Designing Education Ecosystems for the Future: The Role of Digital Technologies

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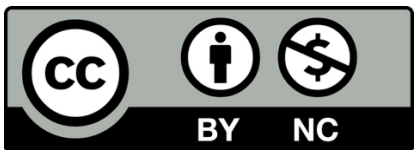
Designing Education Ecosystems for the Future: The Role of Digital Technologies

Report of EDUsummIT 2025



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EDUsummIT: Its Origins and Evolution

Introduction

Under the patronage of UNESCO, EDUsummIT 2025 took place from 23–25 June 2025 at the DCU Institute of Education in Dublin, Ireland. EDUsummIT - the International Summit on Information Technology in Education - is a global community of researchers, policymakers, and practitioners committed to advancing the effective integration of digital technologies in education through the active dissemination and use of research. EDUsummIT is an invitational, self-supporting summit hosted on a voluntary basis.

EDUsummIT 2025 brought together over 130 participants from 29 countries**,** including leading researchers, practitioners, and policymakers, to examine contemporary themes shaping the future of education. Participants collaborated intensively in nine Thematic Working Groups (TWGs), each addressing a critical dimension of educational change in a digital era. Their reports, along with the Call to Action, are presented in this eBook.

The 2025 Summit builds on EDUsummIT's longstanding mission to strengthen connections between research, policy, and practice. As digital technologies continue to evolve rapidly—with artificial intelligence, datafication, and new educational models reshaping learning environments—EDUsummIT 2025 provided an important forum to consider how education systems might respond, adapt, and thrive. Dublin marked the eighth EDUsummIT**,** following previous convenings in The Hague (2009), Paris (2011), Washington D.C. (2013), Bangkok (2015), Borovets (2017), Québec City (2019), and Kyoto (2023).

Origins and Evolution

EDUsummIT was conceived in 2007 by the editors and section editors of the *International Handbook of Information Technology in Primary and Secondary Education* (Voogt & Knezek, 2008). The Handbook revealed a persistent gap between research evidence on the potential of digital technologies and actual conditions in schools and classrooms. Recognizing the need for deeper dialogue among researchers, policymakers, and practitioners, EDUsummIT was established to advance research-informed strategies for technology integration and to identify implementation barriers across diverse educational systems.

Since its first convening in 2009 - co-organized with Kennisnet (The Netherlands), the International Society for Technology in Education (ISTE, USA), and BECTA (UK) - EDUsummIT has maintained its commitment to bringing together global thought leaders to formulate shared understandings, challenge assumptions, and co-create future directions. Each summit concludes with a Call to Action and a collaboratively authored agenda for continued work.

A defining feature of EDUsummIT is its thematic focus, developed jointly by the Steering Committee and the local host. Across the years, these themes have reflected shifts in the global discourse on digital technologies in education, ranging from the conditions for meaningful technology use to global community-building, research-informed practice, and reimagined learning in the digital age. The 2025 theme - *Designing Education Ecosystems*

for the Future: The Role of Digital Technologies - responds directly to the profound systemic changes affecting education worldwide, including the growing influence of AI, increasing datafication, and evolving learning cultures.

At the core of every EDUsummIT are its TWGs, where researchers, policymakers, and practitioners work collaboratively to synthesize research evidence, exchange practical insights, and deliberate intensively in face-to-face sessions across the two-and-a-half-day program. While some topics reappear in multiple summits—reflecting enduring global challenges—each EDUsummIT also introduces new urgent areas for exploration. In 2025, for example, themes such as AI literacy, digital leadership, holistic well-being, and data-intensive education ecosystems reflected current research and policy priorities worldwide.

Global Influence and Impact

EDUsummIT continues to be recognized internationally for its significant contributions to shaping research agendas, informing policy discourses, and strengthening professional practice. The summit serves as a global platform for sharing diverse perspectives, with participants regularly representing all six continents. Its inclusive ethos acknowledges that while challenges related to digital technologies in education are global, effective solutions must remain sensitive to local contexts.

Academic influence is strengthened through the publication of TWG outcomes in eBooks and subsequent special issues of leading international journals. As with previous summits, EDUsummIT 2025 will contribute to advancing scholarly and practice-oriented conversations through these dissemination channels.

Participants play an essential role in sharing the Call to Action and related outputs within their professional networks, extending EDUsummIT's impact to policymakers and practitioners worldwide. UNESCO offices and regional partners support dissemination, helping ensure that insights from EDUsummIT contribute to global policy dialogue on digital technologies in education.

Entering its third decade, EDUsummIT continues to serve as a vital international mechanism for dialogue, collaboration, and innovation. Its work remains grounded in the belief that meaningful integration of digital technologies in education requires sustained, research-informed collaboration between those who investigate, design, and enact educational change.

About EDUsummIT and This eBook

Introduction

This eBook presents the outcome reports of the nine Thematic Working Groups (TWGs) of EDUsummIT 2025, held from 23–25 June at the DCU Institute of Education in Dublin, Ireland. EDUsummIT - the International Summit on Information Technology in Education - is a global knowledge-building community of researchers, practitioners, and policymakers committed to strengthening the relationship between research and practice in the field of digital technologies in education.

Founded in 2007 by the Editors and section editors of the first *International Handbook of Information Technology in Primary and Secondary Education*, EDUsummIT was established to disseminate the Handbook's findings and to stimulate global dialogue on the role, impact, and integration of technology in primary and secondary education. Since then, EDUsummIT has convened every two years and has become a major international forum for reviewing emerging evidence, examining contemporary challenges, and co-creating approaches for shaping the future of teaching and learning.

EDUsummIT 2025 continues this tradition by bringing together over 130 participants from 29 countries - including leading international scholars, educational practitioners, and key policymakers - to engage deeply with the theme *Designing Education Ecosystems for the Future: The Role of Digital Technologies*. TWGs are formed prior to each Summit to prepare discussion papers that synthesize the latest research and practice-based knowledge. These papers provide the foundation for the intensive working sessions held during EDUsummIT, where participants collaboratively refine insights and formulate recommendations.

As with previous summits, the findings of EDUsummIT 2025 are presented first through this eBook and subsequently through publications in international journals, conference presentations, and additional scholarly and practice-oriented outputs. Together, these dissemination activities ensure that EDUsummIT's work contributes to ongoing national and international dialogues on digital innovation in education.

Thematic Working Groups and Their Outcomes

The overarching theme of EDUsummIT 2025 - *Designing Education Ecosystems for the Future* - emerged from reflection on the rapid evolution of digital technologies and their increasing influence across educational systems. Whereas earlier global efforts focused on integrating technology into education, recent years have seen a shift toward conceptualizing digital technologies as shaping entire learning ecosystems, influencing pedagogy, policy, leadership, equity, well-being, and the organization of learning itself.

Within this broad theme, nine TWGs explored critical areas of research and practice:

- **TWG1:** Bridging the gap between research and practice
- **TWG2:** Developing and leading digital learning cultures in schools
- **TWG3:** Technology-enabled inclusivity for diverse learners
- **TWG4:** Teachers' professional digital competence for deep learning
- **TWG5:** AI literacy for teaching and learning
- **TWG6:** Designing educational practices for uncertain futures
- **TWG7:** Resilience and well-being in digitally saturated ecosystems
- **TWG8:** AI, big data, and emerging challenges for teaching and learning
- **TWG9:** Bridging digital competence and digital citizenship

Together, these TWGs provide a comprehensive perspective on how digital technologies are reshaping education. Their contributions highlight the interplay between technological innovation and pedagogical, ethical, organizational, and societal considerations. They also underscore the shared imperative across all groups: ensuring that digital technologies support equitable, meaningful, and human-centered learning.

Topics addressed by the TWGs include the evolving role of AI in education, digital leadership and policy design, teacher professional learning, technology-enabled inclusion, learner well-being, and the competencies required for responsible participation in digitally mediated societies. The collective insights generated form a coherent and forward-looking set of recommendations for policymakers, researchers, and practitioners.

A Call to Action

Education is confronting profound and accelerating challenges that demand coordinated global action. Excessive use of technology—together with its ecological, geopolitical, and societal impacts—has reshaped the foundations of educational systems worldwide. These pressures fundamentally influence how digital technologies should be understood, designed, and enacted within future learning ecosystems. This requires rethinking not only technological tools, but also the practices, policies, and research cultures that shape their use.

Over 130 leading researchers, policymakers, and practitioners from 29 countries gathered **in** Dublin, Ireland**,** from 23–25 June 2025, to examine these issues and identify action items for shaping educational futures. Their work resulted in the following Call to Action.

Practice

Educators and school leaders are called to co-design digitally enabled teaching and learning in ways that are context-responsive, inclusive, and agency-enhancing**.** Through critical and ethical uses of technology - including AI - they play a central role in fostering student empowerment, wellbeing, and equity. This requires professional practices informed by collaboration and research.

Practice Action Items

- Co-design digitally enabled learning environments that meaningfully respond to local contexts and support learner agency.
- Use digital technologies—including AI—critically and ethically to enhance inclusion, wellbeing, and student empowerment.
- Engage in collaborative, research-informed professional learning that strengthens practice and responsiveness to emerging challenges.

Policy

Policy development is most effective when it is dynamic, inclusive, and grounded in collaboration with educators, learners, researchers, and communities. Policies must support ethical and equitable uses of digital technologies, long-term professional learning, and system-wide wellbeing, while aligning with justice-oriented and context-sensitive priorities.

Policy Action Items

- Develop policies through iterative, participatory processes that incorporate the voices of educators, learners, researchers, and communities.
- Promote ethical and equitable uses of digital technologies across education systems.
- Support sustained professional learning and prioritize wellbeing as a system-wide policy commitment.
- Ensure policies remain flexible and responsive to evolving ecological, geopolitical, and societal pressures.

Research

Research on digital education is most impactful when it is co-produced with practitioners and communities, grounded in diverse real-world contexts, and both rigorous and responsive. It must address ethical and equity dimensions of technology, support translation into practice, and reinforce long-term educational resilience.

Research Action Items

- Co-produce research with practitioners and communities to ensure relevance, contextual grounding, and shared ownership.
- Investigate the ethical and equity implications of digital technologies, including AI, within education ecosystems.
- Build long-term, cross-disciplinary research ecosystems that strengthen educational resilience and enable scalable impact.
- Support research translation into practice through collaborative structures that connect researchers, practitioners, and policymakers.

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EDUsummIT is a global community of researchers, policy-makers and practitioners committed to supporting the effective integration of Information Technology (IT) in education by promoting active dissemination and use of research. More information: https://edusummit.info/about-us/

Thematic Working Group 1 - Bridging the gap between research and practice: Improving research-involved guidelines on emerging technologies in education

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Introduction

Bridging the gap between cutting-edge research on educational technologies and practical application has been a constant challenge (Mohajerzad & Schrader, 2022; Reeves & Lin, 2020). In times of rapid technological change, the contribution of research in fostering innovative, evidence-informed practices to enhance teaching, learning, and educational equity needs to be reconsidered.

Challenges and opportunities

As new educational technologies continue to emerge, academic research often struggles to keep pace with the rapid speed of innovation. Each new development typically prompts a surge of scholarly and non-scholarly publications aimed at evaluating its potential benefits, limitations, and implications for educational practice. Among these early contributions, the quality and methodological rigor vary considerably. Nevertheless, certain publications become foundational, exerting long-term influence on subsequent research agendas and practical implementation. Given their enduring impact, it is critical to examine the defining characteristics of these early, high-impact studies on emerging technologies in education.

Simultaneously, policy documents and practice-oriented guidelines developed in response to new technologies face similar challenges. Driven by the urgent demand for actionable recommendations in educational settings, these guidelines are often produced before robust empirical evidence becomes available. As a result, they are frequently grounded in assumptions, preliminary findings, or anecdotal insights rather than systematic research. This creates a fundamental misalignment between the slower, cumulative nature of rigorous

academic inquiry and the accelerated timelines of policy and practice. Bridging this gap requires thoughtful strategies for integrating emerging evidence into early guidance while acknowledging the temporal pressures faced by practitioners and policymakers.

Key contributions of the TWG to the new educational realities

TWG1 aimed to develop guidelines for crafting academically rigorous articles that have the potential to become a driving force in educational innovation. As a rapidly emerging and potentially disruptive technology, artificial intelligence (AI) has captured significant attention within the research community and beyond. The working group employed qualitative content analysis to examine the relationship between artificial intelligence (AI)-related educational guidelines and the research literature that informs them. The methodology was designed to address three core objectives:

> (1) to analyze how AI-related educational guidelines refer to research findings;
>
> (2) to examine the characteristics of highly-cited, pioneering research papers in the field of AI in education; and
>
> (3) to compile a set of recommendations for the development and use of research-oriented practical guidelines on emerging technologies in education.

1. Identification and Analysis of AI-Related Educational Guidelines

The first phase involved the identification and systematic analysis of AI-related educational policy and practice guidelines. A purposive sampling strategy was used to select guidelines from a diverse set of countries, ensuring variation in geographic regions, economic development, and educational governance structures. Countries included in the sample were selected based on their active engagement in AI policy and educational technology reform, as evidenced by national strategy documents and international policy databases. The preliminary sample included Germany, Australia, Singapore, Japan and India which incidentally also had representatives from those countries in our Thematic Working Group.

Each AI-related educational policy and practice guideline was subjected to a qualitative content analysis focusing on the extent and manner in which it referenced research findings. This involved coding references to empirical studies, theoretical frameworks, and meta-analyses. Where available, in-text references were traced to their original sources to determine the rigor and credibility of the cited research. Sometimes, citations were rather indirect, such as providing links to other documents or providing names of researchers that were involved in the process of compiling these documents.

2. Analysis of Highly-Cited Pioneering Research in AI in Education

In the second phase, an extensive bibliometric approach was used to identify seminal research papers in the domain of AI in education. Data was extracted from two academic databases widely adopted in academic research such as Web of Science and Google Scholar. While Web of Science is limited to research papers only, Google Scholar is more comprehensive and includes practice-oriented publications and grey literature. Inclusion

criteria for the selected papers included high citation count per year and a demonstrable influence on subsequent research or policy documents.

Once identified, the selected papers were analyzed to understand their key characteristics, including theoretical orientation, methodological design, educational context, technological focus, and the nature of their findings. This analysis aimed to uncover what constitutes influential research in the field and how such research might inform or be used in practical educational guidance.

3. Development of Recommendations

In the final phase, findings from the guideline analysis and the examination of seminal research papers were synthesized to develop a list of evidence-informed recommendations. These recommendations target researchers, policymakers, and practitioners engaged in the development, dissemination, and use of guidelines concerning emerging technologies in education. In addition to compiling these recommendations, suggestions from other thematic working groups (TWGs) were also considered given the overlap between the topics.

Key insights from other TWGs

Bridging the gap between educational research and practice remains one of the most persistent and multifaceted challenges in the field (Biesta, 2007; van Schaik et al., 2018). As numerous scholars have noted, the divide is not merely a matter of communication or dissemination but is rooted in deeper epistemological, institutional, and cultural factors that shape how research is produced, interpreted, and applied in practice.

A key issue lies in the **types of research designs** traditionally employed in educational research. Much of the existing literature tends to treat educational practitioners, particularly teachers, as subjects rather than partners in the research process. This limits the relevance and applicability of findings to real-world educational settings. Scholars have called for a paradigm shift toward participatory, co-creative, and context-sensitive research methodologies like Design-Based Research (Reeves & Lin, 2020). This approach not only increases ecological validity but also fosters a sense of ownership among practitioners, enhancing the likelihood of sustained implementation.

To support the uptake of research in practice, there is a growing recognition of the need for tailored **science communication strategies** (Cooke et al., 2017; Kappel & Holmen, 2019). One promising avenue involves the production of *companion pieces*, practitioner-oriented summaries, explainer articles, multimedia briefs or social media posts that accompany original academic publications. Scholarly activities aimed at **translating research to practice** can help make complex findings more accessible to non-academic audiences while preserving fidelity to the original evidence base. Moreover, journals and publishing platforms can institutionalize such formats as part of standard publication practices. This aligns with broader movements to not only communicate with but also involve practitioners in science communication.

Another structural lever lies in the design of **teacher education programs**. These programs play a crucial role in the professional socialization of future teachers and should therefore embed competencies related to evidence-informed practice (Ferguson, 2021). This involves

not only the ability to *consume* research but also to *interpret*, *adapt*, and *critically evaluate* evidence in the context of diverse classroom realities.

The establishment of **institutionalized knowledge transfer mechanisms**, such as *clearinghouses* and other knowledge-brokers is another critical strategy (Ryecroft-Smith, 2022; Steiner-Khamsi, 2024). These organizations serve as intermediaries that synthesize, translate, and curate research findings for targeted audiences, including policymakers, school leaders, and teachers. Internationally, some examples include Campbell Collaboration (Norway), *What Works Clearinghouse* (U.S.), *Education Endowment Foundation* (UK), and *Evidenzbasierte Bildungspolitik* (Germany).

Despite increasing interest in practical impact, academic reward structures still tend to prioritize theoretical innovation and publication in high-impact journals. There is a need to **institutionalize practice-oriented contributions** as part of academic merit systems, often labelled as academic engagement (Perkman et al., 2021). For educational researchers, this could include recognizing contributions to practitioner journals, professional development programs, and policy consultations.

Funding agencies play a powerful role in shaping the research agenda. Practice-oriented research can be encouraged through **targeted funding streams** that require collaboration with schools, co-production of knowledge, and clear strategies for impact.

Lastly, emerging technologies such as **artificial intelligence** may offer new tools for narrowing the research–practice gap. AI systems can be leveraged to generate customized, research-informed practice guidelines based on large-scale analysis of empirical studies and contextual data. While still in early stages, such applications could assist educators and policymakers in accessing timely, relevant, and evidence-based insights tailored to their specific needs. However, the accuracy of such systems is still under investigation, especially in the medical field, where misinformation could have severe consequences (Li et al., 2024).

