Dr. Sarah Chardonnens
Specialist in learning sciences and expert in AI literacy
University of Fribourg, Research Scientist Affiliate to the MIT
Author of "The Learning Revolution, AI's influence on intelligence and education" and "Artificial Intelligence et apprentissage"

AI Culture Beyond Technical Skills: A Human-Centered Pedagogical Framework

Policy Recommendations for Schools, Universities, Teacher Training, and Lifelong Learning in the Age of Generative AI

Abstract

AI literacy has become a strategic priority for education systems. Schools, universities, teacher-training institutions, and lifelong learning providers are increasingly expected to prepare learners to understand, use, evaluate, and create with AI. Recent international frameworks have made significant progress by emphasizing the fundamentals of AI—data, algorithms, ethical use, transparency, bias, and responsible interaction with AI systems. These dimensions are necessary. However, in the era of generative AI, they are no longer sufficient.

The main challenge facing our society lies not solely in individuals' ability to use AI tools effectively. The question is whether they are capable of continuing to think, understand, verify, moderate, make decisions, and maintain their intellectual autonomy while using them. A student may know how to formulate queries, generate text, summarize documents, produce images, or obtain explanations from ChatGPT, yet be unable to detect errors, compare sources, verify their understanding, maintain cognitive effort, or take responsibility for final decisions. In such cases, technical competence can coexist with reduced autonomy.

Recent research confirms this concern. Gu and Ericson's integrative review of AI literacy in primary, secondary, and higher education shows that the concept remains fragmented across functional, critical, and sociocultural approaches. Alfarwan's systematic review of generative AI in elementary and secondary education highlights growing adoption, but also the need for stronger pedagogical and policy guidelines. Fan et al. show that generative AI can improve immediate task performance while potentially encouraging technological dependence and "metacognitive laziness." Stadler, Bannert, and Sailer demonstrate that large language models can reduce mental effort but may also weaken the depth of reasoning in scientific research. Zhai, Wibowo, and Li caution that excessive reliance on AI-based dialogue systems could affect students' critical thinking, problem-solving, analytical reasoning, and decision-making.

This guidance note argues that AI culture must go beyond technical skills. It proposes a human-centered AI culture framework structured around five complementary dimensions: cognitive culture, metacognitive culture, motivational culture, ethical culture, and human action culture. Together, these dimensions aim to ensure that AI supports human learning and safeguards the individual.

The goal is to design educational systems in which AI becomes a tool for deeper understanding, rather than a shortcut that bypasses critical thinking. A **human-centered AI culture** should not only teach students how to use tools but also encourage them to question their own relationship with these tools. It should help them ask themselves: Am I actually thinking, or am I simply validating an answer generated by the machine? What clues allow me to say that I have understood? Am I using AI to deepen my learning, or to bypass the effort of learning? Is my use of AI fair, transparent, and responsible? Who holds the decision-making power: me or the system? And, even more profoundly, am I the one guiding AI toward my learning goals, or is AI gradually shaping the way I think, choose, and act?

Educational systems should therefore expand their policies regarding AI literacy and integrate it across all subjects. Universities should train students to document, verify, and justify their use of generative AI. Teacher training should prepare educators to design learning scenarios—potentially supported by AI—that foster attention, effort, reflection, and autonomy. Developers should create AI systems that encourage explanation, verification, and self-regulation rather than focusing solely on speed, convenience, and automation.

A human-centered AI culture is a fundamental educational priority.

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1. Why Current Frameworks for AI Literacy Are Insufficient

The seminal work by Long and Magerko defined AI literacy as a set of competencies that enable individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool in daily life. More recent research has broadened this perspective. Gu and Ericson's integrative review shows that AI literacy is not a single, static concept. It can be understood from a functional perspective, as the ability to use AI systems; from a critical perspective, as the ability to evaluate their outcomes and implications; and from a sociocultural perspective, as the ability to understand how AI reshapes institutions, power relations, knowledge practices, and human action.

