What should teachers teach and students learn in a future of powerful AI?

As the capabilities of artificial intelligence (AI) and robotics continue to evolve, and the ways in which humans carry out tasks change as a result, education systems must begin to reassess the competencies required for life and work in the new context. These changes could be significant and fast. Therefore, policymakers must look beyond incremental changes and guidance on AI usage to project into the future and rethink core questions, such as:

- Should emphasis across competencies, or specific knowledge, skills and attitudes within these competencies, in current curricula shift due to AI?
- Do any competencies become obsolete? Should new competencies be considered?
- How will other curricular aspects (e.g. ordering of content, learning experiences) change?

An expert workshop (September 2024) with leading science education scholars in the United States explored how to approach these questions and served as a pilot effort to extend this discussion to other disciplines and national contexts. This spotlight summarises what we learned.

AI promises to transform society—will the school curriculum follow?

Much is written about AI and education today, particularly on three main topics. First, there is a focus on how to use AI to improve teaching, learning and assessment. Second, a related focus is on identifying and preventing risks of AI usage, such as AI bias, data protection and students using AI to cheat on tests. Third, there is increasing emphasis on adapting curricula to incorporate AI literacy – this is, educating about how AI works and how to use it. These are obviously important questions. However, they also overlook some significant social implications of AI’s transformative potential and its subsequent effects on education. In particular, the fact that if AI and robots were to significantly reshape how humans carry out work and life tasks, the knowledge, skills, and attitudes promoted through education might need to change.

Technological change has impacted the curriculum before. For example, the integration of calculators in schools intensified debates about the value of extensive arithmetic drills in mathematics. Similarly, the emergence of grammar and spell checkers raised concerns about a possible negative impact on students' writing skills, and search engines and online encyclopaedias led to heated debates about the value of transmitting factual information more broadly. Advancements in AI and robotics across multiple capability domains – to date, notable in language processing and generation – promise to create an impact several degrees of magnitude beyond these examples (OECD, 2023[1]).

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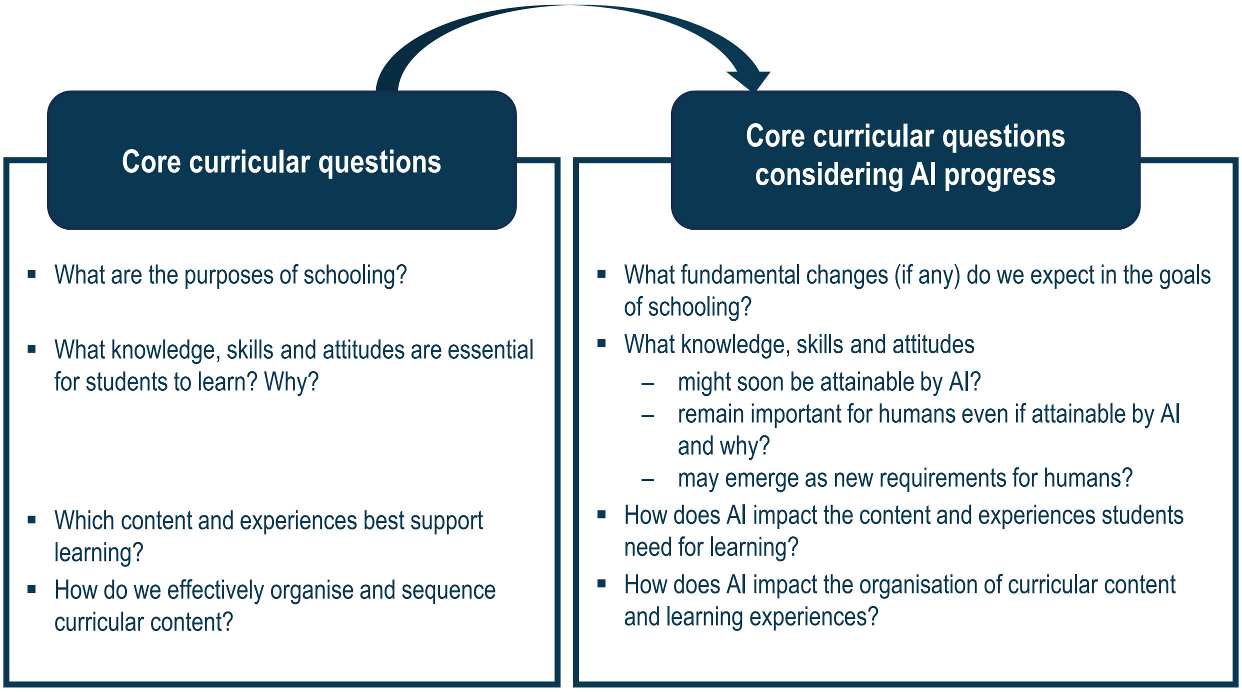
We must revisit core questions in curriculum development