Importantly, these insights are not mutually exclusive nor universally sufficient. Bridging the research–practice gap is not a problem with a single solution but rather a wicked problem that requires multi-level interventions across educational ecosystems. Sustainable progress will require coordinated action among researchers, educators, policymakers, and funders. As these aspects have been explored by dedicated lines of research in the past, TWG1 has focused on a different aspect that has been addressed less frequently. This is the uptake of academic research in educational policy papers and guidelines for educational practice.

Strategies and actions

The observed research–practice gap seems to stem from a disconnect between the descriptive logic of empirical research and the prescriptive nature of policy documents and practice-oriented guidelines. Instead of researchers leaving the descriptive logic and embracing a prescriptive stance, more collaboration is needed between the worlds of research, policy and practice. Other mismatches exist between slow moving research and fast-moving policy and practice - especially when new and emerging technologies in education like Artificial Intelligence (AI) are concerned. Speeding up research leads to questionable quality of early findings which in turn influences the value and applicability of the findings for policy and practice. While these developments cannot be tackled without

risk-taking, we need to be aware of limiting these risks, similar to health recommendations based on medical research whereby, considerable testing or “clinical trials” needs to take place before a medicine is released on the market.

Strategies and actions for policy makers

Policy documents and practical guidance papers rarely cite research (Cooper et al., 2009; Lubiensky et al., 2014). If research is cited, it often is referenced selectively or indirectly, relying on local studies, grey literature, or vague claims (e.g., “research shows”), which weakens transparency and rigor. Research is frequently used to justify predetermined agendas rather than to shape policy through systematic review. This cherry-picking undermines the credibility of “evidence-informed” recommendations. In conclusion, the recommendations TWG1 puts forward the following recommendations:

- Involve researchers, practitioners and policymakers in a joint effort to co-design guidance and policy papers on new and emerging technologies such as AI in education.
- Provide clear references to high-quality research where possible. Explicitly acknowledge gaps in the existing research base and indicate where no references to research are available.
- Provide funds and commission longitudinal field trials and implementation studies involving researchers and practitioners and adjust policy documents and practical guidance according to their results.

Strategies and actions for practitioners

Educators must be more deliberate and purposeful in implementing technologies and resist pressure for rapid adoption. Patience allows time for critical reflection, teacher training, local adaptation and risk management. Research has shown that this patience is needed in all types of policy implementation (Spillane et al., 2002; Viennet & Pont, 2017). Moreover, teachers should be partners in research, co-creating knowledge with scholars. It is important that they develop critical policy literacy to assess where guidelines originate and what evidence underpins them, fostering informed, context-sensitive decision-making and practice. Consideration should be given to:

- Practitioners to critically evaluate policy and guidance to adjust and apply these policies productively within their local contexts.
- Communities of practice to engage in collaborative efforts with each other as well as with researchers and policymakers to develop effective practices and further guidance.
- AI to be used to support teacher agency by summarizing evidence-informed guidance in the future.

Strategies and actions for researchers

How research can inform policy has been extensively debated (Christensen, 2021; Head, 2016). How evidence-based findings are used for policies is heterogeneous and may differ across contexts and policy domains. The most cited AIED (Artificial Intelligence in Education) papers in our study tend to be conceptual papers or early scoping reviews, not original empirical studies, due to the time required for data-driven research. This temporal lag means conceptual work often substitutes for evidence in shaping early practice. Researchers involved in policymaking are often under-acknowledged, functioning as "ghost workers." Enhancing transparency around researcher contributions and aligning research timelines with policy cycles is essential for ensuring that practical guidance is genuinely informed by robust scholarship. We recommend that:

- Researchers focus on providing high-quality descriptive evidence instead of giving in to the prescriptive logic of early demands from policy and practice.
- Adopting participatory and design-based research to address the exclusion of practitioners in traditional research and foster more meaningful collaboration.
- Research ecosystems should be reformed to incentivize rigorous, meaningful scholarship that contributes to both academic quality and practical relevance. The academic reward system needs to prioritize diligent and methodologically sound research over speed of publication.

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Thematic Working Group 2 - Developing and leading digital learning cultures in schools: the role of leadership

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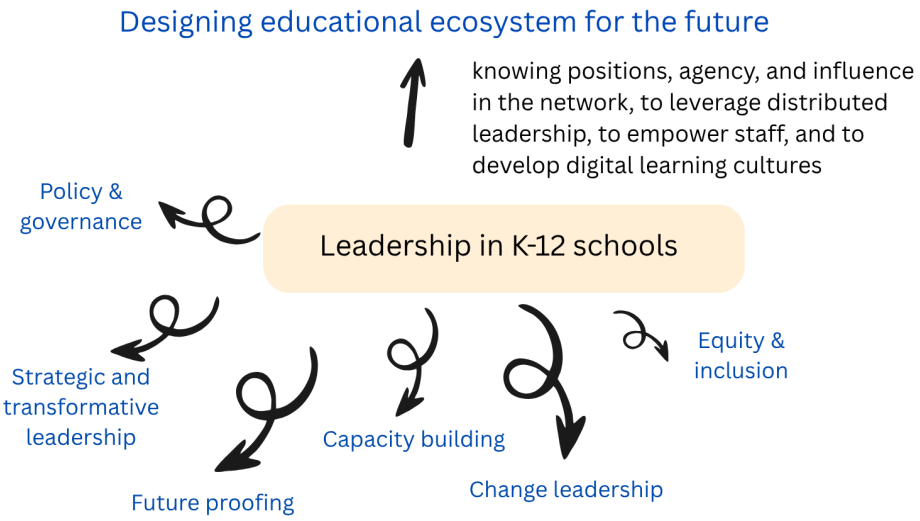
Introduction

TWG2's contribution to the EDUsummIT 2025 overarching theme is inherent in the critical roles school leaders play in co-designing the future education ecosystem, in a complex landscape shaped by rapidly changing digital, social, and cultural environments. It highlights the critical role of school leadership in co-creating digital learning environments conducive to learning, within a network of stakeholders, including teachers, parents, policymakers, and researchers. It includes effective leadership practices for integrating digital technologies into teaching and learning, and leadership programs to support educators in this transition. School leaders need to know their roles, agency, and influence within the network to leverage distributed leadership, to empower staff, and to develop digital learning cultures. They need to have appropriate technical knowledge and confidence so as not to be swayed by sales tactics, trendy strategies, or pressured into actions. To thrive in the dynamic environment with rapidly evolving technologies like artificial intelligence, there is a need to create a competency framework, structures and mechanisms to engage and support school leaders in continuous professional learning.



TWG2 members (see picture below) identified six key aspects of leadership essential to designing an educational ecosystem for the future: strategic and transformative leadership, capacity building, equity and inclusion, policy and governance, leading change, and future-proofing strategies.

Challenges and opportunities

TWG2 identified the leadership challenges and opportunities of developing and leading digital learning cultures in schools. These challenges and opportunities are interrelated; they are confined to a single space in the table below to maintain conciseness.

	Challenges	Opportunities
Strategic and transformative leadership	Leaders face the challenge of creating a shared vision in an unpredictable environment, often with diminishing resources such	Leaders can engage in collaborative efforts with various stakeholders; leverage distributed leadership to create a shared vision that

	as time, staff, and finances, while with increasing expectations.	accommodates the unique contexts of their schools to benefit all students. They can also focus on de-implementing outdated practices.
Capacity building	The scope of competencies needed to respond to all stakeholders' needs is often unclear, limiting the capacity for effective leadership. Leaders may struggle to monitor progress and ensure that all voices are heard in decision-making processes.	Empower both principals and teachers to develop as digital leaders within a supportive learning culture, through targeted professional development programs that align with the evolving needs of the educational landscape. Empower educators with personal agency for continual professional learning.
Equity and inclusion	Standardized models fail to account for individual school contexts and the specific needs of diverse student populations. One-size-fits-all approaches do not consider the complexities of access and socio-demographic factors.	Opportunities to contextualize education, exploring new inclusive models that can accommodate various learning preferences and backgrounds. Innovative approaches can help remove existing barriers.
Policy and governance	Policymakers may lack the grounded knowledge for setting targets and leading digital transformations for diverse contexts. Large organizations may lack the agility to develop timely policy and governance to keep up with technological changes.	Engaging practitioners, early adopters, and researchers in the policy development process can enhance the relevance and agility of educational governance.
Leading change	Developing a comprehensive change strategy that meets the needs of all stakeholders is a complex task. Leaders must navigate emotional responses to change, ensuring ownership and reducing resistance. A lack of coherence in communication can	Cultivating a culture that embraces rapid trial-and-error and innovation. By creating safe spaces for experimentation, school leaders can foster an environment where stakeholders feel empowered to contribute ideas and solutions, review existing routines, and not crippled by the fear of failure.

	further complicate the change process.	
Future proofing	Education systems often struggle to adjust quickly to technological advancements, leading to outdated practices and missed opportunities for improvement. Proliferation of generative AI may lead to compromised human agency and widen the existing digital divide.	Develop guiding principles that facilitate the rapid and responsible adoption of new technologies. By focusing on research-based design, using data-informed practices and establishing flexible frameworks, schools can create environments that encourage experimentation with technology.

Key contributions of the TWG to the new educational realities

The integration of digital technologies into learning contexts does not just change the modality of teaching and learning, it also invites new practices of teaching and learning while, at the same time, raising ethical concerns. Developing and leading digital learning cultures in schools is a complex endeavor that necessitates re-examining school leadership.

Strategic and Transformative Leadership: Effective leadership for designing a digital education ecosystem for the future is crucial for adding new value with technology, redesigning organizational processes, or encouraging new or enhanced teaching and learning goals. Transformative leadership emphasizes a shared vision that aligns with both local needs and broader educational goals. It encourages leaders to integrate various forms of leadership, including instructional, distributed, and transformational leadership (Dexter & Richardson, 2020) to navigate complex environments. It entails a change in perspectives, mindsets, beliefs, behaviors, and culture. According to Zhang et al. (2023), the coherence of strategic leadership practices across stakeholder groups is more critical than strict adherence to any single leadership model. School leaders should avoid abstract frameworks that lack translation into actionable leadership behaviors. For transformation to stick, schools need to align digital strategies with structural affordances—from timetabling to assessment models—and ensure coherence between classroom, school, and policy environments (McCarthy et al., 2024). Strategic leadership, in this sense, involves aligning micro-level (classroom), meso-level (school), and macro-level (system) priorities to foster shared understanding and coordinated action.

Capacity Building: Building the capacity of school leaders and educators is essential for fostering a digital learning culture. This theme highlights the importance of developing robust professional development frameworks and programs (e.g., see Figure 1 based on van Zanten et al., 2025) that empower school leaders and teachers to become digital leaders. Schools could be guided with frameworks or tools that assess and support the competencies of both educators and learners, providing them with tools and resources for effective digital engagement. Moreover, leadership programs could focus on cultivating agency and autonomy among staff, enabling them to reflect on their professional needs and drive their own growth. Certification or endorsement of leadership development providers who meet the

required quality assurance criteria is essential. Continuous monitoring of progress and resource allocation tailored to specific school contexts is vital.

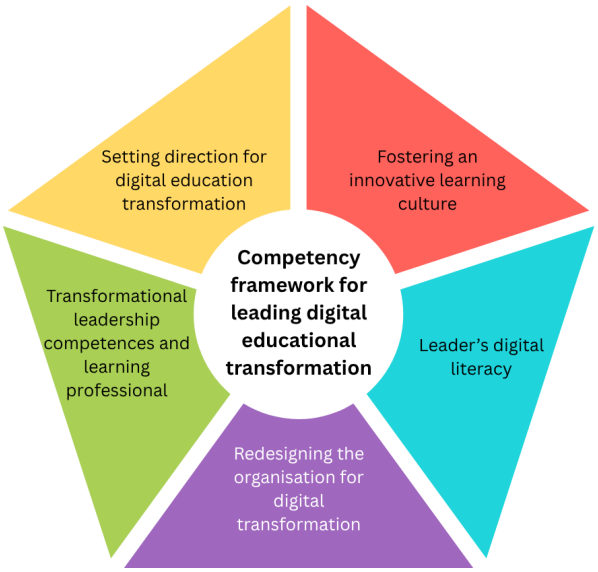


Fig 1. Competency framework for leading digital educational transformation based on van Zanten et al. (2025)

Equity and Inclusion: This theme addresses the critical need for educational systems to provide equitable opportunities for all students, particularly in the context of digital learning. Leaders play important roles in recognizing and dismantling barriers that hinder access to technology and resources, ensuring all learners, regardless of their socio-demographic background, can benefit from digital education. Indigenous and rural communities often face infrastructural and cultural barriers that require more than device distribution. Leaders could pay attention to all aspects of the digital divide (Hodges et al., 2020) that is multifaceted, encompassing not just access but engagement, support, and digital literacy (Lörz et al., 2024). Leadership, then, entails advocacy, resource allocation, and community partnership (Johnson et al., 2022). Innovative practices, such as heterogeneous grouping and AI-supported models, can help create inclusive learning environments. Furthermore, school leaders could foster partnerships with families and communities to enhance support systems for marginalized groups.

Policy and Governance: School leaders play the critical role of interfacing between broader government policymakers and policy development and implementation in schools. This theme emphasizes the need for policymakers to develop flexible, living documents that adapt to the rapidly changing educational landscape. Policymakers could support leadership development programs that go beyond compliance checklists and foster reflective, context-sensitive strategic thinking and a holistic approach to leadership and transformation of education (Eickelmann et al., 2024). Engaging educators, researchers, and community stakeholders in the policy-making process ensures that policies are coherent, relevant and responsive to the needs of schools. Policymakers could focus on setting achievable targets that consider the diverse contexts of educational institutions while promoting collaboration among stakeholders. By shifting from rigid regulations to more agile guidance, educational policies can better support the integration of digital technologies into learning environments.

Leading change: Change leadership is critical in navigating the complexities of digital transformation within schools. This theme underscores the importance of developing guiding frameworks and coherent change strategies that address the needs of all stakeholders involved in the educational process. Frameworks like DigCompEdu (Redecker, 2017) and the Australian Digital Capability Framework (DEWR, 2023) can support strategic alignment, but they must be used critically. The danger lies in adopting frameworks as rigid blueprints rather than flexible guides adapted to local needs. Also, frameworks and models alone do not change schools—relationships, trust, and internal coherence do. Leaders need to understand the emotional dimensions of change and foster a culture that encourages experimentation and innovation. By communicating effectively across various silos and building ownership among staff, leaders can mitigate resistance to change and promote a shared vision for digital initiatives. Also, leaders need to create safe spaces for trial-and-error, allowing educators to explore new practices without fear of failure. Furthermore, leaders should leverage the strengths of their teams to enhance capacity for change, ensuring the entire organization is aligned toward fostering a progressive digital learning culture. Middle leadership (Hargreaves, 2023) could bridge the gap between policy and practice, translating vision into actionable routines.

Future-Proofing leadership: Future proofing in education is often caricatured as blue-sky thinking, but it can be anchored in practical foresight: data-informed decisions, and a culture of innovation that embeds agility (Pietsch & Mah, 2024; Sacavém et al., 2025). Drawing on McCarthy et al. (2024), future-proofing requires school systems to be experimental, reflexive, and inclusive. Leadership development must be rethought as an iterative, inquiry-driven process—not a course or credential. Data-informed leadership can be developed through multidisciplinary collaboration and ethical awareness (Aziz et al., 2024), acknowledging that algorithmic decision-making demands fairness, transparency, and accountability (Lepri et al., 2018), and supported by an analytical culture (Szukits & Móricz, 2023). Emphasizing forward-looking vision and strategies helps school leaders and educators navigate uncertainties in decision-making related to technology integration. By fostering a culture of adaptability and resilience, educational leaders can ensure that their institutions are equipped to thrive in an ever-evolving landscape, ultimately benefiting both learners and educators.

Key insights from other TWGs

Insights with TWG 7: In a digitally saturated education ecosystem, leaders need to consider the mental health and well-being of first-level stakeholders, including teachers, students and parents. Professional development of leaders and teachers on wellbeing and mental health is necessary because only efforts from a large majority of staff can produce effective change.

Insights with TWG 4: Professional development of teachers' digital competence and pedagogies includes developing skills in designing learning environments, a growth mindset, and engagement with students. Leaders play important roles in providing sustained, coherent, relevant and contextualized professional development programs, such as coaching, rather than disjointed and decontextualized courses. Leaders should avoid having

deficit mindsets about teachers, use relevant and deserving encouragement, and remove practices that de-professionalize teachers.

Insights with TWG 1: With a focus on leaders, it is necessary to consider their access to research and researchers to inform or review work towards a future ecosystem. Daniels et al. (2019) present a review of effective leadership characteristics and features of effective professional development activities for school leaders. Schmitz et al (2023) investigated transformational leadership practices to empower teachers to use technology.

Insights with TWG 8: Consideration of a future focused education ecosystem needs to incorporate environmental sustainability factors. Adoption of a postdigital viewpoint is another consideration that could be included.

Strategies and actions

TWG 2 proposed the following strategies and actions for (1) policymakers, (2) practitioners, who, in this context, are leaders in schools and education and (3) researchers working on school leadership.

Strategies and actions for policymakers

1. **Shift from compliance-driven regulation to agile, co-created guidance to enable the design of future educational opportunities**
   Develop living, iterative policies that include regular input from students, parents, teachers, school leaders, and researchers, ensuring that digital education policy and governance remain relevant, context-responsive, and trusted.
2. **Resource leadership development that integrates digital, instructional, and equity goals**
   Support long-term resourcing of leadership programs that promote a range of approaches and models, build strategic foresight, and center digital inclusion.
3. **Enable schools and empower school leaders to tailor digital learning strategies through flexible resourcing**
   Provide schools with decentralized budgetary autonomy and strategic planning approaches that allow them to select technologies, platforms, and models that are responsive to their understanding of learning, students' and community's needs.

