

AI in K–12 Education

Navigating the Challenges

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Executive summary

These seven contributions examine artificial intelligence through the purposes of education: what students should learn, how teachers can support that learning, and which responsibilities remain with people. Prepared for the 2026 [*AI in K–12 Education: Navigating the Challenges*](#) conference at the International School of Boston, the collection connects six challenges: assessment and feedback; critical thinking; well-being; AI and the environment; pedagogy and practice; and leadership. Each contribution addresses several challenges, while retaining its author’s perspective.

Leadership establishes the conditions within which classroom experimentation becomes possible. Mehdi Lazar describes a distributed approach to organizational learning, drawing on the 4I framework to connect individual initiatives with shared institutional direction. Brice Flaquière examines governance through complementary international frameworks, emphasizing the protection of cognitive agency and personal data. Together, these contributions invite school leaders to connect policy, professional learning, and educational aims, while examining the dependencies created by their choice of tools.

Critical thinking requires sustained attention to how learning happens. Marjorie Decriem argues for a reflexive approach in which teachers model their own judgment, create space for discussion, and help students decide when AI serves a learning purpose. Her contribution also returns attention to the relational, cultural, and material experience of education. Across the collection, a recurring concern is the distinction between completing a task successfully with assistance and developing the understanding needed to act independently.

Assessment and feedback make that distinction concrete. Ian Ulmer brings research on feedback into dialogue with his practice as a history teacher, proposing AI support within an iterative writing process. He emphasizes focused guidance, opportunities for revision, teacher review, and the transfer of learning to later work. Anneli Ruehle outlines a four-week tier 2 mathematics pilot that uses AI in a dual role: first as a design assistant to translate diagnostic data into tailored learning sequences, and then as an embedded whiteboard coach that prompts students to visually represent and verbally explain their reasoning. Both models keep teacher judgment, ethical safeguards, and rigorous evaluation at the center. Ultimately, these classroom workflows show that AI is most effective not when it automates learning, but when it reclaims teacher bandwidth and scaffolds the hard work of student revision.

Well-being extends the inquiry beyond academic performance. Darlene Jacokes describes a high school wellness unit that places conversations about personal AI use within students’ developing understanding of healthy relationships, support, and identity. Classroom scenarios and reflections provide opportunities to examine what AI interaction offers and what is essential about human relationships. Her contribution suggests that AI literacy gains depth when it connects with students’ lived experience and stimulates their capacity to make considered choices.

The environmental challenge becomes a test case for inquiry in Mathieu Beau’s contribution. He connects AI-assisted research competency with intellectual sovereignty, understood as a disposition to retain ownership of one’s thinking and responsibility for judgment. Environmental applications, resource demands, and illustrative emissions comparisons become material for examining evidence, assumptions, scale, and alternatives. The comparisons have explicitly limited boundaries; they do not establish AI’s total environmental impact. The proposed classroom inquiry asks students to develop and defend constructive responses to concrete problems.

Pedagogy and practice connect all six challenges. The contributions offer frameworks, classroom accounts, proposed activities, and a planned pilot, each with different evidentiary limits. Together, they suggest that schools define learning purposes, make students’ reasoning visible, support teachers’ judgment, and examine outcomes over time. They offer material for professional discussion and decisions that educators can explain, evaluate, and revise.

Six conference challenges

The conference’s six challenges provide a shared frame for reading the collection. The connections below identify prominent themes in each contribution; they are not exclusive classifications or a claim that each challenge receives equal coverage.

Challenge	Conference focus	Contributions
Assessment and feedback	Rethinking feedback in an AI-rich environment	Ian Ulmer; Anneli Ruehle; Mathieu Beau
Critical thinking	The teacher’s central role and AI literacy	Marjorie Decriem; Brice Flaquière; Mathieu Beau; Darlene Jacokes
Well-being	Ethics and psychological impact	Darlene Jacokes; Anneli Ruehle; Marjorie Decriem
AI and environment	Ecological footprint and responsible use	Mathieu Beau
Pedagogy and practice	From AI-assisted research to classroom design	Marjorie Decriem; Ian Ulmer; Anneli Ruehle; Darlene Jacokes; Mathieu Beau
Leadership	Governance, strategy, and data protection	Mehdi Lazar; Brice Flaquière

Leading the AI Frontier: A Strategic Framework for Educational Innovation

Dr. Mehdi Lazar

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As artificial intelligence reshapes the global educational landscape, the challenge for school leadership is not only to adopt these technologies but also to lead a collective, sustainable transformation of their organization through adult learning and innovation. In most organizations, as it has been the case at the International School of Boston (ISB), impactful and long-lasting learning associated with AI integration has been defined by a move away from top-down mandates toward a systemic, distributed leadership model. In the case of AI integration in ISB's curricula, we viewed innovation through the lens of a "collective ascent," and leadership as the compass that has aligned individual experimentation with a shared institutional direction.

The Summit Innovation Metaphor

Innovation in a school setting is rarely a linear path; it is a complex, non-linear climb. Historically, to follow the metaphor, innovation often manifests as "individual hikes"—teachers experimenting with new tools or methods in isolation. One educator might explore AI for lesson planning, while another uses it for gamification or email management. While these individual efforts are valuable, they risk becoming fragmented, with students experiencing vastly different pedagogical realities depending on their classroom. The role of school leadership is then to provide the "compass" that aligns these diverse "hikes" toward the same summit. The goal is to ensure that the march toward the summit is collective, making the innovation durable and ensuring a consistent, high-quality experience for every student.

The "Double Screen" Challenge

One of the most significant hurdles for educational leaders is the tension between daily operations and transformative innovation. We call this the "double screen" approach. On one screen, the leader must manage the "business as usual"—schedules, parent communications, and immediate logistics. On the second screen, they must create the space for transformation. Balancing these two screens requires a shift in mindset: moving from pure management to systemic, distributed leadership. It involves acknowledging the difficulty of absorbing innovation into a busy school day while providing the resources and "dashboard" necessary to sequence the change effectively.

The 4I Framework: A Roadmap for AI Integration

To navigate this complexity and address the "double screen" tension, we used the 4I Framework (adapted from Crossan et al., 1999) to think through organizational learning and innovation. This sequential yet iterative process—Intuition, Interpretation, Integration, and Institutionalization—provides a structured path for embedding AI into the school culture.

1. Intuition: Recognizing Individual Sparks

The process begins with the "intuition" of individual teachers who try new things in their classrooms based on a training, a reading, or a personal spark. Leadership's task here is recognition. Through informal systems—discussions at the coffee machine, in faculty meetings, or classroom visits—leaders must identify these early adopters and the "hikes" they are taking. At ISB, this involved observing how teachers used AI for planning, data management, and increasing student engagement.

2. Interpretation: Creating Shared Meaning

Once these intuitions are recognized, the leadership must facilitate "interpretation". This is where individual actions begin to take on collective meaning. We achieved this by creating spaces for dialogue, sharing "AI glossaries" to build a common language, and establishing core principles. Our focus was on three pillars: ethical use and data protection, pedagogical value-add, and critical AI literacy (some examples of this work and other initiatives can be found in our 2025 white paper, Beau & Lazar, 2025). This phase transitions the vision from a purely bottom-up movement to a shared strategy.

3. Integration: Moving to Collective Action

Integration is often the most delicate phase, where experimentation becomes "serious" collective action. At this stage, pilot projects are launched to test AI at scale, though not yet across the entire organization. Examples from our practice included:

- AI-Assisted Research Seminars: Utilizing tools like NotebookLM and Python for students in the International Baccalaureate (IB) track.
- Technical Partnerships: Collaborative programs where students engage in Machine Learning at institutions like MIT.
- App Creation: Integrating AI into the curriculum for 9th-grade students in the French track.

4. Institutionalization: Embedding the Change

The final stage is reached when the innovation is so deeply woven into the school's fabric that it persists even after the initial leaders or teachers depart. Institutionalization is marked by structural changes: formalizing AI policies, updating academic honesty regulations, and creating permanent roles like an "AI Coordinator". It also means moving pilot programs into the core curriculum for all students, ensuring that the innovation is no longer an "extra" but a standard part of the educational experience.

Conclusion: systemic and distributed Leadership

The successful integration of AI at the International School of Boston has relied on this systemic view of leadership—one that balances the "double screen" of operations and innovation. By acting as a compass and utilizing a clear framework like the 4I model, leaders can transform isolated "hikes" into a powerful, collective ascent. This distributed approach ensures that AI use and pedagogical practices are embedded and situated as a foundational element of a future-ready, intercultural education.