Countries across the globe commonly define overarching purposes for their education system and identify general goals with respect to the learning outcomes schooling ought to achieve for learners. Defining overall aims and learning goals requires taking a normative stance on the purpose of schools. This often includes important aspects such as preparing individuals for work and citizenship and supporting their autonomy and healthy development. It also raises epistemic questions about what knowledge is worth teaching or, framed in terms of rights, which knowledge students are entitled to learn through schooling. Justifications for selecting specific knowledge, skills and attitudes are linked to practical questions about how to organise and sequence curricular content and how to identify appropriate learning experiences that align with the values established for the system. As Figure 1 shows, AI is starting to reframe key questions.

Figure 1. Rethinking the curriculum for a world of powerful AI



Rethinking the curriculum: A thought experiment

A primary difficulty to begin to address the questions AI poses for curricula lies in the current lack of adequate information on what AI can and cannot do. Knowledge about AI capabilities remains scant and sparse, which hampers policymakers' ability to anticipate the direction and scope of its transformative potential. To address this gap, the OECD is developing a methodology to capture, evaluate, and report AI and robotics capabilities relative to humans in a comprehensive way (OECD, 2021[2]; 2023[3]). This effort, which includes the release of a set of indicators to help policymakers anticipate how AI will transform the way humans carry out work and life tasks (a beta version will be released in June 2025), will contribute to a better understanding of AI and inform prospective policy thinking.

In education, the project aims to develop a principled way of using these indicators to envision a plausible near- or medium-term future where AI capabilities exceed those currently available in classrooms. To this end, the project convened a workshop with education experts experienced in curriculum development (see Box 1). The goal was to integrate AI into their deliberations to understand how the indicators could eventually be used most effectively.

Box 1. OECD's approach: Convening an expert workshop

OECD-NASEM workshop on the implications of AI for science education (September 2024)

The OECD and the National Academies of Sciences, Engineering, and Medicine (NASEM) in the United States convened a 1.5-day workshop in September 2024. The workshop built on previous work of NASEM's Board on Science Education, which launched a K-12 (i.e., early childhood and school) science education framework in 2012 – see Box 2 for an overview. It aimed to have experts in NASEM's network reassess their views on the goals and content of the science curriculum over a decade later and considering a scenario characterised by the widespread presence of high-performing AI. Knowledgeable of science education and with previous experience developing curricular frameworks, NASEM's group of experts (see Box 4) was well-suited to pilot a discussion that can be replicated in other countries and for other curriculum subjects.