Strategies and actions for practitioners (Leaders in schools and school education)

1. **Lead the development of a school-wide digital learning culture grounded in equity and collaboration**
   Take active steps to foster a shared vision for digital transformation that incorporates the perspectives of teachers, students, families, and community stakeholders. Ensure this vision addresses local needs but also aligns with a shared system-wide vision of future-proof education, and removes barriers related to access, skills, and opportunity, particularly for marginalized groups.
2. **Enable stakeholder agency and leadership of digital initiatives through consideration of a range of models**

Ensure leadership that empowers all stakeholders (including teachers and students) to lead digital initiatives, shape professional learning, and co-create innovation. Recognize that developing internal leadership capacity and organizational learning are essential for sustaining change.

3. **Build conditions for experimentation and adaptive change**
   Create time, space, and support for staff and the wider school community to trial new and existing practices and technologies (e.g., AI), learn from both cycles of success, failure, and iteration. Prioritize progress over perfection to foster a culture of purposeful innovation.

Strategies and actions for researchers

1. **Explore the lived realities of digital leadership in context**
   Investigate how different leadership approaches and models operate in situ — for all education organizations, particularly in areas of disadvantage — and how they are related to digital learning cultures within ecosystems for the future.
2. **Co-design tools to support self-assessment and capacity building for leadership for the future**
   Co-create validated instruments and analytics (e.g., digital competence dashboards, leadership readiness tools) that help schools and school leaders monitor their progress, reflect on digital learning practice and culture to plan for future growth.
3. **Engage in research–practice–policy partnerships to inform leadership**
   Move to co-design by working with educators, leaders, learners and industry to co-produce research that enables timely and informed policy decisions and directly supports implementation at scale in the short and long term.

Actions from the TWG

TWG2 calls for coordinated and strategic actions to strengthen transformative leadership and cultivate inclusive, adaptive, and future-ready digital learning cultures in schools.

1. Prepare joint academic articles and policy briefs that explore diverse leadership models, digital equity, and frameworks for school-level implementation of digital transformation strategies.
2. Bring the Call to Action into our respective networks of school leaders, educators and researchers to share best practices, facilitate peer learning, and pilot innovation models.
3. Sharing the ideas from TWG 2 in other conferences.
4. Reflecting on the relevance of ideas in respective contexts.
5. Design a Digital Leadership Toolkit that includes self-assessment instruments, change management models, and templates for creating school-specific digital transformation plans.

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Thematic Working Group 3 - Technology-Enabled Inclusivity: empowering learners from diverse and differing cultures

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Declaration of uses of AI

This chapter results from contributions of members of the EDUsummIT 2025 TWG3, supported in part by specific uses of AI. The TWG3 membership comprised 2 team leaders and 12 members. Within that membership, 3 did not attend the onsite meetings, but did contribute to this chapter online, 7 disclosed their uses of AI, and 4 did not. From the disclosures of AI use, prior to the meeting, Claude 4.0 Sonnet and Perplexity were used to summarize points from the literature referred by members of the group, and summaries were shared with all members. During the onsite meetings, Otter.ai was used to record and gather notes from discussions and these were shared with the onsite members. Claude 4.0 Sonnet was used to summarize these transcripts, to draw out key points that were individually referred to, while early generated summaries were reviewed and edited by onsite members. At a later stage, Google Docs was used to take notes of contributions from onsite members, which produced lists and points for actions and recommendations. Whilst AI was used to formulate earlier outputs, all members declare that these AI-generated outputs were checked, edited and reorganized, without uses of AI, which led to the text as offered in this chapter.

Introduction

In EDUsummIT 2025, TWG 3 explored the design and implementation of technology-enabled, learner-centered approaches for marginalized populations. This focus took forward outcomes, discussions and recommendations from previous EDUsummIT meetings, which focused on influences affecting digitally excluded populations (Passey, Ntebutse, Ahmad, Cochrane, Collin, Ganayem, Langran, Mulla, Rodrigo, Saito, Shonfeld, & Somasi, 2024) and empowering equity through digital agency (Passey, Shonfeld, Appleby, Judge, Saito, & Smits, 2018).

Marginalized populations include individuals facing various forms of oppression, such as those with disabilities and people from under-represented and disadvantaged identities. During the TWG 3 discussions, outcomes emerged that included considerations for policy and practices, adaptive technology integration, and strategies for creating inclusive learning environments for the diverse needs of individuals.

Challenges

Challenges were brainstormed by the group, organized during several rounds of sorting and discussion, including using AI to generate summaries that were member-checked and edited into the following key points and summary.

1. Preventing Lack of Access to and Uses of AI and Educational Technologies from Perpetuating Marginalization Patterns and Digital Inequalities. The core challenge is ensuring that existing and future technology does not continue to reinforce any existing oppressive systems, but guaranteeing that marginalized communities maintain autonomy over technological design, implementation and governance affecting their educational futures.

2. Addressing Multi-Dimensional Digital Divides Beyond Simple Access. Moving beyond “inequalities of having” (access) to “inequalities of knowing” (usage skills) and “inequalities of power” (abilities to mobilize technology for personal goals) (Bihr & Pfefferkorn, 2008; Collin, 2013). Approximately 75% of some communities lack basic electricity access, creating fundamental infrastructure gaps (UNESCO, 2024).

3. Balancing Cultural Preservation with Technological Innovation. Protecting and preserving marginalized knowledge systems while preventing technology from contributing to cultural homogenization. There is a risk that AI systems, predominantly based on Western/English language datasets, may not adequately represent diverse cultural ways of knowing and learning.

4. Supporting Teacher Preparedness and Professional Development. Significant gaps in teacher knowledge and professional readiness for implementing inclusive technology practices should be addressed. Teachers need professional development that goes beyond technical skills to include critical digital pedagogy (Carius & Scartoni, 2023), understanding of bias in technology systems, and abilities to create and orchestrate diverse and upcoming learning environments.

5. Managing the Pace of Technological Change versus Educational Implementation. The difference between the rapid rate of digital technology development and the later application time and (potentially slower) rate of educational adoption and integration into practice can increase digital inequalities (Imran, 2023), particularly affecting marginalized communities.

6. **Lack of Clarity in the Conceptualization of "Marginalization" and "Demarginalization".** The diverse meanings of "demarginalization" globally, and how it emerges at a systemic and local scale, and from an intersectional perspective, are under-defined and under-theorized. A deeper understanding is necessary to achieve genuine inclusion.

Opportunities

Opportunities were brainstormed by the group, organized during rounds of prioritizing and discussion, including using AI to generate summaries, and member-checked and edited into key points and summary that follow.

The opportunities centered on leveraging AI and digital technologies as collaborative tools to transform education systems toward greater inclusivity, with particular emphasis on those with individual and specific needs, Indigenous knowledge integration, community-centered design, and teacher-student empowerment within sustainable research networks aimed at social justice.

Opportunities concern:

1. Personalized and Inclusive Learning Design - Creating specifically contextualized solutions, using Universal Design for Learning principles (Veytia Bucheli et al., 2024) and co-designed tools (human-centered learning analytics) with marginalized communities to support individual learning needs, carefully balancing stakeholders' involvements in designing and deploying learning analytics and AI in educational systems throughout all design phases, actively involving target end-users, especially students, to delineate the balance between human control and automation, and exploring safety, reliability, and trustworthiness as principles in future human-centered learning analytics and AI in educational systems (Alfredo, Echeverria, Jin, Yan, Swiecki, Gašević, & Martinez-Maldonado, 2024; Buckingham Shum, Ferguson, & Martinez-Maldonado, 2019).

2. Teacher and Student Empowerment - Developing digital literacy, digital agency, and inclusive practices through professional development and capacity building.

3. AI as Educational Partner and Amplifier - Using AI to support teachers in diversifying learning environments, seeking to amplify human thinking, and serving as a tool to generate ideas or possibilities, as a potential co-designer/collaborator rather than a replacement.

4. Marginalized Knowledge Integration and Autonomy - Leveraging marginalized ways of learning, supporting learner data ownership, and incorporating traditional knowledge systems into mainstream education.

5. Research and Collaboration Networks - Establishing global networks for best practice sharing, small-scale experimentation, and continued inquiry through action-based research.

6. Institutional Change and Social Justice - Using technology-enabled inclusivity as a catalyst for educational ecosystem transformation toward greater equity and justice.

7. Community-Centered Development - Building on local cultural knowledge, funds of knowledge from elders, and community partnerships for authentic innovation.

The challenges and opportunities identified are interconnected and require systemic, multi-level approaches that prioritize social justice, community agency, and cultural responsiveness rather than technology-first solutions.

Key contributions of TWG3 to new educational realities

TWG 3 developed a list of actions, in a similar manner to the challenges and opportunities lists, and these three lists became a core focus for discussions about recommendations (that follow in section 5).

Actions for Policymakers

1. **Design the development of educational technology policy frameworks** to transform existing frameworks from access-focused to **justice-oriented paradigms** to prioritize community, challenge dominant patterns in educational technology, and ensure equitable participation in technological benefits.
2. **Implement comprehensive policy frameworks** to support diverse and innovative justice-oriented approaches to educational technology that **preserve and protect place-based locally relevant knowledge**, while connecting to global constructs.
3. **Restructure education systems** to develop educators capable of implementing technology-enhanced inclusivity through **comprehensive preparation that integrates social justice and critical digital pedagogy**.

Actions for Practitioners

1. **Cultivate agency of all stakeholders,** to create and facilitate new knowledge, applications and insights to inform policy, research and community conversations that **illustrate the intersections of formal, informal, environmental and personal wisdom** and practice.
2. **Develop critical literacy and agency** for stakeholders to acknowledge current oppressive patterns and inequalities from systemic daily occurrences, and then **create more equitable futures that leverage technology** and digital capabilities as a multiplier of human thinking and potential.
3. **Continuously co-design technology** which is **equitable, reciprocal and responsive** with and to learners and other critical stakeholders.

Actions for Researchers

1. **Further develop and test theoretical understandings** of the diverse possible meanings and reasons for demarginalization and **investigate the long-term impacts of justice-oriented policy implementations** on educational equity outcomes, community empowerment, and cultural preservation.
2. **Develop methodological innovations for participatory action research** in education contexts, including an emphasis on **community-controlled research processes**, global-local collaboration, with a critical eye towards forms of digital technologies.
3. **Construct evidence-based bodies of knowledge** to evaluate the effectiveness of **justice-oriented teacher education approaches** in preparing educators for inclusive technology integration.

These actions need to be framed by justice-oriented approaches, centering community sovereignty and cultural knowledge, and ensuring technology serves to amplify rather than marginalize diverse learners and communities.

Recommendations

The theoretical foundation for these recommendations rests on what we term the **Digital Justice Ecosystem Framework**, which synthesizes insights from the EDUsummIT 2025 discussions with established theoretical perspectives including Design Justice (Costanza-Chock, 2020), and Cultural Historical Activity Theory (Engeström, Miettinen, & Punamäki, 1999).

As a TWG 3 participant noted: “The core challenge of technology-enabled inclusivity is preventing AI and educational technologies from perpetuating marginalization patterns and digital inequalities while ensuring marginalized communities have control over technological design, implementation, and governance affecting their educational futures”.

The framework conceptualizes education ecosystems as complex adaptive systems where technology serves as both a potential agent for liberation and a mechanism for perpetuating marginalization. The model recognizes that “marginalization is not a simple thing to look at. There are degrees of complexity here, **major** degrees of complexity” and that “context makes an enormous difference”.

In the following stakeholder-specific recommendations, we understand ‘stakeholders’ to include all those seen and unseen within the system that surrounds, affords, constrains, and sustains the learning environment.

Recommendations for policymakers

- Cultivate agency of all stakeholders to create and facilitate new knowledge, applications, and insights to inform policy, research, and community conversations that illustrate the intersections of formal, informal, environmental, and personal wisdom and practice.
- Develop critical literacy and agency for stakeholders to acknowledge current oppressive patterns and inequalities from systemic daily occurrences, and then create more equitable futures that leverage technology and digital capabilities as an

amplifier of human thinking and potential, supporting diverse learning environments and creating a more just future for all.
- Continuously co-design technology which is equitable, reciprocal and responsive with and to learners and other critical stakeholders.

Recommendations for practitioners

- Design educational technology policy frameworks which will transform existing frameworks from access-focused to justice-oriented paradigms that prioritize community, challenge dominant patterns in educational technology, and ensure equitable participation in technological benefits.
- Implement comprehensive policy frameworks to support diverse and innovative justice-oriented approaches to educational technology that preserve and protect place-based locally relevant knowledge, while connecting to global constructs.
- Restructure education systems to develop educators capable of implementing technology-enhanced inclusivity through comprehensive preparation that integrates social justice and critical digital pedagogy.

Recommendations for researchers

- Further develop and test theoretical understandings of the diverse possible meanings and reasons for demarginalization and investigate the long-term impacts of justice-oriented policy implementations on educational equity outcomes, community empowerment, and cultural preservation.
- Develop methodological innovations for participatory action research in education contexts, including an emphasis on community-controlled research processes, global-local collaboration, with a critical eye towards technology.
- Construct evidence-based bodies of knowledge to evaluate the effectiveness of justice-oriented teacher education approaches in preparing educators for inclusive technology integration.

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Thematic Working Group 4 - Professional digital competence of teachers: leveraging digital technologies to deepen learning

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Introduction

The competence of teachers to leverage educational technologies in ways that promote students‘ cognitive and emotional engagement and learning has been a persistent theme for many years. The utilization of digital technologies to enhance learning processes, particularly in the development of complex and critical thinking skills, is recognized as a pivotal concern for effective and sustainable learning. Nevertheless, traditional approaches are still more widespread in teaching and learning with digital technologies (e.g., Abedi, 2023; Prestridge et al., 2024). This thematic working group (TWG4) therefore examines how teachers' digital competencies could and should be addressed to enable the shift in using technologies for deep learning.

Positional Statement

TWG4 brought together researchers, practitioners and policymakers from higher education, K-12 education, and professional learning. Our working group has a rich understanding of and empathy for the needs and experiences of teachers who are exploring the use of digital technologies in their educational classrooms, schools and for their own professional

learning. The theme of TWG4 sits at the heart of the purpose of learning with educational technologies, yet is also an ongoing complex representation of the challenges and needs of achieving such an outcome. Our mission was to establish a complex representation of deep learning with a clear relationship to teachers' digital competencies and actions for professional digital growth.

Building on previous knowledge and understanding from EDUsummIT's TWGs in past years, this work is informed by the 2022-23 working groups: Fostering self-regulatory skills in learners: challenges and opportunities for assessment and Pedagogical reasoning and reflective practice: Teacher's Professional Development (TPD) in online education. Teachers who are designing for deep learning through the use of digital technologies develop in their students' skills to self-regulate as a critical part of creative and self-directed learning with technologies (Azevedo, 2009). Additionally, self-regulated learning becomes more prevalent when learning in online spaces (Xu et al., 2023). Drawing on reflective processes, teachers' reasoning for the use of technologies in designing for deep learning is informed by pedagogical knowledge bases, beliefs and practical contingencies (Stefaniak et al., 2021).
TWG4 explored urgent issues associated with the development and enactment of teachers' digital competency to effectively leverage digital technologies in fostering deeper learning. Discussions focused on best practices for integrating digital technologies into the curriculum, professional learning initiatives for digital skills, and innovative pedagogical practices that promote critical thinking, creativity, and collaboration among students through the use of technology. We had two major aims:

1. Define deep learning and connect teacher digital competencies that enable this level of student engagement; and
2. Examine the challenges and opportunities associated with enabling teacher digital competencies.

Challenges and opportunities

One of the first challenges we identified, is the concept of "deep(er) learning,". It became apparent that the notion of what deep learning is or looks like, shifts by subject, context, and time, and has not only cognitive but also emotional dimensions. This makes it difficult to establish common expectations for "what teachers should be able to do." Due to divergent goals, constraints, and experiences across different sectors and disciplines, comparisons and transfer are also complicated.

Moreover, "digital competence" appears to be a moving target within the dynamic realities of technology and schooling. Existing competence frameworks have certain limitations. Static checklists of competencies struggle with a rapidly changing ecology, where professional digital competence should be better understood as a developmental, adaptive expertise situated in context. Many frameworks also under-address the role of beliefs, and values, factors that strongly shape practice. Technological change routinely outpaces teacher preparation and

conventional professional development, leaving gaps mediated by “unseen” beliefs about effort, benefits, and risks.

Designing and orchestrating complex hybrid environments, and maybe even integrating generative AI applications, raises new questions about what it takes for deep learning to occur. This places additional demands on teachers’ competencies, roles and identities. Some entrenched routines must be unlearned to make way for new teaching and learning practices. However, system forces often don’t support the changes needed.

Key contributions of the TWG to the new educational realities

Providing a shared understanding of teachers‘ digital competencies for deep learning

To establish a shared understanding of teachers‘ digital competencies for deep learning, the working group unpacked teaching scenarios and identified associated teacher competencies. The deep learning characteristics that should guide instructional designs, in order of importance, are summarized in Table 1. These characteristics align with the broader educational literature, in which deep learning is described as promoting transfer, critical thinking, and authentic engagement with complex ideas (Smith & Colby, 2007).

Table 1: Deep Learning Characteristics

- engage in problem solving (incl. problem posing, the analysis & exploration of problem spaces, testing of assumptions, experimentation, and argumentation form evidence),
- develop a deep understanding of content through the building of valid mental models and conceptual integration,
- apply and transfer knowledge to new contexts (incl. real world problems, public impact) and to innovative designs,
- engage in metacognition (monitoring & evaluation), epistemic cognition and critical thinking,
- engage in self-regulated learning (apply learning strategies, motivational strategies and self-regulate learning processes),
- interact, communicate and collaborate with each other and technology over time (working & dialogue: listening, discussing, sharing, feedback),
- view learning as an active, constructive and interactive process.