This evolution is significant and demonstrates that AI literacy can no longer be reduced to coding, prompt engineering, or technical understanding. However, in practice, AI literacy often translates into courses on how AI works, the use of data, how algorithms make predictions, writing better prompts, and identifying biases or "hallucinations." These topics are essential, but they do not fully address what happens within the learner when AI becomes a permanent cognitive partner.

The rise of generative AI is a game-changer. Unlike previous educational technologies, generative AI is capable of producing language, explanations, summaries, arguments, feedback, code, images, lesson plans, and even seemingly personalized reasoning. This creates tremendous learning opportunities but also gives rise to new forms of cognitive delegation. Learners may no longer be content to simply use technology to access information. They may use it to think for them, organize arguments, generate solutions, evaluate alternatives, and produce final work.

This results in a paradox. AI can support learning, but it can also bypass the very processes through which learning takes place. A learner can obtain a high-quality answer without having constructed the knowledge themselves. A student can turn in a well-written essay without

having developed the argument. A teacher can generate differentiated activities without fully analyzing the underlying learning needs. A professional can make an AI-supported decision without understanding the uncertainty, biases, or assumptions inherent in the result.

This is why the culture of AI must be reimagined. The question is: “What human capabilities should education protect and develop in an AI-saturated environment?”

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2. The scientific issue: AI can support learning or replace the learning process

Generative AI can provide explanations, examples, feedback, instructional guidance, formative assessment, language support, and personalized advice. Alfarwan’s systematic review of the use of generative AI in primary and secondary education shows that generative AI is increasingly being used to support teaching and learning, particularly through content generation, instructional assistance, and learning support. The meta- analysis by Kaliisa and colleagues on AI-generated feedback in higher education also suggests that such feedback can support learning when it is pedagogically structured and when learners know how to interpret it and act upon it.

However, these same technologies can hinder learning if they reduce the learner’s active engagement. The risk lies not simply in the fact that AI makes mistakes. The deeper risk is that learners will cease to engage in the cognitive, metacognitive, and motivational work necessary for understanding.

The experimental study by Fan et al. is particularly significant in this regard. The authors compared different forms of support: the use of LLMs, assistance from a human expert, writing analysis tools, and no additional support. They found that students using LLMs received higher grades on their essays, but this did not translate into an equivalent gain or transfer of knowledge. Simply regurgitating information is not enough to assimilate it. Furthermore, the study suggests that generative AI can encourage dependence and trigger a form of “metacognitive laziness,” in which learners rely on external support without sufficiently monitoring, evaluating, or regulating their own understanding.

Stadler, Bannert, and Sailer offer another important caution. Their study compared students using LLMs with students using traditional search engines in the context of scientific research. Learners using language models (LLMs) experienced a lower cognitive load, but their reasoning and argumentation were of lower quality. This finding is crucial for policy-making. Reducing cognitive effort is not automatically beneficial from an educational standpoint. Learning often requires productive effort, uncertainty, comparisons, explanations, and revisions. If AI eliminates too much friction, it can lead to cognitive ease at the expense of deeper engagement.

The systematic review by Zhai, Wibowo, and Li on overreliance on AI-based dialogue systems reinforces this concern. Their analysis highlights potential effects on critical thinking, analytical reasoning, decision-making, and problem-solving. These risks are particularly significant in the field of education, as they concern not only what students know but also how they develop the intellectual habits necessary for independent judgment.

This means that AI must be integrated into an educational framework. Under what conditions does AI promote attention, reasoning, self-regulation, motivation, and autonomy?

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3. A Human-Centered Framework for AI Culture

This guidance note proposes a human-centered AI culture framework consisting of five dimensions: cognitive culture, metacognitive culture, motivational culture, ethical culture, and the culture of human autonomy. These dimensions complement existing AI culture frameworks by emphasizing not only the tool but also the learner.