The Institutional Challenge: Governing AI in K-12 Education

Brice Flaquière

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Introduction

The rapid diffusion of generative artificial intelligence across K-12 institutions has challenged the governance structures designed to accompany it. Where earlier waves of educational technology could be absorbed incrementally, generative AI has entered lesson preparation, feedback, administrative correspondence, and student work itself within the span of a few academic years. This contribution try to address the institutional challenge posed by this shift, arguing that school leadership must treat AI governance not as a matter of permissions and restrictions but as a question of how institutions believe learning happens and what it is for. Drawing on published guidance from five foundational frameworks (UNESCO, the European Union, the International Baccalaureate (IB), the French Ministry of Education, and the OECD), this piece argues that institutional policy should prioritize, at the same time, a framework for learning with AI that safeguards cognitive agency against passive offloading, and the protection of personal data, treated not as a downstream compliance concern but as a precondition for any adoption at all. Figure 1 illustrates this framing.

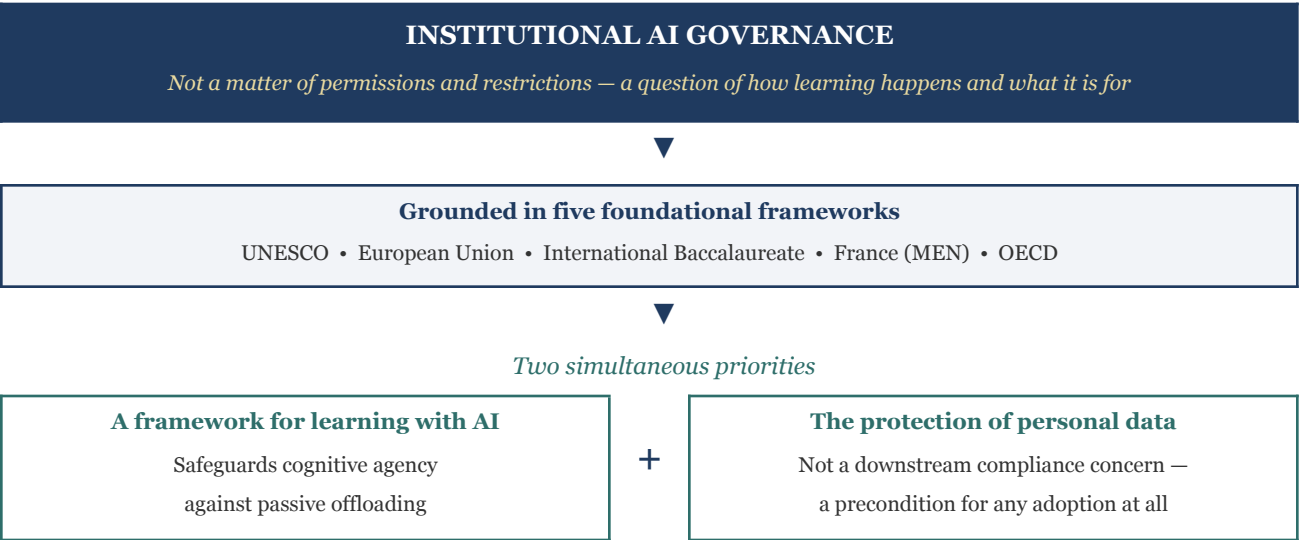


Figure 1. The institutional framing: AI governance as a question of how learning happens and what it is for, grounded in five foundational frameworks and pursued through two simultaneous priorities.

The Governance Gap

Most schools govern AI through multiple instruments: an Acceptable-Use Policy, a Data Processing Addendum, and an academic integrity policy focused primarily on homework and formal assessment, since it is there that unauthorized, use is most visible and most disruptive to grading. That focus has often pushed institutions toward AI-detection software as though it offered a reliable remedy, an assumption independent testing does not support (Weber-Wulff et al., 2023; Liang et al., 2023). The tension is visible even inside

official guidance: France's own framework instructs schools to treat undisclosed AI use as fraud by default, while separately conceding that detectors are unreliable, leaving institutions with a rule to enforce and no dependable means of enforcing it (CIANum, 2026). Legislative mandates show the same gap in another form: Ohio's recent statute requires every district to adopt an AI policy while specifying almost nothing about what such a policy must protect (Ohio Rev. Code § 3301.24). As one recent article puts it: being allowed is not the same as being appropriate, and compliance is not evidence that learning occurred (Kelleher, 2026). A governance approach organized primarily around catching misuse addresses a narrow slice of the problem while leaving the larger question, what students are meant to learn and be able to do without AI, unaddressed.

Priority One: A Framework for Learning with AI

UNESCO anchors AI policy in a humanistic vision in which AI should support human capability rather than substitute for it (Miao & Holmes, 2023). The IB's Academic Integrity Policy operationalizes this at the level of student work, distinguishing AI used to learn from AI used to simulate having learned and deliberately favors teacher judgment and disclosure over detection (International Baccalaureate Organization, Academic Integrity Policy, Appendix 6). France's framework for AI use approaches the same line administratively, conditioning AI use on demonstrated pedagogical value and differentiating student autonomy by grade level (Ministère de l'Éducation nationale, 2025); a companion 2026 report from France's Council for Artificial Intelligence and Digital Affairs proposes a 'dual education', explicitly zoned time with AI for scaffolded, Socratic tools, and protected time without it for consolidating foundational cognitive work (CIANum, 2026).

The OECD's Digital Education Outlook 2026 grounds this same priority empirically rather than normatively. Reviewing the emerging evidence on generative AI in classrooms, it documents what might be called the crutch effect: students supported by AI complete tasks more successfully, yet perform worse once the assistance is removed, early but consistent evidence that task completion and durable learning can move in opposite directions when a tool substitutes for rather than scaffolds a student's thinking (OECD, 2026). The OECD's contribution to the set of frameworks is therefore distinctive: where the others prescribe, it measures, and its findings supply the evidentiary warrant for the developmental caution the other four recommend.

The same distinction has begun to carry direct legal weight in the United States: a recent federal appellate decision found that a school district had violated a student's right to an appropriate education because AI-based accommodations masked his learning difficulties rather than remediating them, showing that misjudging this line is not only a pedagogical failure but, for students with disabilities, a legal one (*William A. v. Clarksville-Montgomery County School System*, 2025). Read together, these sources argue for a developmental framework rather than a permissions list: one that names, by age and subject, which capacities must be built without AI, which may be scaffolded with it, and asks of every use whether it supports the thinking a student is meant to do or replaces it (Kelleher, 2026). Protecting AI-free cognitive work is sometimes cast as the opposite of preparing students for an AI-saturated world; it is better understood as its precondition, since the students who will use these tools most powerfully are those who can still think without them.

Priority Two: Data Protection as a Precondition

The European Union's AI Act (European Union, 2024), read with the General Data Protection Regulation (GDPR; European Union, 2016), classifies many educational AI systems as high-risk, requiring documentation and human oversight rather than leaving data protection to institutional discretion. UNESCO adds a concrete marker often missing from school policy: a recommended minimum age of

thirteen for independent AI use, distinct from the GDPR's consent age of sixteen; below that threshold, AI-supported activity should occur only under direct adult mediation, with an adult, not the student, responsible for the account and the data entered. France's framework is operationally direct: no confidential or personal data may enter public-facing AI tools, and institutions should favor open, auditable tools over opaque commercial ones, a rule that also anticipates the sovereignty concern below. Though these instruments are European, the underlying rationale is not jurisdictional: schools handle data belonging to minors who cannot meaningfully consent, and data once surrendered to an external model cannot be recalled — conditions that make protection a precondition everywhere, whether the applicable regime is the GDPR, the United States' federal student privacy laws, or another national framework.

A Further Consideration: AI Sovereignty

Sovereignty, understood as control over the infrastructure, data path, and continuity of access behind an institution's AI use, deserves a place on the same radar (Hill, 2026). National sovereignty concerns how much a school's AI strategy depends on foreign providers and policy, a concern sharpened by a 2026 episode in which US export controls led a major AI developer to withdraw its most advanced models from customers already using them. Organizational sovereignty concerns the narrower risk of embedded dependency on a single provider's pricing and roadmap. France's CIANum report treats this as a genuine policy priority, recommending a national kiosk of vetted, sovereign AI tools for teachers rather than default reliance on general-purpose consumer tools (CIANum, 2026). This degree of state coordination is unfamiliar in decentralized systems such as the United States, but the underlying question it answers, who controls the tools teachers depend on, applies everywhere.

Guiding Principles for Policy Design

Beyond these two priorities, policy design should follow three further principles, summarized in Figure 2: it should remain neutral, be explicitly developmental, and aim to build students' own metacognitive agency (Kelleher, 2026; OECD, 2026; Kosmyrna et al., 2025; Risko & Gilbert, 2016).