Illustrating the Enactment of Digital Competence in Deep Learning Contexts

Teachers’ digital competencies for deep learning are best illustrated through authentic learning scenarios. Therefore, scenarios from a variety of contexts were documented, systemized and connected to teachers’ digital competencies. In mathematics, for example, digital simulations such as GeoGebra allow students to manipulate variables, pose inquiries, and build conceptual understanding through experimentation and real-world application.

Teachers facilitate this process by designing inquiry-based tasks, scaffolding student engagement, and integrating pedagogical, content, and technological knowledge in contextually appropriate ways. Similarly, in elementary classrooms where learners are investigating local challenges (e.g. river flooding), teachers orchestrate group inquiry where digital tools support research, collaboration, and prototyping of solutions. In both examples, teachers’ competencies extend beyond tool use to include critical reflection, adaptive

expertise, and a commitment to ongoing professional learning that empowers students to construct their own valid mental models.

Identifying and Overcoming Challenges in Designing for Deep Learning

Teachers face persistent challenges in designing for deep learning with technology, including limited disciplinary expertise, rigid pedagogical mindsets, and insufficient integration of real-world problems into classroom designs. These barriers are compounded by systemic pressures such as standardized testing, limited time, and uneven access to resources. To overcome them, teachers benefit from design-based professional learning, opportunities to collaborate with peers, and coaching that emphasizes authentic assessment and reflective practice (Friesen & Brown, 2022; Becker & Jacobsen, 2022, 2023).

Developing robust knowledge bases, connecting the curriculum to real-world applications, and embracing social constructivist and constructionist approaches to designing learning are critical in shifting practice. For example, educational data mining research has highlighted the role of deep learning approaches for educators to understand and support student engagement in technology-mediated environments (Hernández-Blanco et al., 2019). Leadership support, positive professional learning experiences, and systems-level recognition of the value of deep learning processes can further strengthen teachers' capacity to design and sustain technology-enabled deep learning.

Modelling Teachers' Digital Competencies for Deep Learning

The following figures illustrate various ways to conceptualize teachers' digital competencies for deep learning. There are three figures we as a working group put forward as pathways to understanding the competencies-technology-teaching-learning dynamic.

Figure 1 conceptualizes the interplay between teachers' professional digital competencies and the design of deep learning scenarios. Rather than positioning technology as an add-on, the model shows its mediating role in creating opportunities for students to engage in authentic and meaningful learning.

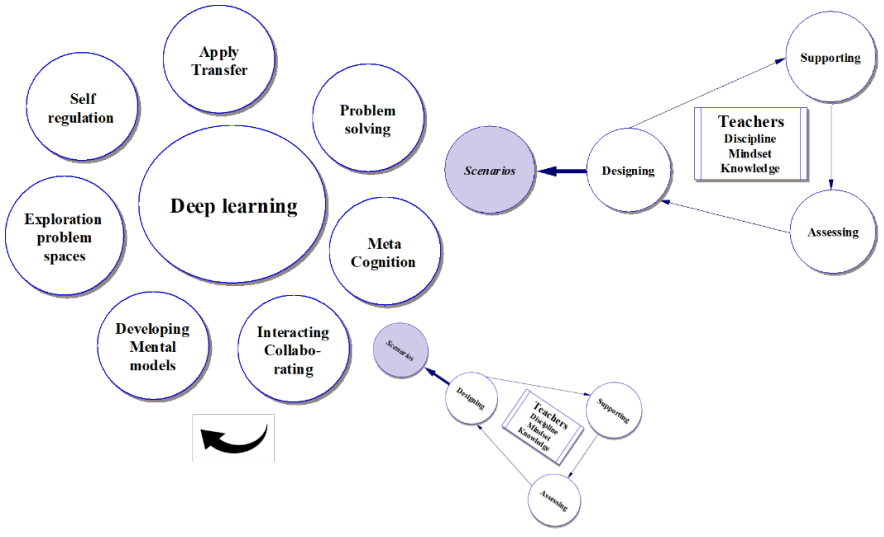

Figure 1: Modelling Teachers' Digital Competencies for Deep Learning I (by TWG4)

Figure 2a) illustrates the intertwined domains of teachers' professional digital competence. The figure emphasizes that competence does not lie in one domain alone but in the integration and interplay among them. This holistic view underscores the importance of teachers developing adaptive expertise that allows them to flexibly combine these domains in authentic contexts.

Figure 2b) shows the "Students blooming in a deep learning ecosystem" model, which uses a metaphor to illustrate how students' deep learning is being shaped by the interdependent relationships within a complex ecosystem of learning. The figure highlights the many intertwined components necessary for a deep learning experience: e.g. long-branched roots (e.g., teachers' mindset and knowledge) rooted in a rich soil (e.g., classroom/school context integrating real-world connections) feed into strong leaves (e.g. teacher's design & scaffolding practices), which create complex deep learning experiences for students (the flower). In this model, technology is viewed as a microcosm (e.g., a terrarium) that permeates the conditions necessary for growth. This metaphor also illustrates that growth cannot be controlled but it can be enabled by increasing the conditions that foster deep learning.

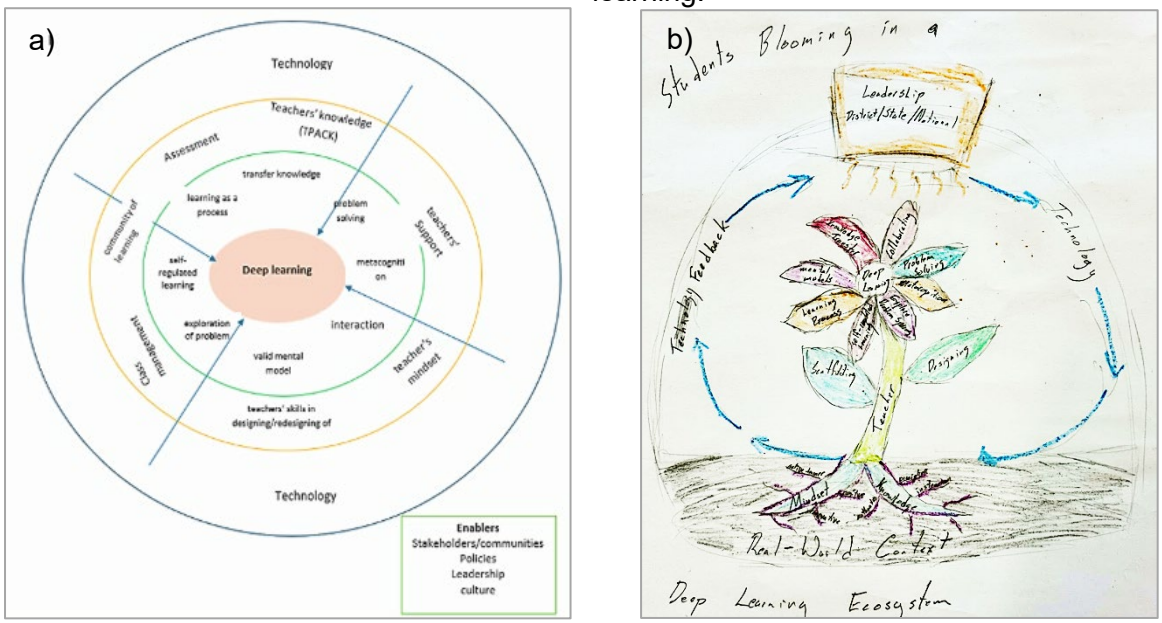

Figure 2: Modelling Teachers' Digital Competencies for Deep Learning II (by TWG4)

Key insights from other TWGs

The following key insights were derived from the rich discussions with the following TWGs:
TWG1: Bridging the Gap Between Research and Practice

Our discussion with TWG1 highlighted the important fact, that research should value teachers as co-creators and co-designers via design-based research and research–practice partnerships. This supports teachers' context-related professional development and addresses the issue of transferring research results regarding teachers' professional competence to different contexts. However, teachers must also develop the skills necessary

to engage in co-design and/or research-based activities with researchers in long-lasting research-practice partnerships. Furthermore, dissemination of research must be ensured through tailored science communication and emerging research evidence needs to be better integrated into practical recommendations and guidelines for teachers and schools. We also discussed an expanded interpretation of the term “practice”, which should also include the perspectives of work professionals, occupational institutions and/or the community. This adds opportunities for authentic, problem-based learning and creates the awareness of the need for deep learning designs.

TWG 2: Developing and leading digital learning cultures in schools: the role of leadership

Discussions with TWG2 emphasized the important role of leadership for learning in cultivating innovation and continuous improvement - critical conditions if teachers are to implement deep-learning designs with technology. For students to be deep learners, teachers and leaders must also be deep learners - a cultural stance that normalizes the experimental and reflective use of technology. Policies should be cyclically adapted and revised to ensure a productive alliance with technological innovations and shifting competence requirements.

TWG 5 and TWG 8: AI and AI-literacy for teaching and learning

GenAI applications, their opportunities and risks, are intensively discussed in recent research. Teachers play an important role in defining and designing GenAI supported learning scenarios which might increase or decrease deep learning opportunities for students. How can GenAI be used to support deep learning? Moreover, students’ uses of and concepts of GenAI frequently outpace teachers’ current competencies. Therefore, teachers’ competence to ensure deep learning needs to be treated as developmental and contextual, embracing the new challenges of GenAI on all educational levels. However, using GenAI for specific tasks may also free up time for reflection and argumentation activities in class, as well as increase higher frequency and quality of formative assessments – all of them directly tied to deep learning processes.

Strategies and actions

Strategies and Actions for Practitioners

- Intentionally design for technology-supported learning experiences that develop students’ critical thinking, creativity, collaboration, communication, and self-regulation skills.
- Intentionally reposition yourself as a facilitator or even co-learner in a technology-supported environment, empowering students to take the lead and support mutual learning through the smart and responsible technology use.
- Use technology to engage in professional learning communities at different levels (local, regional, state, and national), actively critiquing and improving classroom practices and adaptations.
- Engage in design-based research in collaboration with teachers and researchers to create responsive learning environments.

Strategies and Actions for Policy Makers

- Enable the sustained development and implementation of deep learning approaches through ongoing support and funding.
- Address the dynamic nature of technology and innovation by making education policies dynamic and responsive and ensuring the cyclic evaluation and adaptation of policy practices together with educators and researchers.
- Engage in long-term collaborative partnerships with educators, researchers and other stakeholders (research-practice partnerships) to co-design, implement and study new educational approaches and reforms.
- Include principles of deep learning in long-term goals for educational systems and focus assessment practices on deep learning objectives.

Strategies and Actions for Researchers

- Based on existing research, investigate and specify the role of digital technologies in deep learning scenarios (including GenAI) to enable problem solving, critical thinking, and collaborative and self-regulated learning.
- Engage in collaborative, design-based research with educators and students to investigate how professional digital competencies support deep learning in real-world contexts. Generate actionable knowledge that bridges theory and practice.
- Engage in multiple forms of knowledge engagement, dissemination and translation of research for the discipline and the professions.

Actions from the TWG

We plan to take the following actions:

- Write an academic journal article on urgent issues associated with developing and enacting teachers' competency in technology-supported deep learning contexts.
- Present themes and challenges identified by TWG4 at key conferences and meetings.
- Translate and publish brief companion pieces on national educational channels and networks.

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Thematic Working Group 5 - Artificial Intelligence (AI) literacy for teaching and learning: design and implementation

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TWG 5 focused on developing and implementing effective strategies for enhancing AI literacy and agency of teachers, equipping them with the knowledge and skills necessary to integrate AI into their teaching practices. Explorations covered curriculum design, professional development programs, practical classroom applications, and policy guidelines aiming to empower educators to confidently utilize AI tools and foster a deeper understanding of AI concepts among students.

Introduction

OpenAI's release of ChatGPT3 in November 2022 marked a watershed moment in AI's evolution, garnering significant public interest and media coverage. ChatGPT and other generative AI (GenAI) systems demonstrated the ability to generate extended text responses to diverse natural language prompts, often mimicking intelligent human production. Educational applications of non-generative or 'analytical' AI had previously been developing, including bespoke learning platforms, adaptive assessment systems, intelligent predictive analytics, and conversational agents as discussed in EDUsummIT 2019 (Webb, Fluck et al. 2021). However, GenAI's capacity to produce human-like text responses to varied requests represented a significant advancement that could potentially disrupt traditional educational processes.

On the one hand, the capacity for students to use generative AI to complete tasks for them has raised particular concerns around plagiarism and academic integrity, as well as potential negative impacts on creativity, agency and critical thinking. On the other hand, the possible

use of generative AI to amplify human creativity and productivity has the potential to affect individuals from every walk of life and professionals across all industries (Ghosh et al., 2025). Similarly, the use of AI in education by teachers is growing, with concerns around issues such as overreliance or bias, but also opportunities to enhance teaching, assessment, and personalized learning (Ifenthaler et al., 2024). Consequently, knowing how to effectively navigate a world with increasingly powerful generative AI and developing AI literacy has become an imperative for both students and teachers.

Understanding AI Literacy

Building on contemporary research and policy frameworks, AI literacy can be conceptualized as:

> *the integrated set of knowledge, skills and attitudes that enables individuals to understand how AI works and affects society, use AI tools responsibly and effectively, critically evaluate AI outputs and limitations, communicate or collaborate with AI systems, and—at advanced levels—design or adapt AI solutions* (Long & Magerko, 2020; Chiu et al., 2024; European Commission & OECD, 2025).

AI literacy is not simply about learning to use AI tools and how AI works, but also an applied knowledge and understanding of when and how to use it responsibly for (and while) learning (see Figure 1). Therefore, we propose that the concept of AI literacy needs to expand to define two distinct components: 1) learning ***about*** AI (foundational AI knowledge and skills); and 2) learning ***with*** AI (practical AI integration).

- **Learning *About* AI** focuses on technology education; learning what AI is and is not from a historical, cultural, and societal perspective, learning about the distinction between explanatory AI and generative AI, and being able to explanation how AI works in ways that can be understood by a non-technical audience
- **Learning With AI** involves deliberate use and integration into learning activities; using AI as a co-collaborator/learning partner/thought partner, applying pedagogies focusing on dialogue between teacher-student, student-AI, student-student, using AI as a seamlessly integrated teaching tool, which is a part of a learning environment (e.g., adaptive learning tool, automatic speech recognition).

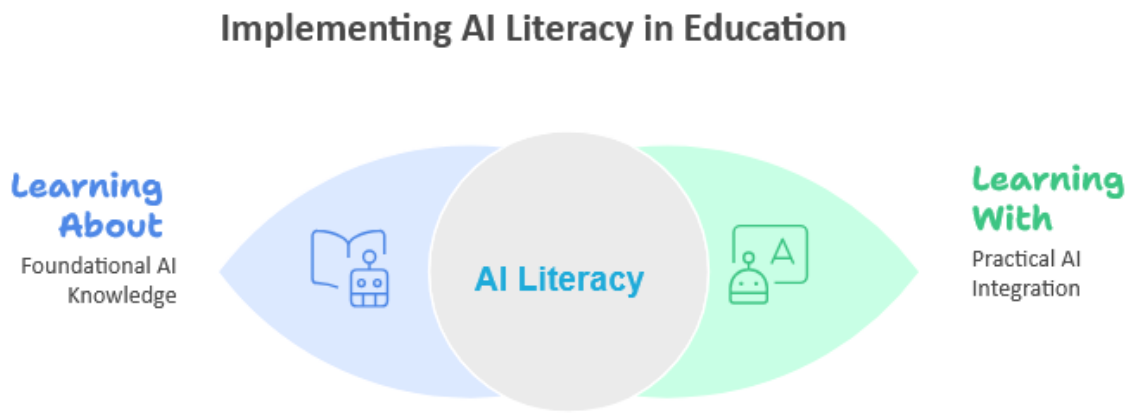

Figure 1: Conceptualizing AI literacy in education

AI literacy is integral to the evolving concept of **digital literacy**, reshaping how individuals access, evaluate, and produce information by influencing competencies such as media, data, and information literacy. As digital literacy expands, it increasingly demands the integration of AI and generative AI tools into everyday practices, emphasizing the need for individuals to develop skills in engaging with these technologies. AI literacy encompasses digital literacy and competence, critical awareness, and ethical understanding, and extends much further than technical tool proficiency. As AI technologies become embedded within the entire educational landscape, we are compelled to reconsider not only what we teach, but how we conceptualize teaching and learning itself.

Developing Student AI Literacy

A number of supporting frameworks and resources are available to support the development of AI literacy. These include:

- **EC/OECD AI Literacy Framework (2025)** — 22 AI literacy competences for school learners (EC & OECD, 2025)
- **UNESCO AI Competency Frameworks (2024)** — parallel matrices for students and teachers describing knowledge, skills and values for responsible AI engagement (Miao, & Cukurova, 2024; Miao, Shiohira & Lao, 2024)
- **AI4K12 "Five Big Ideas"** — a conceptual spine for K-12 curricula, with grade-band progressions linking AI concepts to practices (AAAI & CSTA, 2025)
- **DigComp 2.2 (EU)** — embeds AI under "Digital Content Creation" and "Problem Solving," illustrating links between AI, data and media literacies (Vuorikari et al., 2022)

AI literacy frameworks worldwide share a number of common concepts: **Technical AI knowledge** (understanding AI concepts, data, algorithms) and **the ability to use AI tools and applications** are universally emphasized. A **human-centered perspective** is common: frameworks encourage critical thinking about AI's role and promote uniquely human skills (creativity, empathy, judgment) that complement AI. Each also stresses **ethics and societal impact** — teaching students to consider fairness, transparency, and the consequences of AI on people. Across these models a learning continuum is common, from recognition to use to evaluation to design and creation. As society becomes more AI literate we anticipate frameworks for AI Fluency will emerge describing in more detail the trajectory from AI user to AI developer/creator.

