of Artificial Intelligence and Data in Teaching and Learning for Educators". To address these challenges EU educational authorities should develop clear, legally aligned guidelines that ensure data security, ethical AI usage and transparency while providing training for teachers and students on responsible Learning Analytics practices.

R4: Provide Professional Development and enhance Lifelong Learning about Emerging Technologies in education

To effectively integrate Emerging Technologies such as Augmented Reality, 3D Printing, and AI into education it is essential to provide educators with continuous professional development. Ongoing training programs should not only enhance teachers' technical expertise but also equip them with the pedagogical strategies needed to implement these technologies effectively in the classroom. By fostering a culture of lifelong learning, educators will be better prepared to navigate the evolving digital landscape, adapt to new tools, and design meaningful learning experiences to enhance student engagement and competence development.

To ensure maximum impact, these professional development initiatives should be structured, accessible, and aligned with current educational policies and frameworks. Training sessions should be offered regularly, incorporating hands-on workshops, collaborative learning opportunities and practical case studies. Additionally, creating professional learning communities where educators can share best practices and challenges will further support their ongoing development.

R5: Transform the educational curricula to allow for multidisciplinary collaborations (e.g. between subjects) and to promote competence development

In many cases the traditional national curricula can become an obstacle to a large-scale and mainstream integration of innovative pedagogies, such Design Thinking with Emerging Technologies. To address this secondary education curricula should transform from its current siloed subject-specific structures to more holistic and competence-oriented approaches. This would allow for long-term multidisciplinary projects and collaborations between teachers or between school and the society, leveraging the meaningful integration of such pedagogies. Curricula that exploit Augmented Reality, 3D printing and AI for competence development could equip students with necessary skills for their future careers such as those targeted by the European Skills Agenda.

R6: Support research and innovation actions for the efficient and ethical usage of AI and other Emerging Technologies in real-school contexts

As AI, Augmented Reality, and 3D printing technologies rapidly evolve ongoing research is essential to ensure their meaningful, secure and ethical application in K-12 education. Research and innovation efforts should involve a broad range of stakeholders including academics, educators, policymakers, families and technology companies. By fostering collaboration we can co-create solutions and guidelines that meet the diverse needs of students and teachers, promoting an ethical and inclusive future for education. To ensure the ethical and effective use of Emerging Technologies in education, it is crucial to establish collaborative research initiatives that involve all key stakeholders in shaping inclusive and secure solutions, with the European Union allocating resources to support these efforts.