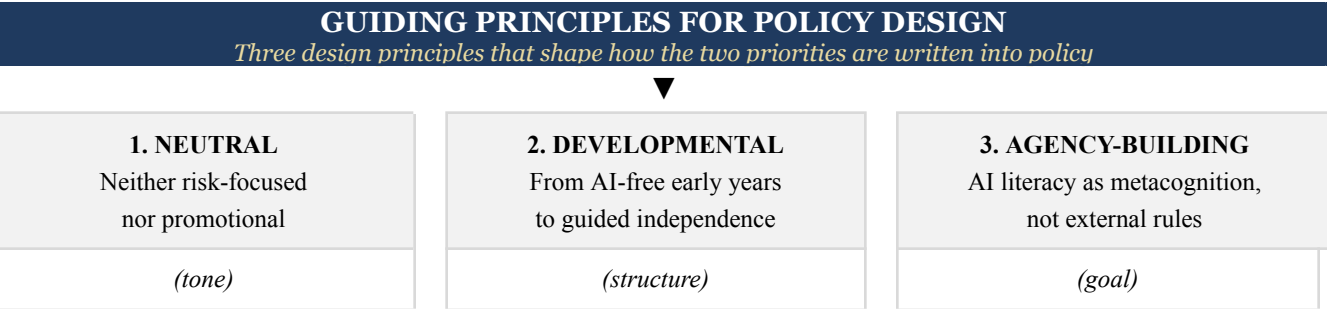


Figure 2. Three design principles governing how the two priorities are written into policy: neutral in tone, developmental in structure, oriented toward building student agency.

Toward an Integrated Institutional Model

The five frameworks reviewed here do not contradict one another on fundamentals; they differ in what each emphasizes (values, law, classroom practice, operational rules, or evidence) which is precisely what makes them complementary rather than competing. UNESCO supplies the humanistic rationale that should anchor institutional values; the European Union supplies binding legal structure and documentation discipline; the IB supplies a trust-based, transparency-oriented classroom model; France supplies concrete operational

rules for both data and sovereignty; and the OECD supplies the empirical evidence base against which any policy's assumptions about learning can be tested.

An institution that draws on each of these in turn, rather than treating them as competing options, is better positioned to write a policy that remains coherent, as technology itself continues to change, than one built around any single source alone.

Figure 3 summarizes this architecture: the five frameworks converge into a single integrated policy, neutral in tone, developmental in structure, and oriented toward metacognitive agency, which in turn translates into four concrete institutional commitments: protecting independent cognitive work at each developmental stage, protecting personal data through one memorable rule, securing sovereignty over embedded AI capabilities, and building students' own capacity to recognize cognitive offloading.

Five Foundational Frameworks

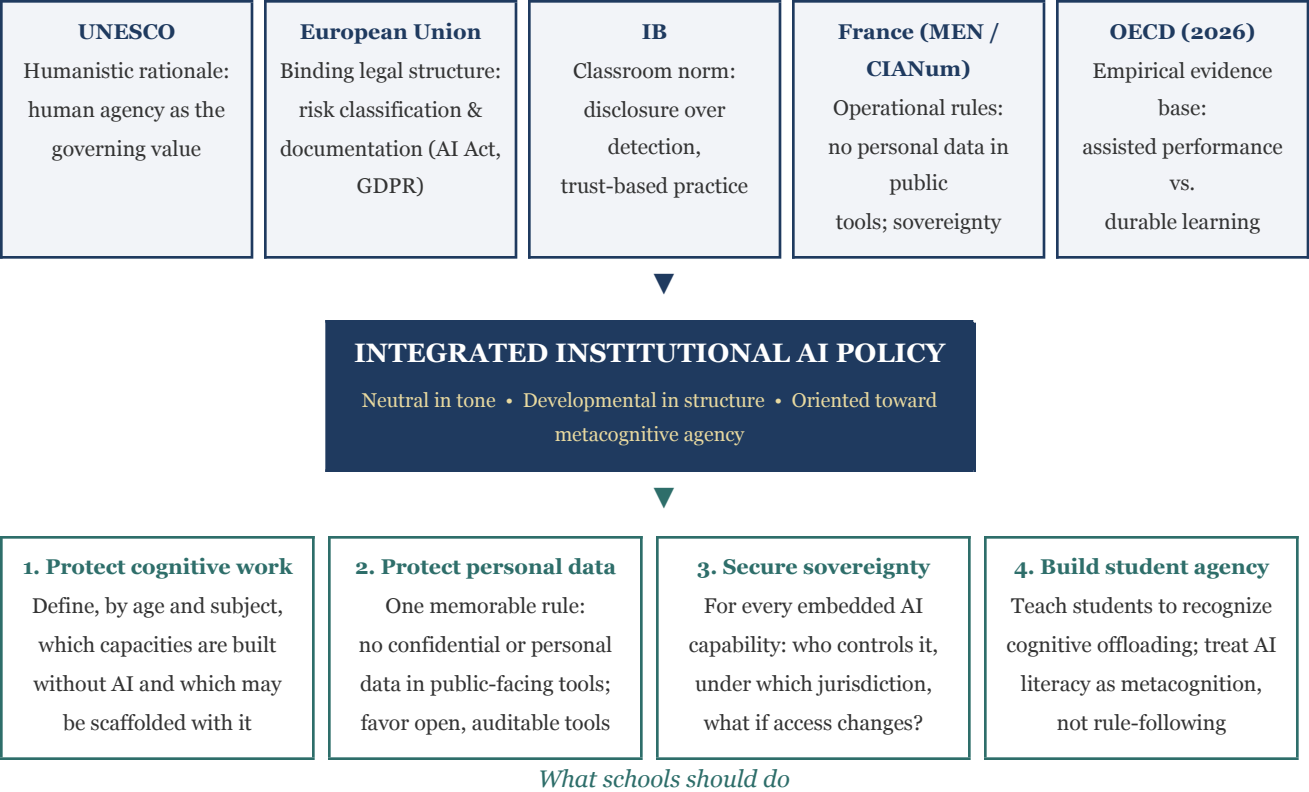


Figure 3. From five foundational frameworks to institutional action: each framework's distinctive contribution converges into a single integrated policy, which translates into four institutional commitments.

Conclusion

Institutional AI governance should be conceived as a statement of how a school believes learning happens and what it is for. It is a framework built around protecting human thinking at each age, from which decisions about tools then follow, and approached this way, it cannot be reduced to a list of permitted systems or a detector score.

UNESCO, the European Union, the IB, France, and the OECD each point toward the same conclusion: schools must define what independent cognitive work they intend to teach, build and protect, at each stage of a student's development, and what data may never leave institutional control. These commitments are held together by a neutral, developmental policy. Such a policy should build students' own capacity to

recognize cognitive offloading and, beyond that safeguard, an AI literacy that augments their learning capacities and their thinking rather than substituting for them.

A Reflexive Approach to AI in Teaching and Learning

Marjorie Decriem

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The integration of artificial intelligence (AI) into the educational ecosystem goes far beyond a simple technological shift: it fundamentally reshapes our relationship with knowledge. As access to information and content generation become instantaneous and automated, the core value of education is moving. What this implies for teachers and students requires a fundamental shift in how they engage with ideas and knowledge.

For centuries, schooling was built upon two foundational pillars: access to information—which was a challenge for a long time until the democratization of knowledge and the Internet shifted this paradigm—and intellectual production capacity (writing, calculating, synthesizing, and applying frameworks), which formed the core of student evaluation. Generative AI now automates a significant share of these tasks. Because access and production are no longer structural barriers, students are no longer required merely to "find" or "produce," but rather to evaluate what is generated, weigh the implications of statements, and exercise renewed intellectual rigor. In this regard, we ask them to develop discernment, moderation, and critical thinking .

To succeed in this transition, educational institutions must address two complex realities. First, we now operate within a *prefigurative culture*; in the sense defined by anthropologist Margaret Mead—an unprecedented social dynamic where adults and educators learn alongside younger generations in the face of constantly evolving technologies (Mead, 1978).

Second, faced with this uncertainty, there is a strong temptation to reduce critical thinking to a set of standardized checklists (fact-checking protocols, source verification grids, and generic rubrics). However, procedural doubt alone is insufficient when dealing with systems capable of producing strikingly plausible arguments. Critical thinking cannot be administered as a simple formula. Furthermore, given how easy it is to produce content using AI, educators themselves might be tempted to use it abundantly in the classroom without exercising the very discernment they ask of their students.

Critical thinking is often mistakenly viewed as a mere technical skill or a set of "thinking strategies." In reality, it relies on key cognitive components. For instance, for Robert Sternberg, true critical depth requires **cognitive skills** to plan what to do, monitor progress while doing it, and evaluate results afterward, but also a **solid foundational knowledge base** to be able to detect bias, inconsistency, or AI-generated hallucinations, and the last dimension: **motivation for Intellectual effort** a desire to learn that requires resisting the cognitive ease offered by immediate, machine-generated answers. It demands active engagement and a willingness to embrace complexity (Sternberg et al., 2007) .

Educators must seize this opportunity to return to the heart of learning: the intrinsic need to learn and the joy of inquiry. By coaching students to reflect on their thought processes—shifting from evaluating the final product to evaluating the path taken to reach it—the teacher's role evolves from an absolute authority into a guide for metacognitive inquiry within an uncertain environment. Artificial intelligence does not make knowledge obsolete; it makes understanding our own thinking indispensable (Shalani Dilinika, 2020).