While research evidence on the best ways to develop AI literacies is still equivocal, there are a number of emerging principles that can be used to guide teaching *about* AI and teaching *with* AI.

When teaching *about* foundational AI knowledge, educators may choose to:

- **Centre the role of humans in creating AI** and avoid anthropomorphisation
- **Develop understanding about the differences between types of AI** and their affordances and constraints (e.g., predictive/explanatory AI vs. GenAI, Intelligent Tutoring Systems, Learning Analytics)
- **Emphasize affordances of AI technologies, rather than specific AI tools**, supporting learners' abilities to make judgements about which AI tools are most appropriate to the learning activity or pedagogical approach
- **Identify misconceptions** that may hinder understanding or use of AI and find ways to address them that are consistent with learners' technical knowledge

- **Scaffold AI learning from foundational technical, practical and ethical perspectives** to the needs of the learners and their contexts

When teaching *with* AI, where AI tools are integrated into learning activities, educators can be encouraged to:

- **Understand the specific affordances of AI tools** (i.e. capabilities and limitations), such as adaptive feedback, content generation, or personalized support, and align them with evolving pedagogical approaches;
- **Experiment with and evaluate pedagogical approaches that might be enabled by AI** such as problem-based learning, collaborative learning, AI-mediated peer feedback and real-time formative assessment;
- **Consider the learning design of activities for effective student learning,** recognizing that initial, independent struggle can be more productive for deeper learning than receiving immediate AI assistance (see Kapur, 2016);
- **Support student self-regulated learning** by explicitly focusing on developing students' self regulated learning both in individual and group learning situations through coregulation and socially shared regulation of learning (building on work from EDUsummIT 2022, see Prasse et al., 2024);
- **Include pedagogical strategies to support students to manage and monitor their effort** while using AI tools;
- **Orient learners to regard AI as a tool for deepening learning, not as an answer machine**;
- **Help learners identify what tasks may be offloaded to AI** to reduce cognitive load and what tasks require deep understanding for learning;
- **Emphasize human agency** — learners must be taught to evaluate generative AI output and to always maintain a critical/evaluative lens when engaging with AI.

While further research will be needed to determine which methods and strategies for teaching about and with AI are most effective, the principles above serve as initial guidance for educators.

Ethical Considerations and Critical Perspectives

AI ethics and the literacies connected to it are inextricably linked to their surrounding context. AI, like any other technology, is a socio-technical product that embeds human interests, cultural perspectives, and intentions of social impact. Drawing on Cultural Historical Activity Theory (CHAT) (Engeström, 1987), we understand that AI tools mediate human activities within complex systems of relationships, community structures, and divisions of labor. This systemic view means that ethical AI literacy cannot simply involve adopting ethical standards or guidelines and ensuring compliance. Instead, it requires understanding how AI tools become embedded within specific educational contexts and how they shape—and are shaped by—local practices, values, and power dynamics.

The integration of AI in education has sparked a range of critical debates:

1. **Protecting privacy and safety**: AI in education often involves collecting vast amounts of student data, including academic performance, behavioral patterns, and biometric information, raising serious privacy and safety concerns;

2. **Bias and fairness**: AI systems can perpetuate existing social and cultural biases from their training data, leading to unfair decision-making and reinforcing systemic inequities;
3. **Trust and transparency**: AI decision-making processes are often opaque, raising questions about accountability when AI systems affect students' learning, development, and well-being;
4. **Equity in AI literacy development**: Ensuring all students can develop critical understanding of AI alongside the creative, ethical, and critical thinking skills needed for informed decision-making in a datafied society;
5. **Offloading learning**: AI misuse may prevent rather than enhance learning, particularly when used to bypass critical thinking and learning processes;
6. **Role of teachers**: Addressing concerns that AI might replace human teachers while recognizing that tailored epistemic, emotional, metacognitive and social scaffolding from teachers and peers remains essential for human learning;
7. **Environmental concerns**: training of AI models and disposal of e-waste raise sustainability issues that affect the whole planet and that can be addressed when deciding whether or not to use these tools.

These ethical considerations cannot be broached through narrow silos of thinking, and instead we draw on Bronfenbrenner's (1994) ecological framework to examine how ethics are shaped across four interconnected layers (see Figure 2).

The Individual: Personal interests, goals, values, and digital skills shape engagement with AI tools. However, many AI mechanisms remain invisible to users, creating challenges for ethical decision-making and raising questions of trust when interacting with opaque systems.

School Context: Teachers work within specific local contexts with particular AI tools, curriculum content, and diverse learners. Ethical decisions are embedded in everyday pedagogical practice as teachers decide whether, when and how to integrate AI tools whilst maintaining professional autonomy.

State and National Context: Educational structures such as national policies, curricula, assessment practices, and funding models shape what is taught and which technologies are available. Policy decisions may prioritize efficiency and standardization, potentially conflicting with local pedagogical needs and professional ethics.

Cultural Values and Norms: Broader cultural contexts encompass societal norms, value systems, and socio-technical imaginaries that shape how AI and ethics are perceived and enacted. Cultural values influence which ethical concerns are foregrounded and whose perspectives are recognized in shaping AI futures.

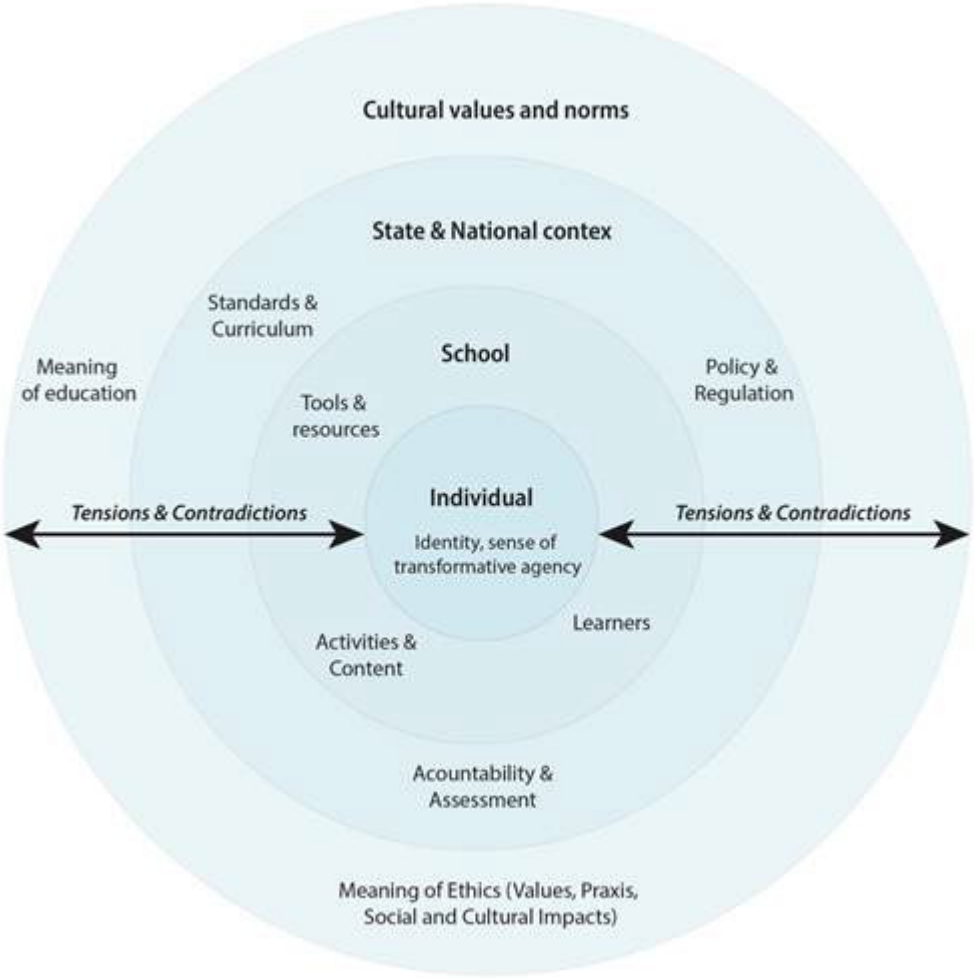

Figure 2. An Ecological Framework for AI Ethics

These levels are not independent but entangled, overlapping, and often contradictory. Ethical AI literacy involves developing the capacity to critically evaluate, resist when necessary, and reshape AI implementation based on educational values and local contexts. This requires maintaining human agency at the center of the learning process whilst harnessing AI's potential to transform educational challenges into opportunities for more equitable and inclusive learning. Understanding AI ethics requires recognizing that AI tools are not neutral instruments but are embedded within complex socio-cultural ecosystems. Rather than framing AI as inherently good or bad, our focus must shift to how AI is designed and integrated into learning processes.

Implementation Opportunities and Challenges

Disruptions typically subtend a range of opportunities and challenges, and the rapid emergence of AI is no exception. Key opportunities include:

- **Enhanced human interaction**: More time for individual guidance and social-emotional support;
- **Personalized learning**: Individualized instruction and differentiated content delivery;

- **Critical thinking development**: Students learning to question AI outputs and maintain agency;
- **Systemic transformation**: Transparent, accountable technology with community oversight.

However, there are a number of challenges to address:

- **Policy-practice gaps**: Insufficient implementation planning and lack of common language across stakeholders;
- **Professional development deficits**: Limited research on AI competencies needed for individual flourishing and social advancement;
- **Static frameworks**: Frameworks that don't evolve with practice and research;
- **Human agency concerns**: Power concentration and governance in edtech industry, risk of technological dependency, and loss of decision-making.

Key insights from other TWGs

The implications of generative AI permeate to all areas of education. However, the work of TWG5 had particular resonance with TWG3 (Tech-enabled inclusivity) and TWG1 (Bridging the gap between research and practice).

From TWG3, we learnt that when thinking about the individual, we need to remember that people are connected to family, culture, and social contexts. Hence empowering learners also means learning together by honoring their cultural heritage so that, in time, they can be empowered to become actors that are comfortable in their (digital) knowledge and can adapt their skills. This links to the ecological framework being used by TWG5 to conceptualize AI literacies and ethics. As well, TWG3 helped us to understand that learning how something works is an empowerment issue. For instance, knowing how a car works may not be needed to drive it, but can be crucial to understand when it breaks and not knowing how it works might introduce risks for the driver and others. This relates directly to TWG5's conception of learning 'about' AI.

TWG1 pointed out that we shouldn't only be concerned about a digital divide that relates to access, but also a 'digital use divide' that relates to practice. If people are provided with access but do not practice, they may still be at a social disadvantage. TWG1 also pointed out that 'Inclusion' encompasses an element of ordering and that the ideas of 'co-development' and 'co-design' may be preferable. They underlined that Indigenous and marginalized communities need to be part of discussions relating to AI literacy. This links with TWG5 points relating to accessibility and the need for AI to be considered as a human product.

Moving Forward: Strategies and actions

Strategies and actions for policy makers

As AI becomes increasingly pervasive and harder to disentangle from educational systems, educators must resist both the urge to block it entirely and the tendency to embrace it uncritically. Supporting learners and educators to engage ethically with AI in education demands a multi-layered and systemic perspective - one that accounts for the interplay and

tensions between individual decision-making, classroom practices, institutional opportunities, and wider cultural structures.

There is an evident need for policy-makers, state authorities and local school administration to create affordances and structures that support the work and agency of teachers. Instead of top-down models, teachers and local communities should be involved in co-design and co-creation of digital ecosystems and educational activity structures, enabling them to become transformative educators.

Strategies and actions for educators

Teachers need thoughtful, pedagogically-informed AI literacy teaching — an approach that interrogates the role of AI, preserves human values and agency, and ensures that learning remains a process of meaning-making, growth, and transformation. Teacher mindsets, beliefs and attitudes about AI shape how it is valued and enacted in classrooms. Supporting teachers to reflect on their pedagogical values and practices is crucial for creating space for AI that is equitable, inclusive, and empowering.

We must be clear about where AI belongs (and doesn't belong) in the learning process. While AI has become ubiquitous, teachers need to be explicit about how AI should or should not be used. This requires teachers to have the AI literacy to discern what is AI, how it can be managed, and how to deliberately integrate AI in a manner that supports learning rather than replacing it.

Self-regulation is a critical issue for practitioners to address in their practice. When integrating AI in the classroom, teachers need to navigate the tension between efficiency and deep engagement with educational processes. Encouraging students to move beyond passive consumption toward active construction of knowledge requires an understanding about what tasks can be offloaded to AI, and which ones require effort to be applied in order to develop deep learning (Burns et al., 2025). The shift from product to process in assessment is central here: we need to prioritize how students learn, not just what they produce.

Strategies and actions for researchers

There is a clear need for interdisciplinary, longitudinal research on the effects and impacts of AI literacy initiatives as well as for understanding the tensions that will inevitably arise when transforming existing systems and social practices in education. Critical and ethical approaches for AI education call for cross-boundary collaboration and systematic action across different levels of the educational system.

This does not mean socializing individuals and communities into existing practices and conditions, but supporting them to become transformative agents who can critically explore and question the status quo, develop informed stances and voices, imagine alternative possibilities, and take collective action toward more just and sustainable AI futures.

Actions from TWG5

TWG5 is a large and cohesive team that was productive in their Dublin meeting and is ambitious in their future goals. As well as this eBook chapter, the team plans the following three publications:

1. Navigating AI's Educational Future: Expert Scenarios and Implications for Teaching and Leadership

2. Revisiting Pedagogical Content Knowledge (PCK) development with Generative AI

3. Situated AI Ethics: A Cultural-Historical and Ecological Framework for Education

The team also intends to respond to emerging research and publication opportunities, based on developments in the AI in Education field.

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Thematic Working Group 6 - Designing educational practices to cope with uncertain futures: the role of digital technologies

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Introduction

As outlined on the EDUsummIT website, the aim of TWG 6 was to collaborate on designing adaptive and resilient education ecosystems that can effectively navigate and thrive amidst future uncertainties by leveraging digital technologies.

As a group we agreed that the current educational ecosystem is under systemic strain in many places throughout the world. Important issues that we identified are an erosion of trust in teachers and the related trend of datafication of education (Daliri-Ngametua et al., 2022), the role of high stakes testing; these tests often dictating a narrow focus on knowledge acquisition and lower order thinking (Krause et al., 2024), highly scripted educational materials on paper or on the computer (Hogan & Sellar, 2021), problematic (social) media use at home that influences learning and interaction in classrooms (Bozzola et al., 2022; House of Commons, 2024), commercial firms and policies that promote educational automation in the light of AI developments, budget cuts and teacher shortages (Bozkurt et al., 2024; Hogan & Sellar, 2021; Kerssens, 2024). This systemic strain influences teachers and students. Teachers see part of their agency being taken away when forced to teach with scripted commercial or state dictated materials, or with Generative AI (GenAI) (Bozkurt et al., 2024; Fitz & Nikolaidis, 2020). Too many of them leave the profession (Huddleston, 2024). Many students feel disengaged and display a shallow approach to learning that does not prepare them for (uncertain) futures (Bozkurt et al., 2024; Lindblom-Ylänne et al. 2019; Winthrop et al., 2025). Over-reliance on GenAI can be tempting for students with such a shallow approach to learning, and may further deteriorate their learning (Bastani et al., 2024).

Many players in the educational ecosystem are involved in this situation for better or for worse; teachers, students, administrators, parents, teacher educators, journalists and the general public, inspectorates, commercial firms producing (scripted) educational technology and/or scripted materials on paper for education, researchers, regional and national policymakers, big tech lobbies, and intergovernmental organizations. It surprised us that

some of the influential forces (e.g., the tech lobby in Europe and in the intergovernmental organizations that span many countries) are so far away and seem to play their role in partly invisible ways. Teaching is not only a matter of teachers and students, but a matter of a much larger ecosystem that they are unable to influence. It is this ecosystem that enables or hinders their enactment of teacher agency (Priestley et al., 2015).

Technology alone cannot be seen as a solution to these problems, as, in many countries, technologies in schools are part of the systemic strain in the educational ecosystem. However, thinking about principles for technology integration in education is warranted and even more so given the challenge of preparing students for uncertain futures.

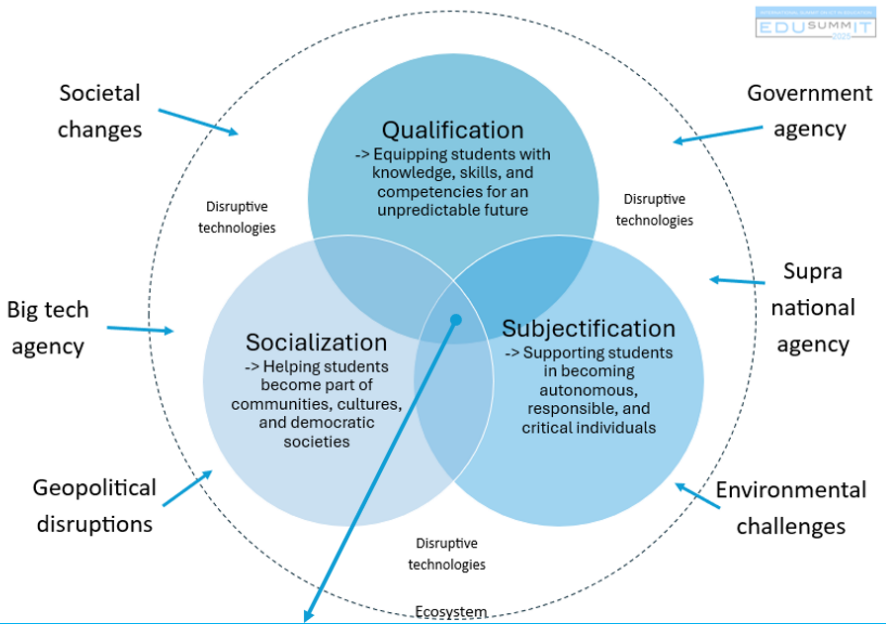
We decided to approach our design problem from the needs of the primary stakeholders: the students and the teachers. We started our endeavor with the essential question ‘how can teachers prepare students for complex and unpredictable situations? We agreed that in the light of complex and converging challenges education must extend beyond a narrow focus on knowledge acquisition, to also foster human agency, social skills, democratic skills, and critical thinking. These skills are essential for seeking and offering social support, interpreting complex information, and making informed decisions in demanding situations.