3.1 Cognitive Culture

Cognitive culture refers to the ability to think alongside AI without delegating the thinking to it. It encompasses the ability to understand information, compare explanations, reason to solve problems, identify contradictions, evaluate evidence, and construct meaning.

In the era of generative AI, cognitive literacy requires learners to distinguish between receiving an answer and understanding a concept. AI can produce fluent explanations, but fluency is not synonymous with truth. It can generate plausible arguments, but plausibility is not synonymous with reasoning. It can summarize content, but a summary is not synonymous with understanding. *Is this true? Does it follow sound, reasoned logic? Do I understand it and can I explain it in my own words?*

Cognitive culture therefore requires explicit pedagogical practices. Learners must be trained to ask themselves the following questions: *What is the claim? What evidence supports it? What assumptions underlie it? What alternative explanations exist? How would I answer this without AI? Which part of this answer can I verify? Which part do I not yet understand?*

This dimension is strongly supported by research on cognitive load, desirable difficulties, self-explanation, retrieval practice, critical thinking, and scientific reasoning. The findings of Stadler et al. are particularly relevant: the reduced cognitive load generated by large language models (LLMs) may be useful in certain contexts, but it can also diminish the depth of engagement required for high-quality reasoning. Cognitive culture should therefore not aim to minimize effort at all costs. It should help learners regulate their effort judiciously.

The policy implication is significant: AI education programs should include tasks that require learners to compare AI results with primary sources, explain the reasoning in their own words, identify weak arguments, and reconstruct solutions without the aid of AI.

3.2 Metacognitive Culture

Metacognitive culture refers to the ability to plan, monitor, evaluate, and regulate one's own learning while interacting with AI. It is the ability to ask oneself: *How do I know I've understood? What else do I need to check? Did the AI help me learn, or did it simply help me finish?*

Metacognition is essential because generative AI can create an illusion of understanding. When an AI system provides a clear explanation, learners may feel as though they have understood

the concept, even if they are unable to explain, apply, or transfer it independently. This risk is amplified by the conversational style of AI systems, which can give the impression that the results are personalized, authoritative, and consistent.

The concept of "metacognitive laziness" developed by Fan et al. provides a solid empirical foundation for this dimension. The problem is not that students lack motivation in the general sense of the term. Rather, it lies in the fact that AI-assisted learning can alter the sequence and quality of self-regulated learning processes. Learners may neglect planning, reduce monitoring, accept feedback too quickly, or fail to assess whether they have actually learned.

Metacognitive literacy should therefore become an essential component of AI literacy. Students should learn to plan their use of AI before beginning a task, monitor their interaction during the task, and evaluate both the outcome and their own learning after the task. This can be implemented through simple routines such as: before using AI, formulate your own hypothesis; while using AI, ask for explanations and counterarguments; after using AI, close the tool and reconstruct what you have understood.

The policy implication concerns schools and universities: requiring evidence of process-based learning, including learning journals, reflection journals, oral explanations, source verification logs, and documentation of AI use.

3.3 Motivational Culture

Motivational literacy refers to the ability to use AI in a way that preserves curiosity, effort, perseverance, autonomy, and a sense of competence. It raises the following question: Am I using AI to learn, or to avoid learning?

This aspect is crucial because AI can either support or undermine motivation. On the one hand, AI can provide immediate feedback, reduce frustration, tailor explanations, help students who are struggling, and make learning more accessible. On the other hand, if AI is used primarily to obtain answers quickly, it can reduce perseverance, weaken tolerance for difficulties, and encourage dependence.

Theories of self-determination, expectancy-value, emotions related to success, and engagement show that learning depends not only on information processing but also on autonomy, competence, value, interest, and emotional regulation. If learners feel that AI makes them more competent, helps them understand, and supports meaningful goals, this can strengthen their engagement. If they use AI to avoid effort, avoid uncertainty, or avoid difficulty, this can undermine deep learning.