To operationalize a critical approach to artificial intelligence in education, institutions must move beyond binary bans and uncritical adoption. In direct alignment with the strategic roadmap of Plan Mlf 2030—which commits the Réseau mlfmonde to refounding an innovative international French educational model around the pillars of Apprendre, S'épanouir, and S'engager—our critical approach to Artificial Intelligence operationalizes these institutional ambitions across Mlf America. In the North American context, generative AI adoption was exceptionally rapid, and schools cannot settle for either passive prohibition or superficial 'prompt engineering.' We partnered with teachers to reflect and take steps to implement a four-level pedagogical framework—one designed to shift the focus from mere technological compliance to human agency and cognitive depth.

Level 1: Cultivating Reflexive Literacy and Teacher Modeling

Critical AI engagement begins with meta-cognition: students need the analytical tools to determine *when*, *why*, and *if* an algorithmic tool serves their learning. Rather than treating AI as a default shortcut, learners must develop the agency to make an explicit, enlightened choice—often opting out entirely when direct friction and cognitive struggle are essential to mastering a skill (Massachusetts Institute of Technology, 2026).

To ground this in daily practice, teachers must transparently model their own workflow (Willingham, 2020). When educators openly demonstrate how they use AI for lesson preparation—such as differentiating reading materials or generating debate scenarios—while critiquing its biases, generic phrasing, and factual limitations in real time, demystification replaces novelty (Shalani Dilinika, 2020).

Level 2: Fostering Safe Spaces for Dialogue and De-Polarization

Classrooms must function as low-stakes environments where both students and educators can experiment openly without fear of surveillance or moralizing judgment. Current discourse around AI frequently defaults to extremes: alarmist panic over academic dishonesty on one side, and a “magical” easy approach on the other.

Moving past this polarization requires adults to examine their own implicit biases and anxieties about technology (Aleman et al., 2024). By establishing a collaborative culture of inquiry rather than punitive policing, teachers and students can candidly interrogate algorithmic bias, ethical dilemmas, data privacy, and intellectual property together.

Level 3: Empowering Students Through Scaffolding and Research

Rather than outsourcing student thinking, AI can be repurposed as a cognitive scaffold to augment intellectual autonomy. When framed intentionally, these tools excel at breaking down complex tasks into manageable stages, for example, for inquiry scaffolding (use as a preliminary brainstorming partner, counter-argument generator, or socratic challenger during early research phases) or assisting with research by outlining conceptual connections, or suggesting alternative perspectives (King & Kitchener, 1994). The student needs to take charge of his learning and remain the editor, curator, and epistemic driver, using the model's outputs as raw material to question, verify, and reshape.

Level 4: Re-Centering the Experience of Learning

The online education experimentation (during COVID or for online-only platforms) highlights the limits of technology use: education is fundamentally relational, sensory, and affective. The classroom must re-anchor itself around the core **learning experience** by **engaging with physical and cultural artifacts** using tangible objects, historical primary sources, physical books, tactile manipulation, and art in the classroom. At the same time, we could work on intellectual courage by integrating ambiguity and incertitude by nurturing a curious mindset in the classroom using debate, spontaneous dialogue, and the slow, collective experience of discovering an idea together and giving a place to imagination and “out-of-the-box thinking”.

By grounding learning in human curiosity and culture, technology recedes into its proper role—an auxiliary tool serving human intellect, not replacing it (Lee et al., 2025).

We partnered with educators to deliberately shift instructional focus away from procedural compliance (such as mere prompting) toward critical inquiry and metacognition, designing learning experiences where student agency and independent thought remain central.

What's Happening in the Classroom? Feedback, Writing, and AI Supports

Ian Ulmer

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Positionality

I am a high school social studies teacher with 26 years of experience in independent and charter schools in both California and New York. Over the years, I have been an early adopter for edtech and am always looking for ways to strengthen student writing. I currently work at an international IB school in Manhattan; we have students from more than 70 countries, many of them are writing in their 2nd or 3rd language. In my 9th grade classes, I believe writing is the best way for students to organize thoughts through developing arguments, supporting with evidence, and critically thinking about sources. I am a classroom teacher (what the literature calls a practitioner) and my research here was to inform and support my own understanding of the best practices for high quality feedback and to see the emerging evidence of AI supports to make feedback more manageable while maintaining teacher agency and student as active-learner through the iterative process of writing.

My school AI Policy has guiding questions for tech use:

1. Does this use of technology foster or hinder deep, focused learning for our students?
2. Does it encourage active, critical thought, or passive consumption and outsourcing of thinking?
3. Does it enhance or detract from meaningful human interaction and collaboration within our learning community?
4. How can we ensure technology serves our pedagogical goals rather than dictating them?

Literature Review

Decades of peer-reviewed educational research have shown that feedback can be an effective tool for developing learning although the effects can vary (Black & Wiliam 1998; Wisniewski et al. 2020). Feedback works best when it is high quality providing students an objective, explanation on how to improve, and appropriate complexity (Sadler 1989; Hattie & Timperley 2007; Shute 2008), when a student has confidently held misconceptions (Butterfield & Metcalfe 2001), and when students still have an opportunity to use it before the assessment as part of an iterative writing process (Sadler 1989; Black & Wiliam 1998). But, there are significant difficulties in delivering high quality feedback including teachers' time constraints, and students' willingness to evaluate and use the feedback (Boud & Dawson 2023). Beyond empirical and observational studies, professional development for teachers focuses on the practical importance of goal-referenced, actionable, and timely, specific feedback (Marzano et al. 2001; Wiggins 2012).

Feedback does not always lead to better outcomes in fact some types of feedback led to negative performance (Kluger & DeNisi 1996) including feedback that focused on personal qualities comments similar to “You are a strong writer” or “This work is disappointing” (Wisniewski et al. 2020). Students often prefer feedback that feels the most helpful rather than the feedback that would be the most effective (Mullet et al 2014). Feedback can also become less effective when it is too complex for the student to use or understand (Shute, 2008), and AI can do a lot of that. AI can generate detailed comments quickly, so the amount and usefulness of those comments need teacher intervention. The importance of this personal human connection can be seen in “wise feedback” which shows improved outcomes when connecting high standards to a students’ capacity to meet them with a particularly strong effect on African American students who reported low trust in school (Yeager et al. 2014).

While there is no clear timeline for when feedback can have the most impact, quick feedback seems to be useful in procedural knowledge (Kulik & Kulik 1988), for beginners (Shute 2008). B.F. Skinner suggested that even a single day delay was too long; however, it seems that separating the writing from the feedback by some time may create a retrieval or spaced practice which increases overall learning, but it is unclear if this transfers to a new assignment (Metcalf et al. 2009; Meyer et al. 2024) Still, students report that they appreciate immediate feedback that supports them during the writing process (Mullet et al. 2014).

The research shows a positive average effect size of $d=.48$ on student learning from feedback (Wisniewski et al. 2020), but high quality feedback is difficult and demanding, requiring teacher time, expertise, and emotional care. The RAND report that surveyed public school teachers found they spent about 10 hours per week beyond contract time (Steiner et al. 2025). Often grading and feedback are completed after school and even at home, and I suggest that teachers produce less high quality feedback when they are exhausted.

AI generated feedback may lessen the teaching workload, and make feedback more feasible. But across the current research on AI feedback, there is not a consistent average performance advantage between teachers and AI, and effects are substantially different across studies (Kaliisa et al. 2026, Steiss et al. 2024), and GPT-4 feedback without guardrails improved student performance during practice, but students underperformed when the AI assistance was removed (Bastani et al. 2025). Additionally, the speed of AI progress up to versions GPT 6.1 and Opus 5.5 at the time of this writing reduces the generalizability of research conducted with deprecated models. AI can offer some support in several of real world constraints it can be fast, many students considered some anonymous AI feedback fairer than teachers’ (Weidlich et al. 2025; Henderson et al. 2026), and in some cases it can provide better rated feedback than teachers on setting clear expectations for meeting objectives, “assessment criteria,” while teachers remain better at feedback that contains improvement directions, priority, accuracy, and a supportive tone (Steiss et al. 2024).

Thesis

I believe that generative AI can help reduce teacher workload by helping teachers individualize high quality feedback and increase learning as part of an iterative writing process, and improve future unassisted writing. My suggested classroom approach involves AI use with humans in the loop. Teachers maintain classroom expertise in setting objectives, supporting complex writing, and maintaining a nurturing teacher student relationship built on trust. Students may benefit from AI feedback with guardrails on smaller assignments, process assignments, or early versions of a draft, which allows the teacher to give more effort and time on longer, more complex assignments and differentiation, while maintaining that personal human connection.

1. Too much work; too little time

There are so many time constraints on teachers. During the day, I juggle everything from prep and planning to monitoring behaviors, adapting curriculum, providing accommodations, and writing high quality feedback; I often wish I had a helper just to help me keep track of everything, and I have been using AI as a classroom and organization support helper for the past few years since I tried Chat GPT December 9, 2022. Keeping track of my inbox and reminding me of calendar meetings in chats has been very helpful, but there are also some very clear needs for feedback and analysis during class time.