To think about the role of teachers and technologies we use Biesta’s model of educational domains and purposes to discuss whether or not and under which conditions specific types of technologies may foster student learning and development for uncertain futures. Biesta’s model (2015) stresses that teaching is much more than the transmission of knowledge. He distinguishes three domains of educational purpose that are always at play in education: qualification, socialization, and subjectification. Qualification means acquiring knowledge, skills, and dispositions. This concept is much richer and more personal than teaching the fragmented knowledge that is needed for most high-stakes tests. Socialization is about cultural transmission and development for social integration and community membership. In challenging times communities and community membership are especially important to deal with problems that arise. Subjectification means becoming a responsible, agentic, and critical individual who takes initiative to engage with the questions of the world. Biesta (2021) stresses the importance of foregrounding the world in education. Not as an object to study, but as a subject that speaks to us and teaches us.

Through Biesta’s lens, we can differentiate between technology that merely automates education and technology that serves the three domains of pedagogical purposes. Educational automation often refers to systems that automatically adapt content and questions to individual student outcomes with minimal teacher interference and interaction (see Forkosh-Baruch et al., 2021). Such software typically demonstrates a narrow focus on qualification while neglecting socialization and subjectification, often severely hampering teacher agency. In contrast, pedagogical technology use would empower all three domains of educational purpose without limiting teacher agency. This approach preserves a meaningful role for teachers and students, ensuring that collaborative thinking and dialogue remain central to the teaching and learning process, with teachers and students in agentic roles.

In the figure below (adapted from Biesta, 2015), we show Biesta’s three domains of educational purpose, elements of the ecosystem, and threats that fuel the uncertainty of the

future. Responding to the question of how to prepare students for these uncertain futures, we postulate that good education occurs when the three domains overlap to foster resilient, active, and responsible citizens. To reach the goals in the center of this model teacher agency is essential: the capacity of teachers to act purposefully and constructively to direct their professional growth, make pedagogical decisions, and influence educational practices and policies within their specific contexts. Therefore, it is essential that the complex ecosystem does not prohibit the enactment of their agency (Priestley et al., 2015).



Resilient, Active and Responsible Citizenship: the ultimate goal - individuals who are skilled, socially grounded, and ethically autonomous in an uncertain world.

We see these three dimensions as guiding principles for current and future education, requiring rigorous critical evaluation and thoughtful use of technologies in schools. This involves moving toward integral pedagogical approaches where the human factor—teacher modeling, classroom dialogue, peer collaboration and face-to-face interaction—remains central to student development. When it comes to technology for education it is important to choose technology wisely which means making sure that it supports these three domains of educational purpose and will be used within a human interaction centered design.

Challenges and opportunities

Regarding our theme we identified the following challenges:
Commercialization of education caused by tech firms with a profit-making agenda. This poses extra risks in the context of increasing demands on public funds and pressures to divert funding to other areas like defense.

- There is no clear, evidence-informed framework guiding the choice of technology and when and how to use technology in education. Possibilities for selling technologies to schools are not restricted by criteria for pedagogical value, and in the case of many countries also not by criteria for safety and privacy.

- Currently many decisions seem to be driven by marketing endeavors or political interests rather than pedagogical value.

Digital technology replacing human interaction, instead of balancing the use of digital technology to foster human interaction, with learning led by the teacher.

- Excessive screen time and reduced face-to-face contact hinder emotional, social, and ethical development (learning, socialization, subjectification)
- Technologies that limit eye contact and non-verbal relational dynamics may weaken the development of empathy and identity.

Educational decision makers who do not integrate socialization and subjectification and a broader view of qualification in their decision making.

- Political, economic, and commercial interests form a challenge to these educational goal domains.

- Suboptimal teacher agency and self-efficacy (due to the way teachers currently must work) form a challenge when the broader eco-system does not change.

- Emphasis on high stakes (automated) testing will pose a challenge as it has a considerable influence on what is taught, and because the commercial interests and lobbies around high stakes and automated testing are substantial.

Regarding our theme we identified the following opportunities:

Improving education

- The current global context forms an incentive to redesign education to foster human agency, social skills, democratic skills, and critical thinking.

- Biesta's three domains of educational purpose provide a pedagogical lens for this transformation.

Empowering teacher and student agency

- Educational policies should create freedom for teachers to enact agency. Reinstating trust in teachers is of the utmost importance. Important ways to create this freedom: eliminating the requirement for high-stakes standardized testing and discouraging the use of scripted educational materials.
- Teachers, as agents within the ecosystem, should be central to shaping school policies around digital technologies. Their experience (wisdom of practice) and pedagogical knowledge are vital for ensuring that technology use in education is equitable, evidence-informed, and aligned with human development. They should be supported by an evidence informed framework.
- Students should be active participants in shaping their learning.
  By giving students voice and responsibility in their learning, education can cultivate their agency, social skills, democratic skills and critical thinking. Student agency is essential for preparing young people to navigate uncertainty and contribute meaningfully to society.

Choosing digital technology that empowers Biesta's pedagogical domains — and does not cause impoverishment of these goals.

- Empowering teachers as pedagogical leaders enables them to make informed, ethical, and context-sensitive decisions about technology use. When decision makers trust and support teachers, teachers can design learning that is responsive to societal, ecological, and technological change — fostering deeper learning and human connection.
- Design a decision-making framework based on the three dimensions of Biesta for (the use of) educational technology.
  When critically selected, technology can enhance collaboration and access to meaningful learning experiences and diverse perspectives. And will not restrict one or more dimensions of Biesta. High-quality tools can support learning without undermining human interaction.
- The decision-making process about technology use in the classroom involves teachers and students.

Key contributions of the TWG to the new educational realities

The TWG's central contribution lies in addressing the distinction between automation of education and pedagogical use of technology. We draw attention to the fact that political and commercial interests may drive educational automation in ways that reduce teacher agency and reduce learning to narrow and scripted forms of knowledge acquisition and testing. The type of education that ensues does not form good preparation for uncertain futures.

We propose to use Biesta's framework of three educational goal domains—qualification, socialization, and subjectification, and preferably their intersection—as a reference point for technology integration. This approach ensures that digital tools support the well-rounded development of students that forms the necessary preparation for uncertain futures. Biesta's framework moves us away from isolating learners in front of screens for lower-order tasks. Instead, it guides educators towards using technology to support collaborative engagement with complex problems. Technology thus supports - rather than replaces - meaningful human interaction and teacher agency.

Key insights from other TWGs

Several key insights from other TWGs informed our work. Important insights on policy making came from TWG 2 and TWG 9. They emphasize moving away from rigid, compliance-driven policy frameworks toward more dynamic, participatory models. TWG2's call for "living iterative policies" with stakeholder input to support teacher agency and educational quality, as does TWG 9's emphasis on evidence-based policy cycles that incorporate practitioner feedback.

TWG 1's emphasis on non-prescriptive "slow diligent research in co-creation with educational practice, confirms that meaningful technology integration cannot be rushed or imposed externally. This aligns with the importance of thoughtful and iterative pedagogical design, where research and practice inform each other continuously.

TWG4's focus on developing critical thinking, creativity, collaboration, communication, and self-regulation through intentionally designed technology-supported experiences parallels our use of Biesta's framework for educational design, just as TWG 7's outcomes do. TWG 7 emphasizes the importance of identifying protective and risk factors related to digital technology to foster learners' holistic wellbeing. TWG 4, 6 and 7 show the importance of the full development of learners rather than efficient content delivery, emphasizing that technology should support the well-rounded development of students.

Strategies and actions

Based on our findings at EduSummIT we have the following recommendations for the role of digital technologies in "Designing Education Ecosystems for the Future".

Strategies and actions for policy makers

- Implement teacher education programs and professional development opportunities that equip teachers with the skills to enact their agency and critically assess and select digital technologies.

- Co-create and apply evidence-informed flexible decision-making frameworks for pedagogical, equitable and inclusive use of digital technologies in education settings.

- Promote and support digital policy that strengthens balanced digital technologies use and supports teacher and student agency.

- Enable the choice of digital technology that serves teachers' pedagogical goals instead of (invisibly) dictating them.

Strategies and actions for practitioners

- Create projects and curricula about real-world challenges, integrating and/or concerning digital technologies, that simultaneously foster knowledge acquisition, social development, and the development of autonomy and responsibility.
- Use digital technologies critically and selectively to support all three of Biesta's pedagogical goal domains (qualification, socialization, and subjectification) at the same time.

- Provide learning opportunities to develop students' agency, healthy digital habits, and critical engagement with the (digital) world to help prepare them to face uncertain futures as resilient, active, and responsible citizens.

Strategies and actions for researchers

- Conduct empirical research about ways to use digital technologies in education to support qualification, socialization, and subjectification and how this contributes to the development of resilient, active and responsible citizens.

- Co-create research about how digital technologies can contribute or limit the conditions for teacher and student agency in different contexts.

- Review research about how digital technologies have been successfully used in times of crisis to support and maintain education to identify principles/practices that can help prepare for uncertain futures.

Actions from the TWG

One or more members of the TWG will present on the topic at conferences, will draft publications about the topic for practitioners, may be involved in translating (parts of) the e-book to their own language and members of the TWG will submit at least one academic article.

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Thematic Working Group 7 - Resilience in a digitally saturated education ecosystem: mitigating risks to promote well-being

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Introduction

A digitally saturated world presents both opportunities and risks for the educational ecosystem and for the well-being of its participants. TWG7 sought to deepen understanding of these dynamics and to explore solutions that would enable individuals, institutions, and organizations to adapt effectively to emerging challenges while safeguarding holistic well-being. From this perspective, TWG7 adopted the more comprehensive well-being framework proposed by Mäkelä et al. (2025), which encompasses planetary, socioeconomic, creative, social, psychological, and physical dimensions, thus providing a multidimensional foundation for advancing the EDUsummIT 2025 theme: *Designing Education Ecosystems for the Future*.

Challenges and opportunities

We first define the concept of a digitally saturated ecosystem. We then outline the challenges and opportunities it presents for educators, researchers, and policymakers, adopting a holistic approach to well-being as proposed by Makela et al. (2025).

Digitally saturated ecosystem

We live in a “digitally saturated ecosystem”. This concept combines the idea of digital saturation and ecosystem. The term “digitally saturated” emphasizes a situation where technology, digital tools, and gadgets have permeated nearly every aspect of daily life, exerting an overwhelming impact on society. Rojas and Chiappe (2024) conceptualize “ecosystem” as complex environments constituted by interdependent technologies, platforms, data flows, and user communities, which facilitate fostering collaboration and communication among diverse stakeholders.
For us, digitally saturated educational ecosystems are learning environments where constant digital engagement is pervasive, influencing all aspects of education from teaching methods and learning opportunities to assessment and student-educator interactions. Digitally saturated education systems—where AI assumes an increasingly pivotal role—are poised to undergo a significant transformation. These systems hold substantial potential for tailoring

learning experiences to individual learners and for providing broad benefits across diverse educational levels and age groups (Rojas & Chiappe, 2024).
The Figure 1 expresses our view of holistic well-being, encompassing both risk and protective factors, across six dimensions.

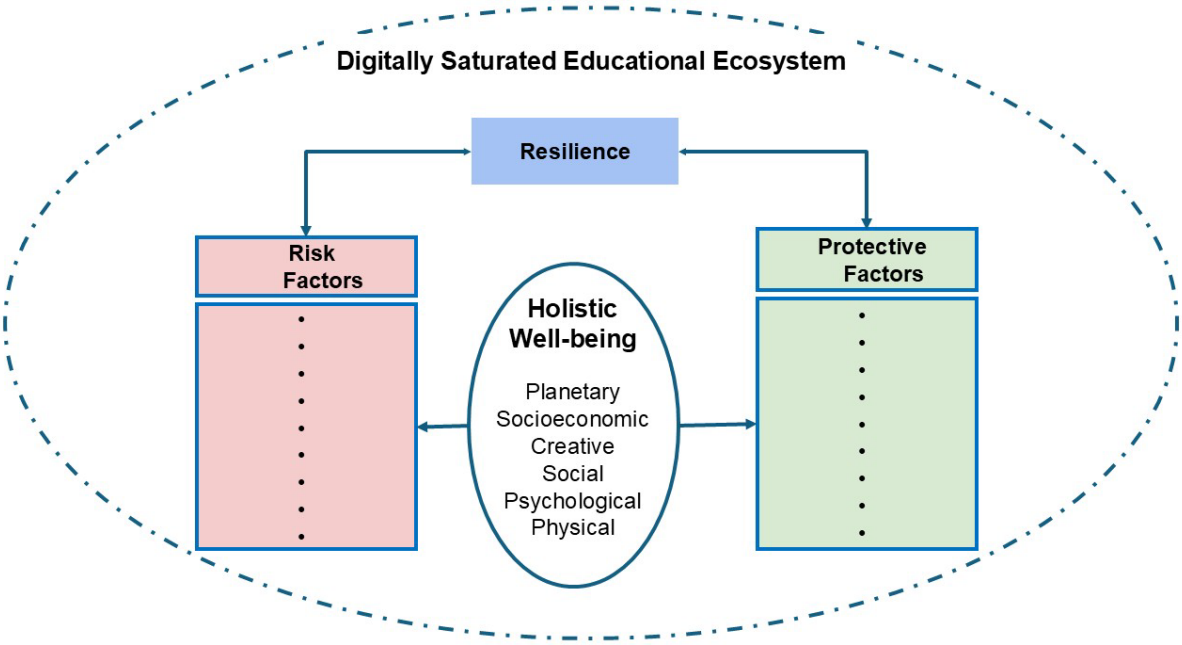

Figure 1 Holistic Well-being in a Digitally Saturated Educational Ecosystem

Six dimensions in a holistic approach to well-being

TWG7 adopted a holistic approach to well-being, as described in Mäkelä et al. (2025), which outlined six dimensions of human well-being, starting with planetary well-being. This approach argues that human well-being is highly interconnected with these dimensions. We further expanded on this idea by incorporating the concept of resilience, as described by Dodge et al. (2012). The TWG7 team categorized risk factors (barriers, stressors) and protective factors (enablers) for each dimension.

Planetary Well-being

Planetary well-being includes environmental sustainability, cultural preservation, sustainability skills, a deep connection with nature, and peace education. However, digital technologies pose significant risks to these areas. These include AI-related biases, high energy consumption, water depletion, pollution, reduced time spent in nature, misinformation, and the amplification of extreme views, all of which can undermine efforts to protect planetary well-being (Larson, et al., 2018; Torjinski et al., 2024).
For instance, the energy demands of data centers contribute to greenhouse gas emissions, worsening climate change and affecting sustainability. Their cooling systems consume vast amounts of water, harming ecosystems. Excessive screen time reduces opportunities to engage with nature, weakening environmental empathy. Online misinformation distorts

people’s understanding of climate issues, thereby reducing their awareness of and skills in sustainability.

Yet, digital technologies also offer tools and affordances to support planetary well-being. For example, easy access to global sustainability knowledge empowers individuals to take informed, pro-environmental actions. Digital tools can help people collaborate on research, accelerating environmental solutions.

Socio-economic Well-being

Risks to socio-economic well-being in a holistic framework often arise from structural inequalities and individual vulnerabilities. Limited access to quality education and training can undermine the development of essential working skills, leaving individuals less prepared for the demands of the labour market. Economic inequities, such as wage gaps, precarious employment, and regional disparities, further exacerbate exclusion and social stratification.

Protective factors, on the other hand, strengthen socio-economic well-being by fostering inclusion, empowerment, and adaptability. Access to lifelong learning opportunities and vocational training enhances employability and supports the continuous development of working skills. Economic equity can be protected through fair labour policies, progressive taxation, and robust welfare systems that reduce inequality and buffer against crises. Entrepreneurship flourishes when supported by inclusive financial systems, mentorship networks, and innovation-friendly policies, enabling individuals to transform ideas into sustainable livelihoods. Moreover, community solidarity, social capital, and supportive institutions function as protective layers, ensuring individuals can thrive despite broader economic fluctuations.

Creative Well-being

While digital technologies can provide unprecedented opportunities for creative expression, they also introduce risk factors that may undermine creative well-being. Overexposure to algorithmically curated content may narrow aesthetic sensibility by reinforcing dominant cultural trends and limiting the discovery of diverse creative influences, leading to a loss of imagination. The prevalence of ready-made templates, generative tools, and instant content production can discourage the development of deep creation competences, fostering imitation rather than originality. Digital environments also carry the risk of performance pressure, where the pursuit of visibility, likes, or algorithmic relevance overshadows intrinsic motivation, thereby inhibiting playfulness and authentic self-expression.

Conversely, digital environments also provide influential protective factors that can nurture creative well-being. Digital platforms enable access to vast repositories of knowledge, tools, and communities, fostering exploration and experimentation that strengthen creation competences. Online collaboration and co-creation environments can enhance creativity by bringing together diverse perspectives and skills. Exposure to global artistic expressions through digital channels broadens aesthetic sensibility and cultivates intercultural

appreciation. When coupled with mindful digital literacy, these affordances empower individuals to use technology as a catalyst for creativity.