Because the indicators themselves are still under development, the OECD-NASEM workshop tasked participants to reflect on the curricular implications of AI based on an ad hoc definition of AI capabilities. Participants were asked to derive implications from the following scenario, which is informed by the ongoing work to develop the indicators but goes beyond the current state of the indicator scales:

> *In the relatively near future, AI will be capable of performing all scientific reasoning and problem solving at a level that exceeds both average and expert human performance. This development will happen soon enough that it will affect the potential job prospects of most students who are currently in school. Although AI will show high levels of scientific reasoning and problem solving, AI's other capabilities will be more limited. In particular, sensorimotor capabilities that support physical tasks will still fall short of human-level performance and social capabilities that rely on sensorimotor capabilities will also be substantially limited. In addition, there may still be limits in AI's capabilities with respect to less-structured, non-scientific reasoning and problem solving. As a result of continuing limits on AI capabilities, automation of many jobs will still not be possible and a fully employed labour force will still be economically viable. However, humans will no longer be economically competitive in performing the aspects of job tasks that focus on scientific reasoning and problem solving.*

Revisiting the science curriculum for a future of powerful AI

What should the goals of science education be in an AI future?

Participants engaged in a discussion about the goals of science education, which also benefited from a set of short thought papers that some experts had been asked to provide ahead of the meeting. The group rapidly reached agreement on the overall purpose of science education: to educate students to become "competent outsiders", i.e. individuals who, while not specialists in every scientific discipline, possess the ability to understand, engage with, and critically evaluate scientific information. Participants further elaborated on their vision, agreeing on the following statement:

> *Science education must provide high-quality, equitable educational opportunities that support* ***scientific literacy as a fundamental right****, preparing students to become flexible, adaptive, creative and socially aware problem solvers, curious about the world around them and able to live and work in an ever-changing world.*

The group then broke down this general statement into a set of more concrete objectives, which are reflected in Figure 2.

Figure 2. The goals of science education in a future of powerful AI

Summary of the expert discussion

Develop **scientific understanding** to facilitate practical epistemology, promote lifelong learning and reinforce trust in science	Teach how science works, where its knowledge comes from and how to evaluate it, helping students to distinguish how scientific questions differ from social, economic, and theological questions.
Promote **democratic civic engagement** by helping individuals engage with science in ways that drive social progress and planetary well-being	Help students find and grapple with questions about the types of knowledge that inform public decisions, how they do so and why. Make the social relevance of scientific knowledge visible as well as its limits, such as in dealing with value-based issues.
Support individuals to find **meaning and joy** in life through science, contributing to their intellectual and emotional growth	Provide opportunities for intellectual and aesthetic fulfilment through engagement with science and engineering tasks. Cultivate curiosity and a strong sense of identity as learners, celebrating the fulfilment that comes with learning new things.
Develop **critical understanding of AI** and other technologies and support individuals to use them productively	Teach students to understand AI as a set of tools with specific capabilities and limitations, helping them understand how technology works, when and to what degree it should be trusted and develop the competency to use it safely and ethically.

The reader may see the goals identified by the group closely align with those that many education systems already set for themselves today. Does this mean that AI will not impact the goals of science education? Are education curricula in place already suitable for a future of high-performing AI? In discussing goals, experts highlighted a longstanding emphasis on preparing learners for jobs related to STEM subjects (i.e. science, technology, engineering and mathematics). Such a focus has historically led to educational practices catering only to a select few destined for scientific careers, such as explicit tracking based on perceived ability and more subtle forms of sorting, like prioritising rote learning and favouring breadth over depth in curriculum coverage.

These practices are often justified by the need for a well-prepared STEM workforce to support economic growth and employment. However, they overshadow broader educational goals that participant experts consider important, such as fostering curiosity and basic epistemic understanding for all students – goals they have advocated for in the past irrespective of AI developments. Effectively pursuing these goals is essential for democratising scientific literacy, seen by experts as a fundamental right, while contributing to intellectual and emotional maturation. From this view, traditional approaches to science education may have underserved all students, not only those remaining outside STEM trajectories.

AI may not lead to entirely new curricular goals but shift emphasis amongst current priorities

Rather than establishing brand new goals for education, AI could serve as a catalyst to move decisively away from the narrow focus on labour market needs. Instead, education systems could leverage AI to foster a science education that emphasises intellectual and aesthetic fulfilment and democratic civic engagement, encouraging all students to find meaning and joy through science. Experts acknowledged that while the transformational potential of AI in STEM jobs remains uncertain, the more significant the impact of AI, the greater the opportunity to shift emphasis amongst existing priorities.