2. Writing in the History class

In my history courses, students often end up writing more than they do in their other classes, because I believe that writing is thinking, or more broadly: organizing your thoughts for writing is the key to learning. In history we focus on the iterative process of writing over several days: outline → feedback → draft → feedback → peer review → feedback → revision → feedback → final draft. This iterative process over several days is a key component of our process and students develop writing skills very quickly during the first trimester. But, this process consumes my time and energy. It is difficult to write high quality feedback during the middle of class, and it is even more difficult to keep track of the types of feedback and writing errors for every student. I have wanted a way to digitally organize student data so that I could have a clear view of the specific issues that each individual student has had and what they are currently working on. I also want a clearer view of how the whole class is doing.

3. AI can help

AI can provide data for class-wide misconceptions to the teacher which could be used in a “re-teach” during class. This can inform the exit ticket as well to make sure the reteach was successful. Information from the exit ticket can then be evaluated by the AI with suggestions for follow-up homework questions.

On the writing side, AI can provide feedback to the entire class of students on the early draft, asking questions and prompting students on writing procedure like including a topic sentence, adding more specific details, and providing more evidence to support arguments. This frees teacher time to make high-impact feedback for certain students. Additionally, because the AI has access to all student writing in the class, it can evaluate misconceptions and create a classwide checklist for students to revise their own work. This can be effective because students have access to the feedback while they can still use it. Finally, in order to ensure transfer, students complete reflection questions about what they will do next time using the feedback from this writing.

4. What I do in one class period

1. **Do Now responses.** My AI agent evaluates the responses to develop a whole-class understanding.
2. **Drafting in Flint K12.** Students have finished their research and begin their first draft.
 - Flint K12 runs on Claude; the security page declares that it keeps student data separate and is COPPA and FERPA compliant.
 - It protects critical thinking by running on guardrails as a tutor; it asks questions and gives guidance, but never gives direct answers or writes drafts.

- Its dashboard shows me every student's activity, writing, and chats.
 - Its whole-class analytics report lets me catch content and procedural writing errors while students can still fix them.
3. **Five-minute break.** I review the Do Now analysis. For example: "While students showed strong factual recall, many could benefit from adding more specific details and context... the number of people affected (120,000), specific dates, or the name of Executive Order 9066."
 4. **Respond to data during the lesson.** I reinforce those points when class resumes.
 5. **Drafting in Flint K12.** Students reflect on the feedback and use it to edit their writing.
 6. **Exit Ticket responses.**
 7. **Homework.** By the end of class, my AI agent evaluates the exit ticket for whole-class understanding, and suggests areas of improvement as homework; Flint K12 has also evaluated every student's writing and drafted a checklist of the most common fixes. I review and edit. Then assign it as homework.

These AI supports have provided quick feedback to every student and allowed me more time for high-need students and developing complex writing skills. I also now have a broader view of how the entire class is doing on the writing and new a list of the abilities and needs of every student, so I can support deep, focused learning.

Every direct student interaction with AI comes in the form of a heavily safeguarded tutor. I am not sharing the classwide or individual evaluations, and I vet and update the suggested checklist before students see it. It is here, in the middle of an AI heavy class, that I maintain my humanity and the humanity of my students with thoughtful, responsible and ethical use of AI that helps me be a better teacher and increases student learning.

Suggestions for a prompt to create guardrails on AI feedback

Students want to know:

- What did I do well?
 - Where can I improve?
 - How can I improve?
 - What should I do next time?
1. Prioritize before elaborating. Identify only one or two changes that are likely to improve work. Do not provide an exhaustive commentary.
 2. Define the next action. Feedback should tell students what to do, not just what is wrong.
 3. Calibrate directness using evidence in the draft: Never supply the complete answer.
 - a. If the student shows they know the skill but applied it unevenly (it works in one place and not another), ask a question that points them to the gap and lets them reason it out.
 - b. If the draft suggests the knowledge, procedure, or strategy is missing (the skill does not appear anywhere), give a short explanation of what the skill requires, then one action.

4. Preserve the cognitive load. Do not rewrite a student's sentence, thesis, or paragraph when a prompt or hint can trigger productive revision. Never write for the student. You may quote a short phrase from the student's own draft to show where to look. If a model helps, use a brief example on an unrelated topic, never on this assignment.
5. Each next action must be something the student can start in this revision session, specific to this draft, and small enough to do in one sitting.
6. Ask for transfer after revision. Require the student to articulate what changed and what they would apply next time. Do not answer these questions for them.

Rethinking Tier 2 Math Intervention: AI Tools as Design Assistant and Supporting Coach

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Math teachers regularly encounter the challenge of having to cater to multiple groups of students with different needs in the same classroom. Some students are still building fraction number sense, others are ready for multi-digit division, yet others need reinforcement of the concept of place value. Differentiated Tier 2 support is supposed to close these gaps. However, often the bottleneck is not pedagogical knowledge but bandwidth: diagnosing where a student's understanding breaks down and translating that into an efficient support plan can take hours per student, something teachers usually do not have.¹

To address this problem, I have added AI-based approaches in two places to my student math support program. First, I integrated AI to assist with the time-consuming task of cross-referencing a student's diagnostic report against approved tasks and drafting a learning sequence. With the support of artificial intelligence, this step can now take minutes instead of hours. Second, once that sequence has been reviewed and the specific problems have been selected for each individual student, an AI coach embedded in the digital whiteboard tool *Snorkl*² guides the student while they work on their assigned problems. The initial step of implementing this workflow was a one-month pilot program for students in grades 4–6, whose math results were below the 50th achievement percentile on our external diagnostic assessment, the Measure of Academic Progress (MAP) test.³ The seven students in the program met with me every morning for 30 minutes a day to work on *Snorkl*.

Designing the Dual-AI Workflow

The temptation with today's powerful educational AI tools is to reach for their most automated version: a system that assesses, assigns, and adjusts without a teacher in the loop.⁴ However, to retain control of the process and to ensure that every step of the way can be accompanied and assessed by a teacher, the workflow was broken down into several distinct steps. First, a student's diagnostic report was parsed for skill gaps by a Gemini Gem that I programmed with the help of an AI chatbot to perform this task. Next, it drafted a four-week task sequence against pedagogical rules that I defined in advance. Once this had been reviewed, the problems were assigned to the individual students on *Snorkl*.

Snorkl, the interactive tool students then get to work with, was chosen for several reasons. It asks students to construct visual canvas representations (partitioning fraction bars, drawing number lines, etc.), to write equations that help solve the given problem, and most importantly, to narrate their reasoning aloud. When a student's answer is incomplete or mathematically flawed, the AI coach does not correct it directly; it first

¹ Compare **Fuchs, Fuchs, & Compton (2012)**. *Rethinking Response to Intervention at Elementary Grade Levels*.

² Website: **Snorkl (2024)**. *Digital whiteboard tool*. <https://snorkl.app/>

³ Students with documented learning differences, who are served by our learning specialists, were not included.

⁴ Compare **U.S. Department of Education, Office of Educational Technology (2023)**. *Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations*.

gives positive feedback, then asks one or two reflective questions and lets the student revise their drawing or explanation, sometimes across several iterations, until their reasoning holds up. In addition, *Snorkl* includes native multilingual support,⁵ allowing English Language Learners to express complex mathematical thinking in their primary language while developing core concepts.

The teacher can then see every iteration the student has gone through and listen to their recorded explanations, which provides a far richer picture of how a student thinks than a simple right-or-wrong answer, helping the teacher to continue their individualized support in a more targeted way. Importantly, the AI coach only operates inside the scope of pre-selected problems and rules; it is not a chatbot students converse with freely, and it does not decide what a student practices next.

Ethical Safeguards and the Human Element

While designing this program, it is important to keep ethical aspects as well as screen time concerns in mind. Teachers rightly worry that "AI-assisted intervention" is code for "AI replaces the intervention." Parents worry that screen time is being dressed up as personalized learning.⁶ To address this, signing up for the pilot program was completely optional, and an equivalent, paper-based support was offered for families who did not wish for their children to be exposed to screens to this extent. In addition, it is crucial to ensure close collaboration with parents and students and to provide constant human support. If a student's confusion runs deeper than the AI can address, it is important that a human steps in and provides immediate support.

Evaluating Impact and Next Steps

Success for this pilot will be measured with multiple metrics. The most important one will be a re-assessment on the same diagnostic in November, which will show whether the specific gaps identified at the outset have closed. In addition, I am reviewing the *Snorkl* recordings to see whether students grow more willing to revise a flawed explanation rather than abandon it, and whether their reasoning becomes more precise and confident across the four weeks. Teacher observation and family feedback will round out the picture. The findings from this pilot, successes and open questions alike, will be shared at ISB's AI conference in November.