Social Well-being

In the digital era, social well-being faces several risk factors that may undermine the core elements identified by Mäkelä et al. (2025), such as empathy, belongingness, and psychosocial safety. Risks emerge from phenomena such as online harassment, cyberbullying, exclusion in digital communities, and the amplification of social comparison through social media, all of which may erode self-esteem, sense of belonging, and psychosocial safety. Algorithm-driven content bubbles may further limit social awareness by narrowing exposure to diverse perspectives, thereby weakening empathy and inclusive attitudes.

Online platforms may broaden opportunities for social participation, particularly for individuals facing barriers in physical settings, thereby supporting inclusion and belongingness. Empathy and social awareness can be cultivated through exposure to diverse cultural narratives, collaborative online projects, and virtual communities designed around shared interests or supportive purposes. Furthermore, structured digital environments that prioritize psychosocial safety—for example, platforms with strong moderation policies and inclusive design—act as protective buffers against harm. Finally, digital literacy and competence empower individuals to critically navigate online interactions, balance digital and offline engagements, and leverage digital collaboration tools in ways that reinforce social competences and collective well-being.

Psychological Well-being

A holistic approach to psychological well-being emphasizes the importance of growth mindsets and higher self-efficacy as protective factors. Having a growth mindset enables individuals to cope with stress and adversity with confidence and resilience, whereas a fixed mindset can hinder their ability to do so. Supportive online communities can also have a positive impact on mental health, helping to mitigate the negative effects of social isolation and loneliness. By promoting a sense of belonging and connection, these communities can provide a buffer against cyberbullying and lead to increased confidence, improved mood, and a more positive psychological state.

The impact of generative AI on psychological well-being is a growing concern. EEG neural connectivity studies show that using AI assistance can lead to decreased cognitive engagement (see Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task). Moreover, two Florida middle-school students (aged 13 and 14) were arrested and subsequently charged with third-degree felony offences for allegedly generating and disseminating AI-mediated explicit images of classmates aged 12–13, in violation of a 2022 Florida statute criminalizing non consensual distribution of altered sexual depictions—the first such case reported in the United States. These incidents highlight the need to monitor research on the negative psychological effects of generative AI.

Physical Well-being

The integration of digital technologies in education exerts both beneficial and harmful influences on students' physical well-being. Excessive screen exposure has been linked to significant physical health issues, including heightened risks to various health issues for students, such as physical inactivity, weight concerns, anxiety and depression symptoms, poor rest and irregular sleep routines (Zablotsky et al., 2025). Particularly, sleep quality is notably affected. Device presence in bedrooms and pre-bedtime screen use reduce sleep efficiency; children watching TV more than an hour daily have higher risks of sleep disorders. Sedentary device use reduces physical activity, raising obesity risks through lower energy expenditure and poor dietary habits. Higher screen time correlates with increased BMI and reduced compliance with physical activity guidelines.

Conversely, well-designed digital interventions can enhance physical fitness. An AI-based physical activity program for primary school children significantly improved flexibility, muscular endurance, and overall fitness through personalized exercises and gamification (Park, et al., 2025). Digital health education also shows promise. Building digital resilience, through awareness of risks, problem-solving skills, and recovery strategies, helps balance risks and benefits (Sun et al., 2022).

Resilience in a digitally saturated society (education ecosystem)

The concept of digital resilience is crucial in today's digitally saturated society. It refers to an individual's ability to recognize digital threats and make informed decisions about their online presence (Sun et al., 2022). We can find different approaches to the concept of digital resilience.

Pan et al. (2024), Tran et al. (2020), and Budak et al. (2021) found that adolescents' digital resilience was **positively associated with their digital literacy**, positive parent-child relationships, and school-based digital literacy programs, particularly those focused on cyberbullying prevention (*Figure 2*). Overall, digital resilience is essential for navigating the digital world, and understanding its relationship with digital literacy is critical for educators and policymakers.

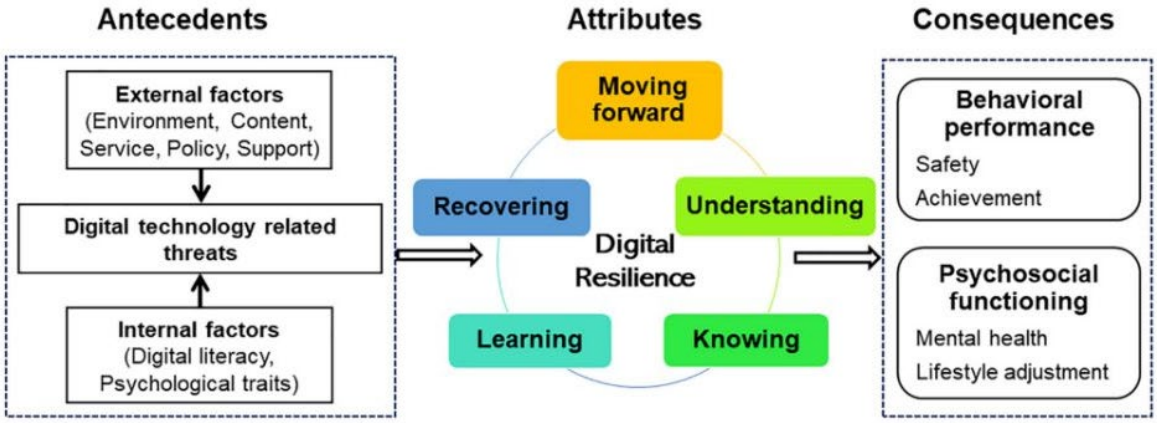

Figure 2 Model of digital resilience (taken from Sun et al., 2022)

Key contributions of the TWG7 to the new educational realities

A key contribution of the TWG7 to the new educational realities lies in foregrounding the interplay between holistic well-being and the rapidly evolving digital ecosystem, with particular attention to the transformative role of artificial intelligence. By situating risks—such as cognitive overload, inequitable access, and potential erosion of autonomy—alongside protective factors—such as critical digital literacies, adaptive learning opportunities, and supportive pedagogical frameworks—our reflections underscore the necessity of equipping individuals with resilience-oriented competences. This perspective advances the discourse by highlighting well-being not merely as an outcome but as an active process of navigating complexity, uncertainty, and innovation in education. Furthermore, it contributes to a growing body of scholarship that calls for evidence-based strategies to ensure that the integration of AI and digital technologies enhances rather than diminishes human agency, creativity, and socio-economic equity. In doing so, it sets an agenda for future research that is both urgent and foundational for sustaining human flourishing in digitally mediated learning environments.

Key insights from other TWGs

The main goal of EDUsummIT'25 is to explore the Role of Digital Technologies for Designing Education Ecosystems for the Future from different perspectives. In close discussion with other thematic working groups, we consolidate around the following key statements:

Practitioners

Provide learning opportunities, projects, and curricula for learners about real-world challenges that integrate digital technologies, simultaneously fostering knowledge acquisition, reducing digital inequities in access, skills, and empowerment, and developing responsibility, as well as well-being digital habits and critical engagement to face uncertain futures as resilient individuals in an equitable and collaborative context.

Policy Makers

Resource leadership development that integrates digital, instructional, and equity goals. Co-create and apply evidence-informed, flexible decision-making frameworks for responsible, equitable, and inclusive use of digital technologies in education settings, ensuring the well-being.

Researchers

Prioritize research in the pedagogy of digital citizenship as a practice within a variety of contexts, including well-being. Co-create research about how digital technologies can contribute to or limit the conditions for teachers and students. Move to co-design by working with educators, leaders, learners and industry to co-produce research in the short and long term.

Strategies and actions

The Education Ecosystems for the Future should be designed based on a holistic well-being approach and resiliency, promoting continuous and systematic professional development of educators at all levels. The role of digital technologies, with AI support, will become more prominent in all areas. To keep the well-being of learners and educators, we believe that:

Strategies and actions for policymakers

- Policymakers should promote programs that foster understanding and resilience to navigate the challenges of a dynamically evolving, digitally saturated ecosystem, to empower holistic well-being that includes dimensions of physical, psychological, social, creative, socioeconomic, and planetary well-being at both individual and societal levels.
- Policymakers should provide initiatives for continuous and systematic professional development of educators, considering both protective factors and various risk factors related to digital technology to promote learners' and educators' holistic well-being.

Strategies and actions for practitioners

- Educators should be trained about the concept of holistic well-being. They should be supported to promote their own well-being as well as learners' well-being in collaboration with peers, families, and communities.
- In the digitally saturated education ecosystems, educators should consider both protective and risk factors related to digital technology and establish networks of support with peers, family, psychological counsellors, and community to promote holistic well-being.

Strategies and actions for researchers

- Researchers should investigate the interplay between digital technologies and holistic well-being across multiple dimensions, including physical, psychological, social, creative, socioeconomic, and planetary, to generate evidence-based insights that can guide policy and practice, examining both protective and risk factors of resilience.
- Researchers should investigate and develop effective tools, professional development models, and pedagogies to enhance holistic well-being.

Actions from the TWG

The members of TWG7 will conduct follow-ups on EDUsummIT'25 in various countries and present the key results from the summit to policymakers, practitioners, and researchers.

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Thematic Working Group 8 - Artificial Intelligence (AI), Big Data, Teaching and Learning: Future Challenges and Opportunities

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Introduction

With the advent of generative artificial intelligence (Gen-AI) paradigms, educational practice is increasingly adopting them, mainly using Gen-AI as a tool. Various research studies have investigated the use of such tools and underlying data infrastructures, providing insights into systems and approaches in which educational stakeholders and AI tools build upon each other's complementary strengths to achieve educational outcomes and/or improve mutually (Stöhr et al., 2024). However, research into the core needs of co-developing artificial intelligence (AI) technologies for educational practices is still lacking. Furthermore, current research and practice suggest that a broader international perspective on adoption models as well as on policy recommendations for educational organizations (e.g., K-12, higher education) may help to move often isolated efforts on AI in education forward (Ifenthaler et al., 2024). Actionable frameworks and co-creation models are required to evolve educational AI and integrate such technology into practice successfully (Shehata et al., 2024).
The members of thematic working group 8 (TWG) researched and discussed how the data needs of AI technology, including the role of big data, its integration and adoption pathways within educational organizations and change processes, can influence policy, industry-academia cooperation and learning and teaching practices, to gain a better understanding of AI for education that goes beyond the current perspective of AI tools in education. Objectives include: (1) To review recent research and innovations of AI in education and their link to supporting learning, teaching, and educational decision-making to identify key issues and trends in policy and practice. (2) To examine the potential for further development and

innovation of AI in education. (3) To make recommendations for policy, practice, and research.

Challenges and opportunities

We used a Delphi method (Scheibe et al., 1975) and involved the panel of experts in the working group to systematically collect data and synthesize future trends related to the topic of AI and big data in education. It involved the following 4 phases: Phase 1 aimed to identify topic trends. It was achieved by 24 May 2025. Phase 2 aimed to expand the expert base and synthesis topic trends. Phase 3 conducted a literature review related to the final list of trends. Phase 4 focused on preparing the report and compiling it for publication and outreach.

As a result of phase 1, we received and compiled a list of 56 trends from 17 international experts. They were subsequently grouped into 15 themes. Through these 17 experts, we expanded the expert base with 53 new experts in phase 2, bringing the final sample to *N* = 70 respondents (36 = female, 33 = male, 1 = prefer not to say). The professional expertise of participants was distributed among academia (n = 26), research (n = 23), industry (n = 5), policy (n = 8), and teachers (n = 8), with an average of 19.5 years (*SD* = 10.69) of professional experience. Based on this, the following themes emerged to be further investigated in the next round of the Delphi study:

- *AI-related competences for learners and educators*

With AI increasingly integrated into educational environments, a critical need emerges to cultivate specific competencies among learners and educators (Casal-Otero et al., 2023). These competencies encompass technical skills and cognitive, ethical, and emotional dimensions, enabling effective engagement with AI technologies in education (Delcker et al., 2025). For learners, this involves understanding fundamental AI concepts such as machine learning algorithms, data processing, and the ethical implications associated with AI systems. Moreover, developing critical thinking skills is essential to evaluate AI-generated content critically, distinguishing between credible information and potential biases or inaccuracies inherent in AI outputs (Sanusi et al., 2022). Educators face a parallel set of challenges. They must become proficient in utilizing AI tools to enhance pedagogical practices while maintaining a critical perspective on their limitations (Luckin et al., 2016).

- *Automated assessment and feedback with AI agents*

Automated assessment systems powered by AI agents are increasingly being deployed to provide real-time, individualized feedback that can significantly impact individual students' academic performance (Hawkins et al., 2025). One of the primary opportunities of automated assessment is its ability to process vast amounts of data quickly and accurately (Heil & Ifenthaler, 2023). Unlike traditional assessment methods that often provide delayed feedback after grading, AI-driven systems offer instantaneous insights into performance. This immediacy helps reinforce correct responses and rectify misunderstandings swiftly, thereby supporting a more iterative and reflective learning process (Gambo et al., 2025). However, the deployment of automated assessment systems raises several critical

considerations. One significant challenge is ensuring the validity and reliability of AI-generated assessments and feedback (Usher, 2025).

- *Evolved roles of teachers while teaching with AI agents*

Traditionally seen as the primary source of knowledge and facilitators of learning, educators are now tasked with integrating AI technologies into their pedagogical practices, transforming their roles to meet contemporary educational demands (Luckin et al., 2016). Teachers become orchestrators of more student-centered learning environments that emphasize the development of learners' capacities to navigate complex information landscapes independently. Integrating AI into classrooms requires teachers to develop competencies in technology management and digital literacy (Fraillon, 2024), ensuring they understand AI tools' underlying mechanisms to effectively incorporate them into curricula (Yim & Su, 2024).

- *Explainability and Trustworthiness of AI agents*

Integrating AI into educational contexts raises critical questions about explainability and trustworthiness, which are essential to ensure that these technologies serve their intended purposes effectively and ethically. Explainability pertains to the transparency with which AI systems operate, enabling stakeholders (teachers, students, and administrators) to understand how decisions or recommendations are derived (Dai et al., 2026). In education, where decisions can significantly impact learning outcomes, stakeholders must comprehend the rationale behind AI-generated insights or interventions. Without explainability, there exists a risk of eroding trust in these systems, as opaque algorithms might lead to decisions that appear arbitrary or unjustified (Wang et al., 2024). Trustworthiness extends beyond mere transparency; it encompasses reliability, fairness, and accountability (Alexandron et al., 2019).

- *Accessibility and Equal Access of AI agents*

AI technologies are becoming increasingly prevalent in educational environments, and ensuring accessibility and equal access emerges as a paramount concern. Accessibility refers to the design and implementation of AI tools that are usable by all individuals, regardless of their physical or cognitive abilities (Patvardhan et al., 2024). Equal access extends beyond physical or cognitive accessibility to address broader socio-economic disparities that may limit some students' opportunities to benefit from AI technologies. Moreover, equitable access demands vigilance against algorithmic biases that could perpetuate existing inequalities within educational systems (Baker & Hawn, 2021). AI systems must be trained on diverse datasets representing a wide range of demographic groups to avoid reinforcing stereotypes or marginalizing already disadvantaged populations.

Key contributions of the TWG to the new educational realities

An education ecosystem is a dynamic, sustainable and interconnected network of individuals, institutions, data, technologies, policies, and processes, as well as cultures that collectively influence and impact the teaching and learning in formal, non-formal and informal contexts. The educational ecosystem approach emphasizes the need for AI to be designed with pedagogical considerations in mind, as well as its ability to adapt and respond to

learners' needs dynamically based on real-time data analysis. Integrating AI into educational settings presents a multifaceted opportunity to enhance learning while posing significant challenges that require careful navigation by researchers, educators, and policymakers. Developing AI competencies, including technical skills, critical thinking, ethical reasoning, and data literacy, is crucial across education to effectively harness AI's potential without impeding learning. Future-oriented curricula must integrate these skills with the needs of both learners and educators. Automated assessment systems have the potential to offer personalized insights but require validation and ethical oversight to ensure fairness and alignment with educational goals. Educators' roles further evolve into guides, mentors, and technology managers, necessitating ongoing professional development to maintain the integrity of AI-supported education. Enhancing AI's transparency and trustworthiness is vital, including stakeholder engagement in the learning design, which further ensures accountability. Addressing algorithmic biases by training on diverse datasets is essential for equitable access to AI technologies, with policymakers advocating for resource provision to bridge the digital divide. Future research must emphasize inclusivity and accessibility in AI-supported education.

Key insights from other TWGs

In developing our comprehensive understanding of integrating AI into educational ecosystems, insights from other TWGs are instrumental. TWGs highlight how essential it is to establish a robust foundation for technical infrastructure and pedagogical frameworks that allow AI systems to adapt and respond to diverse learner needs in real-time. Furthermore, TWGs underscored the importance of addressing algorithmic biases through diversified datasets, ensuring equitable access and inclusivity within AI-driven educational tools. This aligns with our emphasis on fairness and transparency in educational AI systems. In addition, TWGs insights into curriculum development emerged as pivotal. Their discussions revolved around integrating AI competencies—technical skills, critical thinking, ethical reasoning, and data literacy—into future-oriented curricula. This integration is crucial to prepare learners and educators alike for the evolving landscape of AI-enhanced education. Finally, TWGs provided valuable perspectives on the role of educators in AI-augmented settings. Their insights emphasized the transition of educators into guides, mentors, and technology managers, necessitating continuous professional development. This aligns with our view that educators must evolve to maintain the integrity of AI-supported learning environments. Collectively, these TWGs enrich the recommendations of TWG8 by underscoring the multifaceted considerations essential for successfully integrating AI into education ecosystems.