This is particularly important for young learners. In elementary and secondary education, Alfarwan's study highlights the need for careful guidance as generative AI is integrated into teaching practices. Students should not be taught that AI is merely a productivity tool. They must learn to distinguish between situations where AI can reduce unnecessary difficulty and those where such difficulty has educational value.

AI training programs should teach students to distinguish between productive assistance and avoidance. Teachers should design tasks in which AI fosters curiosity, feedback, and review, without removing the learner's responsibility to think, persevere, and explain.

3.4 Ethical Culture

Ethical culture refers to the ability to identify and address the ethical, social, cultural, and political implications of AI use. It encompasses bias, discrimination, privacy, transparency, authorship, accountability, environmental impact, accessibility, and justice.

Ethical literacy is already present in major international frameworks, notably UNESCO's AI competency frameworks for teachers and students. UNESCO emphasizes a human-centered approach, AI ethics, the fundamentals of AI, pedagogy, professional development, responsible citizenship, and inclusive design. The European AI Act also considers several educational uses of AI to pose a high risk, including systems used for admissions, assessment of learning outcomes, academic counseling, and exam proctoring.

However, an ethical culture must not remain abstract. Students and teachers need concrete practices. They should be able to ask themselves the following questions: *What data was used? Who benefits from this system? Who is at risk of being disadvantaged? What assumptions does the model reproduce? Can the result be explained? What happens if the system makes a mistake? Who is responsible?*

An ethical culture must also include epistemic responsibility. Generative AI systems can produce hallucinations, biased associations, and culturally reductive results. Learners must therefore be trained not only to recognize bias in principle, but also to verify claims, compare perspectives, identify missing voices, and understand how AI systems can shape what appears credible.

An ethical culture of AI should be integrated into all disciplines. It should not be limited to isolated courses on bias. It should be put into practice in writing, the sciences, history, citizenship education, vocational training, teacher training, and professional development.

3.5 Culture of Human Action

The culture of human agency is the distinctive dimension of this framework. It refers to the ability to remain in control of one's own decisions, reasoning, learning, and responsibilities while interacting with AI systems.

This dimension raises the following question: *Who makes the final decision—me or the machine?*

Mastery of human agency includes the ability to maintain control, suspend judgment, verify recommendations, resist automation biases, make informed decisions, and take responsibility for outcomes. It is not anti-technology. It is the prerequisite for responsible collaboration between humans and AI.

This dimension is urgently needed, as generative AI systems are becoming increasingly persuasive. Their outputs are fluid, rapid, confident, and personalized. In educational contexts, this can lead learners to place excessive trust in the results, to follow recommendations uncritically, or to view AI-generated reasoning as superior to their own. In teacher training, this can lead future teachers to rely on AI-generated lesson plans without exercising sufficient pedagogical judgment. At the university level, this can lead students to submit polished assignments without developing their own intellectual understanding.

Mastery of human agency must therefore be considered a policy priority. It encompasses cognitive mastery, metacognitive mastery, motivational mastery, and ethical mastery. A learner who exercises human agency does not merely use AI. They guide it, question it, verify it, learn from it, and remain responsible for the final judgment.

Educational systems should establish the principle of meaningful human oversight in AI-assisted learning. Learners should always be able to explain what the AI did, what they accepted, what they rejected, what they verified, and what decision they ultimately made.

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4. Risks of a Purely Technical Approach

4.1 Automation Bias

Automation bias occurs when humans place excessive trust in automated systems and accept their results even when they are incomplete, biased, or incorrect. In the field of education, this risk arises when students accept AI-generated explanations without verification, when teachers rely on automated assessment scores without examining the underlying reasoning, or when institutions use predictive analytics to rank students without adequate human oversight.

The AI Act recognizes the seriousness of these risks by classifying several AI systems used in education as high-risk, particularly those used for admission, assessment, placement, and monitoring. This confirms that mastering AI cannot be reduced to the mere use of tools. It must include critical thinking, accountability, and human oversight.