In conclusion, the goal of this pilot is not to make Tier 2 intervention easier and faster for its own sake, but to ensure student support is as differentiated as needed, while giving teachers back the hours that they would have to spend on diagnosis and planning, so that they can instead accompany a student, noticing where their thinking gets truly stuck, and decide what they need next. AI, used this way, is not the intervention. It is the scaffolding that makes a genuinely differentiated intervention possible at the scale one teacher and one class period actually allow.

⁵ Compare **Moschkovich (2012)**. *Mathematics, the Common Core, and Language: Recommendations for Mathematics Instruction for ELLs*.

⁶ Compare **Center for Democracy & Technology (2025)**. *Schools' Embrace of AI Connected to Increased Risks*.

Conversations About Relationships in the Age of AI: Lessons From a High School Classroom

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Concern about the impact of technology on teens' social and emotional development is not new. Shifts in social habits arose with texting, social media and multiplayer gaming, to name a few examples. Schools have responded by building robust digital literacy and wellness programming, teaching students from a young age to develop healthy tech habits in their personal lives and social groups.

AI chatbots and companion apps bring the latest era of concern. Some risks are new iterations of old themes – for example, the spread of fake images and false information. Other risks are entirely new. Unlike earlier technologies, AI does not mediate socialization between teens – it can supplant that human conversation and connection. Chatbots, social companions, and specialized tools like therapy apps are built to learn personal information and preferences and to mimic human conversation in ways that feel novel, engaging, and often startlingly realistic.

AI use is already present in teens' daily lives. A recent survey from Common Sense Media found 89% of kids and teens ages 9 to 17 use AI for entertainment or fun. 40% have used AI for practicing conversation or social skills, and 37% have discussed their feelings or personal problems with AI (O'Neil, Anderson, White, Zimmermann, Mann, & Robb, 2026). Our students at the International School of Boston described using AI chatbots for entertainment, advice, and emotional support. In their own words, chatbots are "easy," "helpful," and "usually right."

Alongside these perceived benefits sit real risks. Conversations with chatbots such as ChatGPT, Gemini and Claude can offer inappropriate information and problematic content. Even kids and teens recognize the issue, with 1 in 6 (17%) reporting on the same Common Sense Media survey that an AI chatbot has shown them something they felt wasn't OK or wasn't meant for someone their age (ibid). AI companion apps mimic connection convincingly. A risk assessment from Common Sense Media and Stanford's Brainstorm Lab rated social AI companions as posing "unacceptable risk" to minors, citing their tendency to foster emotional dependency, miss signs of crisis, and offer harmful guidance (Common Sense Media, 2025).

As AI tools become ever more accessible for experimentation and social interaction, teens need to develop intuition for appropriate use. Digital wellness curricula must evolve to address technology not only as a social mediator, but as a substitute for social connection. Curricula around health, wellness, and social-emotional learning must place renewed emphasis on building a strong, stable sense of self in social context. We can guide teens to think critically and act responsibly in both their human relationships and their AI use by integrating learning across these arenas.

Pedagogical approaches to digital wellness rooted in fear or prohibition are ineffective. Teens hear the risks, but often lack the self-regulation and perspective to navigate situations in a healthier way. Our responsibility is to inform, empower and build critical thinking. At the International School of Boston, we created a comprehensive AI digital wellness curriculum that centers humanity (rather than the technology). A series of essential questions guided class activities and student self-examination:

AI Digital Wellness Unit Essential Questions

- How does interacting with AI chatbots and companions affect the development of healthy human social relationships?
- What are the gaps and biases of AI models and how do we navigate these as a user?
- What are the risks to personal and social development when we rely on advice, support, and information from AI?
- What advice or guidelines should teens follow when using AI tools for personal and social uses?

Through scenario-based activities, discussions and debates, and jigsaw learning, students fostered shared understanding and appreciation for diverse perspectives. Weekly reflection journaling promoted introspection and developed a record of emerging beliefs around AI-digital thriving. A summative project encouraged students to develop personal guidelines for safe and ethical AI use. Our topics were as follows:

AI Digital Wellness Unit Topics

- How teens are using AI for personal and social purposes
- What to know about AI technology, its gaps, and its limitations
- AI as a companion mimicking human roles (friend, romantic partner, therapist)
- Misuse and risks of AI content
- Human thriving in the age of AI: Fostering meaning
- Student personal reflection on AI's impact and maintaining a healthy balance
- Summative: Create an AI responsible use plan for fellow teens

This curriculum was piloted with a 10th grade Health and Wellness class at the International School of Boston in 2025. The experience yielded lively conversations and meaningful reflections about AI and social relationships. A sample of our class experiences offer the reader perspective on how students are grappling with their social connections and AI's capabilities.

In our school context, students had already completed technology coursework covering AI's risks and limitations, giving them an initial skepticism about AI's strengths as a social tool. Yet they described extensive use of AI for personal reasons. They tasked it with creating a sleep plan. They asked it to generate a funny video for their friend's birthday. They prompted it for advice again and again: for ideas on what to wear, for how to tell if their friend is mad at them, for what to say to their crush. Students reflected on what's exciting about using AI for personal requests: One wrote, "When you feel alone and sad, it could be really comforting to talk to AI. It can generate sweet and fun dialogues." Another shared, "It's exciting because we can play around to see what it will say/generate." Validating students' positive experiences using AI in these ways opens the door to further conversation.

Most students were quick to dismiss the idea of AI as a "friend." Challenging students to think beyond the label and compare AI's capabilities with the qualities of a good human friendship changed the dynamic and led to a robust exploration. In one lesson, students moved from a warm-up activity, identifying and sharing qualities of a good friend, to a scenario exercise evaluating whether an AI companion could meet the same standard. Students reported that AI seems to "listen", "give good advice", and "be on my side." In pinning down the differences with human interaction, we explored the importance of shared experiences, physical proximity, touch and non-verbal interaction. A specific kind of relationship came up in discussion: a long-distance friend we regularly have long text conversations with. How is this interaction similar and different to texting with a chatbot? Students' closing reflections shared a nuanced appreciation for human connection: One student wrote, "Real friendships have acts of service, physical touch, mutual discussion about their interests and mine. Both people put effort into the relationship." Another shared, "[AI] is easier and doesn't provide a challenge, but we need a challenge when it comes to relationships." One wrote:

“Other people help our souls stay us, and give us our personality.” Students grappled with this important question: When teens use AI for companionship, what are they missing out on?

Our lesson exploring AI use for mental health took a different approach, shifting from comparison toward clear guidelines. As students are already using AI for advice and support around personal issues, it is critical to validate how these tools effectively mimic empathic conversation. Chatbots frequently validate thoughts and feelings, and offer ideas that do not challenge the user’s perspective. However, even targeted “therapy” tools fail to recognize warning signs of mental health disorders and may feed into signals of crisis (Grabb, Lamparth, Vasan, 2024). We framed this distinction concretely: AI functions, at best, like a well-meaning friend who perhaps has worked with a therapist themselves. It does not act with the consistent expertise and judgment of a trained mental health professional. Educating students about the mistakes and limitations of AI’s support drives home the message that they must continue to seek supportive adults and mental health professionals when signs and symptoms of mental health concerns are present. As one student put it, “Don’t talk to AI about serious issues, especially regarding your/someone’s safety. Talk to a person.”

In this student cohort, skepticism of AI was a strong instinct. While they understood that AI chatbots and companions are not a replacement for human interaction, the reasons why were at times challenging to articulate. When presented with thoughtful scenarios, videos and examples, students developed an understanding of where AI interaction might cross their own boundaries as they navigate social uses. The deeper work of identity and social development, not AI literacy alone, is what ultimately equips students to make wise decisions for their own personal values and growth.

For educators and caregivers, a lesson from this unit is structural: AI digital wellness is best approached in the context of teens’ holistic development. When students were asked to evaluate AI against the standard of real friendship or real partnership, they engaged far more seriously than they did with direct instruction on AI or relationships alone. Schools can examine their wellness programming and build AI conversations into relationship and safety topics. Caregivers and mentors can facilitate dialog about what healthy support and connection look like in friendships and other relationships, encouraging teens to seek meaningful connection. These conversations, whether in the classroom or at home, share a common goal: helping students build clear values and sound judgment for the relationships, human and otherwise, that will shape their lives.

AI-Assisted Research and Intellectual Sovereignty

An Environmental Test Case for Education

Dr. Mathieu Beau

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AI education should equip students to investigate questions, exercise judgment, and take responsibility for what they create. In recent work co-authored with Mehdi Lazar and Brice Flaquière (Beau et al., 2026), we proposed a framework for AI-assisted research competency (AARC) to pursue this aim. Its purpose is intellectual sovereignty: a disposition through which students can use powerful tools while retaining ownership of their thinking. This offers a unified framework for students' inquiry activities and equips them with research skills, critical thinking, and independence of mind in the age of AI.