Strategies and actions

Based on the findings of the Delphi study and the persona reflections, as well as informed by current research findings, we recommend the following actions for policy makers (PM), researchers (RE) and practitioners (PR), with each strategy linked to the corresponding challenges identified above:

- In order to foster a deep understanding of how education ecosystems are shaped by—and actively contribute to—the broader societal landscape of artificial intelligence:

        - **Facilitating exchange** of knowledge and best practices between stakeholders inside and outside the education ecosystem (PM, RE, PR)
        - **Fostering collaborative** knowledge construction through equitable and sustainable public-private stakeholder partnerships (PM, RE, PR)
        - **Creating an open culture** that acknowledges and responds to the evolving needs, challenges and agency of stakeholders and the affordances of technology (PM, RE, PR)

- In order to understand and responsibly utilize multimodal data as a foundational component and product of AI-enhanced education ecosystems:
    - **Create awareness, research and understand** the effects of the bias of (synthetic and real-world) educational data and model performance (RE, PR, PM)
    - **Utilize** the principles of data science for co-designing AI-enhanced ecosystems with open data (RE, PR)
    - **Formulate and implement** actionable guidelines for equitable access, data protection, and privacy and use of data (PM)

- In order to ensure inclusive and equitable access to the AI-enhanced education ecosystems through accessible design, adequate infrastructure, and aligned policy frameworks:
    - **Design and implement** AI-enhanced education ecosystems guided by principles of inclusivity and equity (e.g. universal design for learning) (PR)
    - **Invest and maintain** in equitable infrastructure, connectivity, and support systems (PM)
    - **Research, monitor and advise** on the equity impacts of AI adoption and usage in the education ecosystem (RE)

- In order to establish and continuously reflect on a shared vision of a highly dynamic education ecosystem concerning AI in education and society:
        - **Openness** towards new developments of AI-enhanced technology and infrastructure, including ongoing integration and evaluation (PM, RE, PR)
        - **Accepting and shaping** the evolving **role** of educators and pedagogies (PR, PM, RE)

- In order to iteratively develop, integrate, evaluate and implement acceptable usage of AI in the education ecosystem:
        - **Synthesize, analyze, and utilize** generic principles (e.g., risks and benefits of adoption, intellectual property) for acceptable AI in the education ecosystem (PR)
        - **Identify**, **understand and adhere** to generic principles for acceptable, trustworthy, transparent and unbiased use of AI in educational ecosystems (PR, PM, RE)
        - **Conduct** interdisciplinary **research** focused on the impacts of AI-enhanced educational ecosystems and develop new principles for acceptable usage (RE)

- In order to foster a culture of lifelong learning in the context of quickly evolving developments of AI in the education ecosystem:

- **Iteratively identify**, review and facilitate the development of knowledge, skills and competencies needed for an AI-enhanced society (PR, RE, PM)
- **Provide** ongoing and seamless professional learning opportunities in formal, non-formal and informal settings (PR)
- **Identify and allocate** the associated resources (e.g. time, budget, people) to support a culture of lifelong learning (PM)
- **Research, monitor and advise** on the impact of AI on teaching, learning, model performance, socio-emotional learning and degeneration of knowledge, etc. (RE)

Actions from the TWG

TWG8 members will be invited to co-author a journal-length article based on the group's process, deliberations, and outcomes from EDUsummIT 2025. Members are invited to utilize the outcomes of the meeting at conferences and to make presentations that include the group's ideas.

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Thematic Working Group 9 - Bridging digital competence to digital citizenship: preparing learners for a digital society

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Introduction

Thematic Working Group 9 (TWG9) at EDUsummIT 2025 explored how digital competences enable learners to act as engaged citizens in societies where human, technological, and social boundaries are blurred, a condition described as “postdigital” (Jandrić et al., 2018; Fawns, 2022). TWG9 adopted this postdigital perspective to engage with this “messier view” (Markauskaite et al., 2023, p. 11) of the complex sociotechnical relations shaping citizenship today.

TWG9 built on its theoretical framework by emphasizing digital citizenship as a situational and evolving practice shaped by sociotechnical dynamics. Technology is not neutral: it reflects and reenforces power structures and influences whose voices are heard, tracked, or silenced (Örtegren, 2024). Learners can, from early education, navigate digital environments responsibly and ethically to practice digital citizenship (Heath & Marcovitz, 2019).

TWG9 asked how power dynamics differ (or are reproduced) in digital versus physical learning; whether digital competence can challenge educational and societal power imbalances; and if it can be taught without grounding it in democratic understandings. Issues of trust, misinformation, and eroding epistemic consensus complicate the task of fostering critical thinking in a post-truth era while sustaining trust in media and democratic institutions (Chinn et al., 2020; Hughes et al, 2024). Digital citizenship was framed as a lived, evolving practice shaped by sociotechnical entanglements and cultural values, not a fixed set of competencies. Responsibility extends beyond individuals to institutions and tech corporations, whose partnerships with education raise ethical and political concerns,

especially where online civic participation entails real risks, as in authoritarian regimes. Thus, it must be seen as culturally and politically mediated, not universally defined (Huschle et al., 2024; Veugelers, 2007).

Grounded in wider EduSummIT discussions and relevant literature, TWG9 proposes an exploration of the concept of digital, and specifically post-digital, citizenship as a situated practice that both shapes and is shaped by the context in which it is enacted (Figure 1).

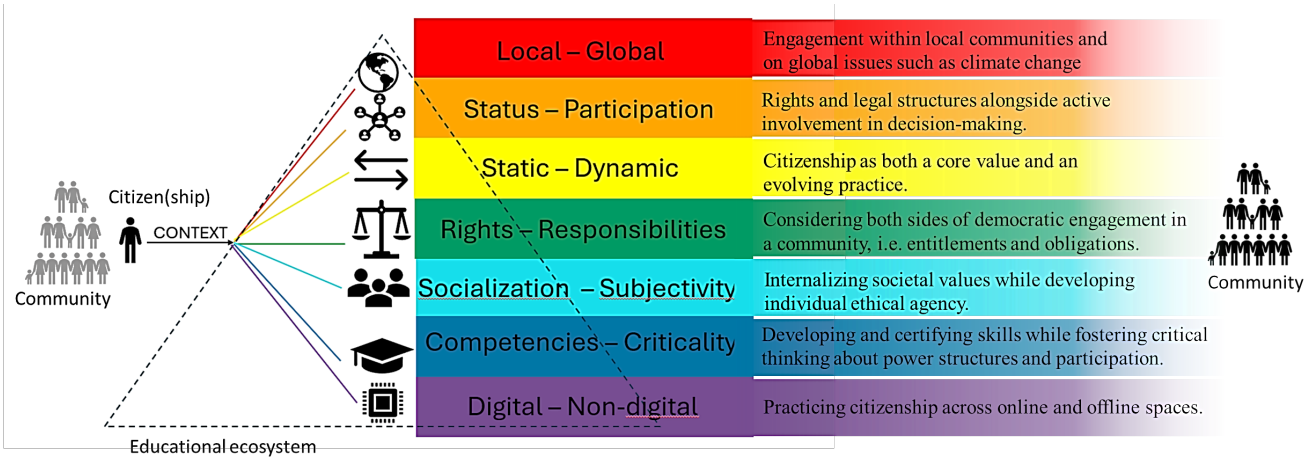

Figure 1: TWG9's Post-Digital Citizenship Model.

In our model, postdigital citizenship emerges from shared community narratives. From an educational perspective, it is shaped by specific contexts (e.g. classroom presence, extra-school activities) and enacted across interrelated dimensions. This enactment then reshapes the community in a recursive cycle.

Preparing learners for digital citizenship must move beyond technical digital skills to integrate digital competence with broader democratic values, fostering critical, participatory, and responsible engagement in digital ecosystems. This form of citizenship is both individual and collective, shaped by context. It intersects critical pedagogy by recognizing that digital citizenship involves the ongoing practice of contributing to and shaping communities for mutual benefit. Such interactions require agency, trust and critical awareness. Moreover, individuals must position themselves critically within evolving sociocultural narratives of what constitutes “good” citizenship—and how these narratives, in turn, influence practices and imaginaries.

TWG9 stressed empowering all individuals—not only formal learners—to engage critically and ethically in digital public life. This calls for co-designed curricula, context-responsive practices, and sustained professional development addressing ethical, civic, and critical literacies. They posed the core question, “For whom is digital citizenship intended, and on whose terms?” As digital societies evolve, education must adapt, centering digital citizenship as a lived, ethical, collective practice continually redefined within complex sociotechnical contexts.

Challenges and opportunities

Building on our exploration of digital citizenship as an evolving, ethical, and sociotechnical practice, TWG9 identified key challenges and opportunities across research, educational practice, and policy. These reflect the shifting demands of a post-truth digital era and the need for inclusive, context-sensitive approaches to education. While significant, challenges can be reframed as opportunities to collaboratively reconstruct digital citizenship as a civic practice integrating competences with ethical, critical, and participatory engagement.

Researchers

A persistent challenge for **researchers** is the fragmented nature of definitions of the competences, dispositions, and values necessary for digital citizenship in both post-truth and digitally mediated contexts. While various frameworks (e.g., UNICEF, 2019; UNESCO, 2018; European Commission, 2022) aim to foster competent and responsible digital citizens, they differ in emphasis and lack coherence. A key gap lies in the insufficient articulation and shared understanding of the ethical and critical dimensions of citizenship (Veugelers, 2007; Westheimer & Kahne, 2004), which blurs the line between technical skills and citizenship. In teacher education contexts, there is a tendency to prioritize professional digital competences (McDonagh et al., 2021; Sel & Demirci, 2025), overshadowing agentic and ethical dimensions. This raises methodological questions about how to ethically engage learners as co-participants in increasingly datafied research settings (Sel & Demirci, 2025) and how to ensure validity in fast-changing environments. Learner agency needs to be understood not only as an individual trait but also as a capacity embedded in and shaped by collective social dynamics.

Researchers have the opportunity to take a leading role in building practical, co-constructed definitions of digital citizenship in collaboration with schools and local communities. This involves exploring, through empirical research, what constitutes “meaningful civic participation” in diverse sociotechnical contexts. Such work can establish a research habitus in which learners and educators are treated as equal co-participants, aligning research practices with the democratic ethos of digital citizenship. Moreover, researchers can innovate methodologies that connect global debates on digital citizenship with the lived realities of local communities, integrating macro-level analysis with situated experience to produce more contextually-relevant, ethically-grounded practices (Chinn et al., 2020; Hughes et al., 2024).

Practitioners

For **practitioners**, challenges often emerge in everyday realities. The term “digital citizenship” is not consistently embedded in educational discourse, resulting in a lack of alignment in practice. Many teachers conflate it with general behavioral norms or online safety (Heath & Marcovitz, 2019; Ozturk, 2021), or with related concepts such as “global citizenship” or “digital well-being,” creating confusion or the perception that it is already addressed. These issues are compounded by the abstract nature of the concept in the literature. Furthermore, systemic barriers, including workload, disparities in ICT skills, and limited professional development opportunities, restrict educators’ ability to engage deeply with digital citizenship education. Meanwhile, digital inequities of access, skills, and

empowerment are acutely visible in classrooms and fundamentally shape who participates in digital life, and on whose terms (Cotnam-Kappel & Ciocca, 2024). Without clarity and support, digital citizenship risks being reduced to a set of compliance-oriented rules rather than a dynamic and agentive practice.

Practitioners can act as co-creators of digital citizenship practices, fostering cultures of dialogue, relationships, and participation with learners. Through such collaborative engagement, digital citizenship can be redefined as “ethical, critical, and agentive participation” rather than a static set of skills. School-based digital ecosystems can serve as safe environments for experimenting with and enacting these practices before they are applied in broader public contexts. Embedding digital citizenship education into existing curricula, rather than treating it as a separate subject, was seen by TWG9 as a key strategy for alignment and sustainability.

Policymakers

For **policymakers**, a key challenge is enabling the implementation of collaborative networks that connect practitioners, researchers, and civil society actors at the school and local levels. National frameworks need to be sensitive to local contexts while maintaining coherence with broader democratic goals. The promotion of digital citizenship requires the active involvement of diverse stakeholders to ensure that practices are relevant, ethical, and inclusive. Policymakers must address inequality in digital participation, adopting a critical stance toward structural barriers and ensuring that participation conditions are inclusive and contextually grounded. Effective policy will emerge from the support of digital citizenship development through practical mechanisms, adequate resources, and flexibility for local adaptation.

Policymakers can use digital citizenship as a test case for designing flexible policies and model curricula that integrate the voices of teachers, students, and researchers. This participatory approach can set a precedent for citizenship education that is both inclusive and context-responsive. Rather than establishing digital citizenship as a standalone subject, it should be integrated into existing curricula and aligned with broader educational priorities. TWG9’s proposed model (Figure 1) offers a guiding framework for this integration, bridging national goals with local realities.

Key contributions of the TWG to the new educational ecosystems

TWG9 presents a layered view of digital citizenship positioning it as integral to educational ecosystems—networks shaped by people, institutions, technology, and policy. These environments are never neutral; stakeholder dynamics, power, and technology integration influence them (Jandrić et al., 2018; Örtegren, 2024). Ethical concerns include user status, data privacy, and the commercial interests embedded in educational platforms (Ozturk, 2021).

Defining digital citizenship, preparing teachers, and identifying learner competencies affect policy, curricula, resources, and professional networks. As platforms become embedded in schools, they may fragment learning, reinforce inequalities, or commodify interactions. Key questions arose: “Who is served in these ecosystems?” “Are students positioned as products

or agents?" For TWG9, agency is central, seen as the capacity to critically and collectively navigate the social, political, and technological conditions of learning. A distinctive contribution is TWG9's adoption of a postdigital lens (Fawns, 2022; Markauskaite et al., 2023), challenging binaries such as online/offline, digital/real, or human/machine. For **researchers**, TWG9 outlined directions for future inquiry: examining digital citizenship in a post-truth world (Chinn et al., 2020); investigating how global conceptions of postdigital citizenship are locally negotiated; and adopting participatory, community-based methodologies that center schools and learners as co-constructors of meaning in their own contexts.

For **policymakers**, the TWG advanced a flexible framework (Figure 1) to support the integration of digital citizenship into diverse educational systems. This model aims to bridge national educational priorities with the realities of local cultures and school communities, helping policymakers, school leaders, and educators situate digital citizenship meaningfully and responsively in their ecosystems. For **practitioners**, TWG9 foregrounds how digital citizenship (viewed through a postdigital lens) is inseparable from learners' social, cultural, linguistic, and material lives. Rather than reducing digital citizenship to a set of behavioral rules or technical skills, the group emphasized its emergence as a lived, relational, and context-dependent practice. Educators, in this view, are co-learners who develop this practice alongside students within shared digital ecosystems through dialogue, trust, and ethical engagement. This reframing invites practitioners to ask themselves: what kinds of educational environments are needed to make ethical and agentive digital participation possible? And how can schools serve as hybrid spaces where justice-oriented digital citizenship can be cultivated meaningfully, rather than prescribed abstractly, while centering students' lived realities?

Key insights from other TWGs

Visits from TWG2 and TWG3 revealed strong alignment with our framing of digital citizenship as a lived, ethical, postdigital practice. TWG2 emphasized the importance of leaders as co-creators of school-based digital cultures driving change, not just managing it. They highlighted agility, future-proofing, and inclusive stakeholder engagement, including students, educators, and tech designers. TWG3 underscored that technology is not neutral, stressing the need for socially responsible design, especially in addressing marginalization, with cultural protocols, land-based knowledge, and learner-driven adaptation. Both TWGs reinforced the need to center human agency and context in digital ecosystems, echoing TWG9's view of digital citizenship as a relational, justice-oriented practice shaped by real-world conditions.

Strategies and actions

TWG9's recommendations for the role of digital technologies in Designing Education Ecosystems for the Future consider three main stakeholders: policymakers, practitioners and researchers.

Strategies and actions for policymakers

We call on policymakers to:

1. Ensure that policies for the competences essential for active citizenship in a digital society are created and implemented at all levels of education.
2. Enact policies supporting the development of digital citizenship, ensuring that practitioners can identify their role in those policies by providing them with means and resources (e.g. funding, human resources, training, local support networks).
3. Create dynamic, evidence-based policy cycles where research, practice, and implementation enable iterative refinement with adequate resources.

Strategies and actions for practitioners

We call on practitioners to:

1. Raise conversations with colleagues and students about what digital citizenship means in their context. Explore with a variety of stakeholders (educators, leaders, students, parents, community members) where (or if) it appears in their local curricula, how their students' access, culture and skills shape it, and what it looks like in practice in their school community. Use this to guide more context-specific pedagogical approaches.
2. Recognize and embrace their roles as co-creators of their school's digital ecosystems that shape how students experience and enact their digital citizenship. Through their design choices, they can reduce digital inequities of access, skills, and empowerment, and actively support the development of students' agency so that all learners can fully and meaningfully participate in society.
3. Reframe digital citizenship as a co-constructed, relational practice. Move beyond the digital/in-person binary to support authentic, relational, situated practices that build *broader* communication and participation skills.

Strategies and actions for researchers

We call on researchers to:

1. Identify the essential competences for digital citizenship in an increasingly datafied, post-truth society.
2. Prioritize research on the pedagogy of digital citizenship as a practice across contexts.
3. Investigate citizenship education within the broader educational ecosystem, analyzing how context, structures, and emerging drivers, enablers, and barriers shape civic participation and digital agency.

Actions from the TWG

TWG9 members will continue exploring digital citizenship as an ethical, postdigital practice. Plans include conference symposium proposals (ECER, AERA, EDMEDIA, SITE), an EDUsummIT special issue article, and outreach through brief articles or translations for national education networks to connect global frameworks to local practice. TWG9 is considering design-based research to identify digital educational ecosystems supporting critical, inclusive citizenship amid platform technologies and pervasive datafication, will

collaborate with other working groups to align with broader educational changes, and remains committed to growing this work through future events and international partnerships.

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