4.2 Cognitive Offloading

Cognitive offloading refers to the delegation of cognitive tasks to external tools. A certain degree of offloading can be useful. Calculators, search engines, note-taking systems, and digital reminders can support cognition. The problem lies not in offloading itself, but in excessive or premature offloading. When students delegate memorization, reasoning, writing, or problem-solving too early, they risk reducing the practice necessary for learning. Learning means training the brain to improve performance and prepare for the unexpected—to develop adaptability.

If AI takes over not only mechanical tasks but also complex intellectual processes, it hinders our potential: reasoning, synthesis, explanation, planning, feedback, and evaluation. A human-centered approach must therefore help learners determine which tasks can be delegated and which must remain active for learning to take place.

4.3 The Illusion of Understanding

Generative AI can produce explanations that appear clear and comprehensive. This can create an illusion of understanding. Learners may believe they understand because the output is comprehensible, but they may not be able to explain the concept on their own, apply it to a new problem, or identify errors.

This is why AI-assisted learning should always include transfer checks. Students should not simply read the explanations provided by the AI. They should rephrase them, question them, apply them, compare them, and reconstruct them from memory.

4.4 Reduction in Self-Regulation

Self-regulated learning requires learners to set goals, develop strategies, track their progress, evaluate results, and adjust their actions. If AI provides immediate solutions without requiring reflection, learners may bypass these processes. The findings of Fan et al. suggest that generative AI can disrupt self-regulated learning processes even when motivation levels appear similar.

AI literacy should therefore include explicit training in self-regulation. Students should learn to use AI as a coach, not as a substitute for self-regulation. Teachers should design activities in which AI supports planning, monitoring, and revision rather than replacing them.

4.5 Methodological Caution: Data Must Be Evaluated Critically

The rapid growth of AI research in education also carries a risk of premature policy conclusions. For example, the 2025 meta-analysis by Wang and Fan on the effects of ChatGPT on learning performance, perceptions of learning, and higher-order thinking initially reported positive effects, but the article has since been retracted. This does not mean that ChatGPT cannot support learning. It means that policies must be based on convergent, high-quality, and non-retracted data, and avoid drawing overly broad conclusions from rapidly evolving studies.

This argument reinforces the thesis put forward in this note: AI culture must include a scientific and epistemic culture. Learners, teachers, policymakers, and institutions must learn to evaluate the evidence—not just the results generated by AI.

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5. Policy Recommendations

5.1 For Governments and Ministries of Education

National education policies would benefit from recognizing a human-centered AI culture as a cross-curricular competency present throughout the curriculum. It is not solely the domain of computer science or technology, but also pertains to languages, the sciences, the humanities, the arts, vocational training, citizenship education, and teacher training.

With this in mind, school curricula could be organized around five major learning objectives

The first objective is to enable learners to understand the fundamental concepts of AI, as well as its limitations. The second aims to develop their ability to critically evaluate the results produced by AI systems. The third focuses on the use of AI as a learning aid, by strengthening self-regulation, metacognition, and learner responsibility. The fourth encourages the identification of the ethical, social, and civic implications associated with these technologies.

Finally, the fifth objective centers on preserving human autonomy in decisions made with the support of AI.

Beyond educational content, governments also have a role to play in developing national guidelines regarding the use of AI in assessment, data governance, and student protection. These guidelines would benefit from drawing, where relevant, on existing international frameworks, notably UNESCO's AI competency frameworks, the work of the OECD and the European Commission on digital literacy and AI, as well as the European AI Act.

5.2 For Schools

Schools would benefit from moving beyond a tool-centered approach to AI adoption and toward genuine pedagogical integration. The challenge is not merely to teach students how to formulate effective queries, but to develop their ability to question, verify, compare, explain, and make decisions.