The impact of AI on the environment, which is a real issue, is also a challenging topic to discuss with students and others concerned about it. They have an opinion about it, yet none of the positions seemed satisfactory. On one side, some AI enthusiasts argue that we should not worry about it because AI is a great tool and represents progress. On the other, some present AI as dangerous for the environment, arguing that we should avoid it or restrict its use to people who really need it. Neither position satisfies me, and as teachers, I believe we should encourage our students to examine such positions through evidence and careful interpretation of that evidence. So, I decided to use this somewhat polemical issue to illustrate the importance of AI-assisted research competency and the disposition of intellectual sovereignty. Together, they can help develop nuanced and curious minds that go beyond fashionable positions and judgments of good or evil to build more constructive solutions.

In this contribution, I would like first to summarize the AARC framework and present the disposition of intellectual sovereignty, then apply them to the problem of AI and the environment, in the hope that this could serve as material for future classroom investigations.

1. AI-Assisted Research: Making Inquiry Visible

AI-assisted research competency (AARC) is the integrated capacity to conduct inquiry with AI while retaining authorship, judgment, verification, and intellectual responsibility (Beau et al., 2026). It brings together traditional research skills, AI literacy, and AI intuition. Literacy supplies conceptual and ethical understanding; intuition develops through experimentation, observation, reflection, and adaptation, helping learners judge how systems behave in particular situations (Beau & Lazar, 2026).

AARC comprises seven dimensions: question formulation; need evaluation and tool selection; interaction and prompt design; verification and source evaluation; synthesis and argumentation; authorship and disclosure; and reflection and defense. Three commitments govern their practice: verify, cite, and reflect (Beau et al., 2026). Students must check evidentiary sources, acknowledge assistance, and explain how their conclusions developed.

This changes what educators assess. A polished report alone cannot establish that its author understands the inquiry. Research notes, source comparisons, revisions, and oral defense make the underlying decisions visible. Teachers can ask why students selected a tool, rejected a claim, or changed an interpretation.

Whether delegation supports learning depends on the competency a task develops. Formatting assistance may help students concentrate on argumentation; outsourcing the argument may bypass the learning itself. The curriculum progressively transfers responsibility through foundation, transfer, and autonomy (Beau et al., 2026). Note that AARC is a conceptual and design framework whose educational effects require empirical evaluation, but it offers an intellectual foundation for future research in AI and education and for supporting students' transition from secondary to higher education, where research skills are important.

2. Intellectual Sovereignty as a Disposition

Within this framework, epistemic agency names the competence to seek knowledge, evaluate evidence, form justified beliefs, and take intellectual responsibility for one's conclusions. AARC strengthens this agency by helping students decide what to delegate to AI, what requires their own reasoning, and how to verify and defend the resulting work. Intellectual sovereignty names the disposition to exercise that competence: to claim ownership of one's thinking and retain responsibility for judgment (Beau et al., 2026).

This disposition draws on intellectual curiosity, epistemic vigilance, humility, honesty, and courage. Students need curiosity to pursue questions, vigilance to scrutinize claims, humility to recognize uncertainty, honesty to disclose assistance, and courage to revise a position or question a prevailing assumption (Beau et al., 2026).

Sovereignty involves responsible engagement with expertise and other perspectives. Students, like professional researchers, can rely on specialists while examining the relevance and limits of their evidence. They must also investigate their own assumptions. The same standards should apply to research assisted by AI. AI can help students explore the literature, identify gaps, refine data analysis, and formulate conclusions, but students should retain ownership of their work and be able to defend their results and conclusions.

To help students develop this ability, it is important to 1) keep track of their work and progress using, for example, document version histories and task and reflection sheets, and 2) assess their understanding through an interview in which they defend their conclusions without AI assistance, allowing the teacher to evaluate their intellectual ownership of the work.

Epistemic agency is the competence that teachers help students build and assess; intellectual sovereignty is the disposition they help students develop through feedback and reinforcement. In this sense, the final oral evaluation goes beyond assessing the finished product: it provides evidence of the stage students have reached in developing this disposition. It helps teachers identify where students exercise independent judgment and where further support is needed.

What I am going to say now goes beyond the scope of Beau et al. (2026) and is more of a personal reflection. I believe it is important to understand that intellectual sovereignty is not simply a matter of complying with moral rules, and that it differs from the ethical aspects of AI literacy. I see it as a personal ethic grounded in students' own understanding of why ownership of their thinking matters. Students should not be morally pressured into being sovereign; they should recognize the need for it because it gives them the power to be creative and to own their creations. And I believe this is the key to the next section of this contribution, AI and the environment, where moral and ethical values alone are not sufficient to develop constructive and independent thinking that could benefit the community. Individuals sometimes need to step back from peer pressure to produce something original and creative that could, in turn, benefit the group.

3. Test Case: AI and the Environment

Now, let’s explore a somewhat controversial issue: the impact of AI on the environment. The goal of this section is to move beyond polemical positions through reasoned inquiry and to help students develop the disposition of intellectual sovereignty so that they can reach their own conclusions.

We will first briefly review how AI could contribute to environmental research and examine the limitations of these contributions. Then, we will investigate AI’s environmental footprint and emphasize the educator’s role in supporting students’ inquiry. Finally, we will explore how these dimensions interact and how students can use AI-assisted research to develop constructive proposals, evaluate their consequences, and revise their judgments.

3.1. AI's Potential Contribution to Environmental Research

AI and environmental sustainability intersect through several distinct questions. One concerns AI's contribution to research and technological development. The International Energy Agency (IEA, 2025) identifies applications in renewable-energy integration, weather forecasting, energy efficiency, and innovation. Students can investigate a specific application: what problem does it address, what evidence supports its effectiveness, and what would happen without it?

Scientific usefulness does not guarantee environmental benefit. Faster discovery must translate into effective deployment, and each application requires assessment. The environmental contribution of AI should therefore be investigated through particular cases rather than assumed for the technology as a whole.

In the last section, we will propose an activity for students at school. What is important here is to understand that AI is neither perfect nor entirely bad, but can be useful in addressing certain problems, particularly by assisting environmental research. This could help students who have a negative view of AI examine its usefulness in practice, just as they would examine the benefits and costs of a car, a phone, or any other modern technology.

An analogy can be drawn with nuclear technology, which has applications in medicine and electricity generation, although the latter also raises debates beyond the scope of this contribution. The point is to examine specific applications, their benefits, and their risks before judging the technology as a whole.

3.2. AI's Environmental Footprint and the Role of Educators

The second question is how many resources AI itself consumes. The IEA’s 2026 update estimates that all data centres consumed 485 TWh of electricity in 2025 and projects approximately 950 TWh in 2030 (IEA, 2026). These figures include services other than AI, so we should be careful about how we interpret them. It is also important to distinguish the resources needed for one interaction from those needed to support millions of users.

Table 1. Classroom resources for investigating AI and the environment

Classroom resource	What students can investigate	Essential distinction
IEA reports (2025, 2026)	Infrastructure demand and possible environmental benefits	Observed estimates, projections, and AI's share
AI Energy Score (n.d.)	Energy efficiency across models and tasks	Controlled GPU benchmarks versus a complete service

Classroom resource	What students can investigate	Essential distinction
EcoLogits (n.d.)	Estimated impacts of particular models and workloads	Modeled impacts, assumptions, and measurement
ADEME's Impact CO ₂ (n.d.)	Transport and other everyday activities	CO ₂ e, lifecycle boundaries, and local conditions

To give students a sense of scale, Tables 2-3 compare operational CO₂ emissions using explicit assumptions. A 2026 study estimates a median electricity use of 0.31 Wh per ordinary text query for models with more than 200 billion parameters running on H100 GPU nodes. In a modeled scenario requiring 15 times as many tokens, the estimate rises to 3.91 Wh (Oviedo et al., 2026)! These figures do not tell us what every query consumes or what an average user or researcher actually uses. They provide estimates for a specific scenario. For the comparison, we convert these electricity estimates into CO₂ emissions using 0.35 kg CO₂/kWh, rounded from the EPA's 2023 US electricity-generation average (U.S. Environmental Protection Agency [EPA], 2025b). Here again, this is an assumption that makes the calculation possible, rather than a measurement of the electricity mix used by every AI provider.

Table 2. Annual comparison: population evidence and illustrative personal scenarios

Activity	Basis of comparison	Operational CO ₂ per year	Equivalent passenger-vehicle miles
Everyday AI user: illustrative scenario	20 ordinary text queries/day × 365 days, at 0.31 Wh/query (Oviedo et al., 2026; EPA, 2025b)	≈0.8 kg	≈2
Researcher: illustrative text workloads	100 queries/workday × 220 days: ordinary queries at 0.31 Wh, or longer queries at 3.91 Wh (Oviedo et al., 2026; EPA, 2025b)	≈2.4 kg / ≈30 kg	≈6 / ≈75
US passenger-vehicle commuter: average distance, assumed attendance	National mean private-vehicle commute: 13.56 miles each way (2022); two trips/day × 220 days; solo travel (Federal Highway Administration, 2024; EPA, 2026)	≈2,400 kg	≈6,000
Air travel: global population average, historical passenger-only baseline (2019)	785 million tonnes of passenger-transport CO ₂ ÷ 7.7 billion residents, including non-flyers (Graver et al., 2020; United Nations Department of Economic and Social Affairs, Population Division [UN DESA], 2019; EPA, 2026)	≈102 kg/person	≈255
International-school student: illustrative travel scenario	Two Boston–Paris round trips/year; four one-way flights (Air Miles Calculator, n.d.; EPA, 2025a)	≈2,250 kg/student	≈5,600

To place this section in the context of the community where I teach, I included the international-school example as an illustrative scenario. It does not represent a measured average for students at the International School of Boston. Nevertheless, investigating our students' carbon footprint could be an interesting community service initiative or student project. Based on a survey, students could estimate and compare the carbon emissions associated with their AI use and air travel, using a common time period and clearly stating the assumptions and limitations of the comparison.