With this in mind, every AI-assisted classroom activity could be organized in three stages. Before interacting with the tool, students articulate their own understanding, a hypothesis, or a plan of action. While using the AI, they engage critically with the system, ask for justifications, weigh different perspectives, and identify areas of uncertainty. After using the AI, they articulate what they have learned, what they have adjusted, what they have discarded, and what they are now able to accomplish independently.

This pedagogical integration also benefits from taking learners' developmental stages into account. Younger students require more structured support, as their metacognitive, critical

thinking, and self-regulatory skills are still developing. An introduction to AI can thus be designed as a progressive journey, tailored to students' ages and closely aligned with subject-specific learning.

5.3 For Universities

In higher education, the challenges posed by AI extend far beyond the issue of academic integrity alone. Rules regarding plagiarism, transparency, and disclosure of AI use remain essential, but they are not sufficient to prepare students to learn, reason, and generate knowledge in a transformed digital environment. Mastery of AI can thus be viewed as an integral component of university-level intellectual education.

From this perspective, students would benefit from documenting their use of AI, justifying their methodological choices, verifying their sources, explaining their reasoning, and demonstrating an independent understanding of the material they are studying. Assessment would then no longer be limited to the final product but would also take into account the processes of learning, research, revision, and decision-making. Oral defenses, reflective comments, annotated drafts, research journals, and exercises comparing sources can help students maintain intellectual accountability for their own work.

Universities also have an important role to play in teaching students how to critically evaluate feedback generated by AI. The work of Kaliisa et al. suggests that such feedback can support learning, but that it is not automatically effective. Students therefore need to learn how to interpret this feedback, select relevant elements, decide what revisions to make, and understand why certain changes actually improve the quality of their work. The challenge is not merely to use AI feedback, but to remain capable of assessing its value, limitations, and effects on one's own thinking.

5.4 Regarding Teacher Training

Teacher training is a strategic priority. Teachers are not merely users of AI tools; they are the designers of learning environments in which AI can transform attention, effort, feedback, autonomy, and assessment.

Teacher training programs should include, as a mandatory component, a human-centered AI culture. Future teachers who master the fundamentals of AI—in terms of ethics, pedagogy, implications for assessment, and classroom management—could thus design learning tasks that prevent dependency and encourage reflection.

The work of Zawacki-Richter and her colleagues on AI in education has repeatedly demonstrated the importance of teacher preparation and the risk that educators may not be sufficiently prepared for AI-assisted teaching. UNESCO's AI Competency Framework for Teachers directly addresses this gap by defining the knowledge, skills, and values that teachers need in the age of AI.

Teacher training should therefore include concrete design practices: When should AI be used? What learning process does it support? Which human processes must remain active? What evidence will demonstrate that the student has acquired the knowledge? What are the ethical risks involved? How will the teacher maintain their human judgment?

5.5 For Developers of Educational AI

For developers, the challenge lies not only in designing AI systems that are effective, fast, and easy to use, but also in creating environments capable of supporting human autonomy. Many tools today prioritize fluidity, personalization, and ease of use. In the field of education, this optimization would benefit from also including reflection, verification, explanation, and self-regulation.

This approach can translate into concrete design choices: indicators of uncertainty, prompts to compare multiple sources, checkpoints such as “explain your reasoning,” metacognitive questions, reflective pauses, self-assessments of confidence levels, revision histories, or dashboards for teachers. The goal is not only to make the results visible but also to highlight the learning processes that led to those results.

Such an approach also calls for particular vigilance regarding forms of persuasive design that might encourage excessive reliance on AI. AI-based educational systems would do well to avoid any posture of infallible authority. Instead, they can cultivate a form of epistemic humility: making uncertainties visible, encouraging verification, allowing for doubt, and keeping learners in the role of active decision-makers.

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6. Roadmap for Implementation

The implementation of a human-centered AI culture policy can be viewed as a gradual process, structured in several complementary stages.

Implementing a Human-Centered AI Culture Policy

A five-phase process

1. Audit Existing AI Culture Initiatives

Assess current practices

tool use • ethics • cognition • metacognition • motivation • learner autonomy

2. Revise Curricula

Define human-centered learning outcomes

age-specific • discipline-specific • level-specific

elementary/secondary: curiosity, verification, responsible use |
higher education: reasoning, evidence evaluation, authorship, research integrity

3. Develop Teachers' Professional Competencies

Support pedagogical integration of AI

instructional design • classroom supervision •
student autonomy • learning-process assessment

4. Transform Assessment Practices

Make learning processes visible

understanding • reasoning • verification • self-regulation

5. Guide Partnerships with AI Developers

Prioritize pedagogical and ethical values

explanation • transparency • data protection •
accessibility • human control

A first step is to conduct an assessment of existing initiatives related to AI culture. This audit would help determine whether current initiatives focus primarily on the use of tools and ethical issues, or whether they also incorporate broader dimensions, such as cognition, metacognition, motivation, and learner autonomy.

In a second phase, curricula could be revised to incorporate human-centered learning outcomes. These outcomes would benefit from being tailored to the learners' ages, the relevant disciplines, and the various levels of education. In elementary and secondary education, the focus could be on curiosity, verification, responsible use, and guided interaction with AI. In higher , priorities would shift more toward disciplinary reasoning, evidence evaluation, authorship of work, research integrity, and professional responsibility.

The third phase would focus on teachers' professional development. Training would not be limited to learning about tools but would aim to support the design of instructional scenarios that integrate AI, the supervision of its use in the classroom, the preservation of student autonomy, and the assessment of learning processes.

The fourth phase would focus on the evolution of assessment practices. The challenge would no longer be merely to evaluate what students produce with the help of AI, but also to make visible what they understand, how they reason, the verification processes they employ, and how they regulate their own learning.

Finally, a fifth phase would call for guiding partnerships with developers based on explicit pedagogical values. Schools and universities could thus prioritize tools that promote explanation, transparency, data protection, accessibility, and the maintenance of human control over important decisions.

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7. Future Prospects

A human-centered AI culture can be viewed as a new educational paradigm in the era of generative AI. It complements existing frameworks by shifting the focus from the tool to the learner, from technical competence to intellectual autonomy, and from the adoption of AI to human development.

This framework offers a potential contribution to UNESCO's AI competency frameworks, the work of the OECD and the European Commission on AI culture, the European Action Plan for Digital Education, and national educational strategies. It can also inform the implementation of the European AI Act by helping institutions better understand why the educational uses of AI require transparency, accountability, and human oversight.

Future research could examine how a human-centered AI culture can be defined, measured, taught, and assessed across different age groups, disciplines, and educational contexts. It would be particularly useful to identify pedagogical approaches that enable learners to use AI while preserving their attention, reasoning, motivation, metacognition, and autonomy. Another important area of research concerns the very design of AI tools: how can we develop systems that support reflection, explanation, and the regulation of learning, rather than dependence or excessive cognitive delegation?

The future of AI in education, therefore, is not simply a matter of pitting human learning against artificial intelligence. Rather, the central question is how to design learning environments in which AI enhances human capabilities without replacing them.

From this perspective, fostering a culture of AI that goes beyond technical skills is not merely an extension of digital education. It emerges as an essential condition for supporting democratic, ethical, and autonomous learning in the era of generative AI.

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About the Author:

Dr. Sarah Chardonnens is a specialist in learning sciences and the culture of artificial intelligence. As an associate professor at the University of Fribourg, she studies the cognitive, metacognitive, motivational, and ethical processes involved in human learning in the era of generative AI. Author of the bestseller *" The learning Revolution, AI's influence on intelligence and education", and "AI et apprentissage*", she develops a humanistic and scientific approach to educational AI, centered on intellectual autonomy, responsibility, self-regulation, and human development. Her work aims to help institutions, teachers, and learners integrate AI in a critical, ethical, and pedagogically relevant manner.

www.sarahchardonnens.ch