Table 3. Individual units: AI queries, vehicle mileage, and Boston–Paris flights

Unit of activity	Operational CO ₂	Equivalent passenger-vehicle miles	Equivalent ordinary AI queries
One ordinary text AI query, at 0.31 Wh (Oviedo et al., 2026; EPA, 2025b)	≈0.11 g	≈0.00027	1
One longer AI query, at 3.91 Wh (Oviedo et al., 2026; EPA, 2025b)	≈1.37 g	≈0.0034	≈13
One mile in a typical US passenger vehicle (EPA, 2026)	≈400 g	1	≈3,700
100 miles in that vehicle (EPA, 2026)	≈40 kg	100	≈370,000
Boston → Paris, one passenger, one way (Air Miles Calculator, n.d.; EPA, 2025a)	≈560 kg	≈1,400	≈5.2 million
Boston ↔ Paris, one passenger, round trip (Air Miles Calculator, n.d.; EPA, 2025a)	≈1,120 kg	≈2,800	≈10.4 million

Calculation basis: electricity uses the eGRID2023 US CO₂ output rate of 767.209 lb/MWh (≈0.348 kg/kWh), rounded to 0.35 kg/kWh (EPA, 2025b). Passenger-vehicle travel uses the EPA's approximately 0.400 kg CO₂/vehicle-mile (EPA, 2026). Commuting uses the 2022 mean private-vehicle commute trip length of 13.56 miles (Federal Highway Administration, 2024, Table 7-4). The air-travel population average divides 785 million tonnes of 2019 passenger-transport CO₂, excluding freight (Graver et al., 2020), by the mid-2019 world population of about 7.7 billion (UN DESA, 2019). Boston–Paris uses approximately 3,450 great-circle miles (3,448.4 miles; Air Miles Calculator, n.d.) × the EPA's generic long-haul factor of 0.163 kg CO₂/passenger-mile (EPA, 2025a, Table 10); it is not an airline-specific or cabin-specific measurement. Equivalent activities divide emissions by the same vehicle or AI factor. Figures are rounded.

It is important to understand what these comparisons include. They cover CO₂ emissions from electricity generation or fuel combustion, but leave out AI training, manufacturing, upstream fuel emissions, user devices, and aviation's additional climate effects, including contrails. They also leave out water use and the consumption of material resources. Students using classroom calculators should therefore check what each estimate includes before comparing it with these figures.

Under these assumptions, using text AI produces much less operational CO₂ than commuting or transatlantic travel. This gives students a sense of proportion, but it does not settle the question of AI's overall environmental impact. They should also investigate how efficiency, the number of users, pressure on local resources, and the alternatives available affect the comparison.

In international schools, travel often helps families stay connected across countries. I believe environmental education should help students reflect on these circumstances and their possible choices without turning their family situation into a moral judgment. The goal is to help them understand the scale of different impacts and use this understanding to make informed choices and propose constructive solutions.

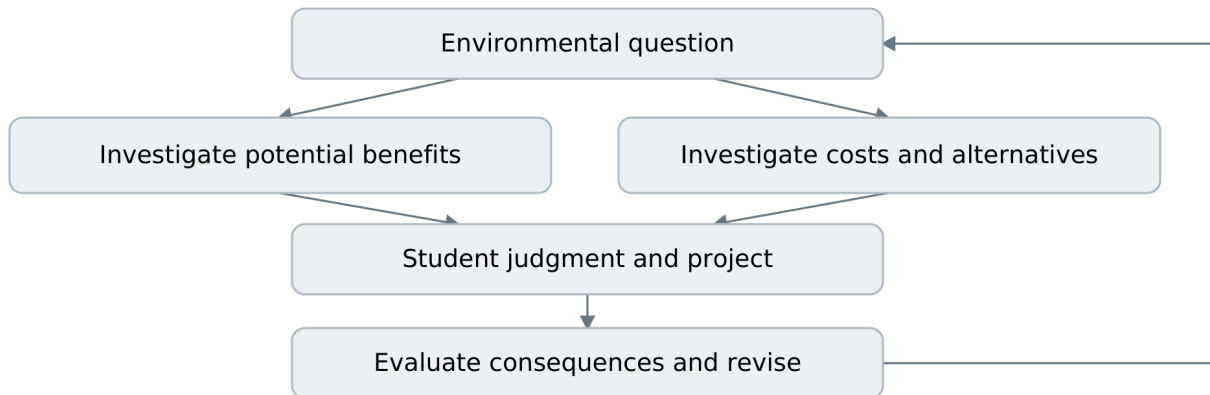
3.3. Connecting Research, Impact, and Student Agency

These two aspects, AI’s contribution to environmental research and its own environmental impact, are connected and should be considered together. AI may help us develop solutions, but using it also consumes resources. The question is therefore to investigate where it is useful, what its costs are, and whether the benefits justify those costs. This is a dynamic process, as new findings and technologies may lead us to reconsider our conclusions; see Figure 1.

For example, students could investigate energy use in their school building. They could formulate a research question, compare approaches with and without AI, and explain their assumptions. Did AI help them understand the problem better or identify a useful solution? Was its use justified given the resources it consumed? Students could then present their recommendations, discuss them with others, and revise their conclusions.

This is where education has an important role to play. By investigating a concrete problem, students can develop their own judgment and propose something useful for their community. Intellectual sovereignty takes shape through this work: students examine evidence, make choices, and take responsibility for what they propose. The educator supports this process without deciding in advance which conclusions students should reach.

Figure 1. Environmental inquiry as a cycle of judgment and action



AI-assisted research supports the inquiry; intellectual virtues govern its practice. The feedback cycle is a proposed educational model.

Editorial conclusion

What should students become able to understand and do through their education, and how can AI support that development? The contributions in this collection return to this question from different positions. Their examples span institutional strategy, governance, critical thinking, feedback, mathematics intervention, relationships, and environmental inquiry. Across these settings, the educational value of AI depends on the purposes it serves and on the decisions people make around its use.

One useful distinction concerns the work produced during an activity and the learning students carry beyond it. A stronger draft, a completed exercise, or a fluent explanation can be valuable, but each leaves open questions about understanding, transfer, and independence. Teachers need opportunities to observe how students reason, respond to feedback, revise an interpretation, and explain their choices. These opportunities take different forms across the contributions, including oral explanation, successive drafts, reflective discussion, and the defense of research conclusions. Their design should follow the capacity being developed and the needs of the learners involved.

Institutional leadership helps make this work sustainable. Teachers need time to experiment, discuss difficulties, and evaluate what happens in their classrooms. Schools need shared expectations that connect professional learning, student development, and the protection of personal data. They also need to examine the practical dependencies created by particular platforms. The leadership contributions offer complementary ways to connect individual initiative with institutional responsibility. How those proposals should be implemented will depend on the school's context, resources, and applicable obligations.

The collection also shows why academic learning cannot be separated from students' wider experience. Their relationships, confidence, willingness to question, and sense of ownership influence how they engage with AI. Conversations about wellness and environmental responsibility can provide opportunities for inquiry when students are encouraged to examine evidence and articulate their own judgments. Educational guidance has particular value when it helps them understand a problem, consider other perspectives, and take responsibility for a position they can defend and revise.

Several questions require further investigation. Does an AI-supported activity improve students' later work without assistance? Does time saved in planning or feedback lead to more effective human support? How do experiences differ across age groups, subjects, languages, and learning needs? What do students and families identify as helpful or difficult? Environmental inquiry adds questions about the scale and boundaries of resource estimates, the benefits of particular applications, and the alternatives available. These questions call for evidence appropriate to each claim, including classroom observation, student work, carefully designed evaluation, and transparent accounts of limitations.

The contributions provide starting points for this work, with different levels of evidence and different purposes. Conceptual frameworks invite testing; practitioner accounts offer approaches to examine in other settings; a planned pilot creates an opportunity to document both successes and difficulties. The conference can extend the discussion by bringing these perspectives into contact with participants' experience. Schools can then develop proposals that are specific enough to evaluate and flexible enough to revise. The educational aim is to help students become knowledgeable, thoughtful, and responsible participants in a world where AI is increasingly present, with the confidence to use it, question it, and make decisions of their own.

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