What should be included in the formal science curriculum?

Having identified an AI-driven social transformation as an opportunity to rebalance curriculum goals, the discussion shifted to exploring the related content and learning experiences that ought to be included in the formal curriculum. This discussion included a revision of the practices, concepts and ideas that structured NASEM's 2012 Framework for K-12 Science Education (see Box 2 below) as well as specific considerations for what educating younger (4–11-year-olds) and older (12-20) students should entail. The next paragraphs summarise the main ideas contributed by the group.

Box 2. The 2012 Framework for K-12 Science Education in a nutshell

NASEM's 2012 Framework built on a large body of research on teaching and learning in science. From this work, the authors concluded that K-12 science and engineering education should focus on:

- a limited number of disciplinary core ideas and cross-cutting concepts,
- be designed so that students continually build on and revise their knowledge and abilities over multiple years, and
- support the integration of such knowledge and abilities with the practices needed to engage in scientific and engineering practice – see Table 1 for further detail.

Table 1. A focus on science and engineering practices, cross-cutting concepts and core ideas

Practices *Defining practices of science and engineering*	**Cross-cutting concepts** *Concepts commonly applied across science and engineering fields*	**Disciplinary core ideas** *"Big" ideas in science and engineering*
• Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analysing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information	• Patterns • Cause and effect: Mechanism and explanation • Scale, proportion and quantity • Systems and system models • Energy and matter: Flows, cycles, and conservation • Structure and function • Stability and change	*Physical sciences:* • Matter and its interactions • Motion and stability: Forces and interactions • Energy • Waves and their applications in technologies for information transfer *Life sciences:* • From molecules to organisms: Structures and processes • Ecosystems: Interactions, energy, and dynamics • Heredity: Inheritance and variation of traits • Biological evolution: Unity and diversity *Earth and space sciences:* • Earth's place in the universe • Earth's systems • Earth and human activity *Engineering, technology and application of science:* • Engineering design • Links among engineering, technology, science, and society

Source: National Research Council (2012), *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, https://doi.org/10.17226/13165.

Build on grounded practices that are meaningful to learners

Experts voiced the need to re-evaluate the type of engagement students have with science and engineering practices in schools – a defining element of the 2012 Framework. They pointed out that preparing students as "competent outsiders" does not necessarily require them to replicate the exact practices of professional scientists and engineers, a common view of what science school education should do. Moreover, they were concerned that science practices in schools often devolve into rote tasks, pursued for their own sake, with no or little attention to students' perspectives.

> Science learning should build on asking the questions "how does this work?" and "how do you know?"

Instead, the group thinks that education should focus on inquiry practices that are accessible and meaningful, incorporating scientific knowledge and reasoning into addressing relevant questions for students and their communities – Box 3 illustrates the contrast between common and envisaged practices.

Box 3. Placing relevant questions at the core of the science curriculum

Filling school science practices with meaning from the perspective of students

Engagement with scientific practices in schools often involves a focus on disciplinary coherence. For example, a unit on sound waves might begin with the concept that sound occurs as a wave traveling through a medium, having students explore it through a series of structured activities, such as observing how sugar on plastic wrap vibrates when a nearby drum is struck, or noting that sound ceases when air is removed from a bell jar containing a ringing timer. These experiments aim to illustrate important scientific principles like wave propagation, frequency, and amplitude, and they are all appropriate from this perspective. However, their relevance might not be apparent to students, who may complete these activities without understanding why they were asked to engage them in the first place.

Alternatively, a lesson on the same topic could begin by addressing real-world issues such as noise pollution in students' neighbourhoods. This approach encourages students to formulate their own questions, such as "How does sound travel from the highway to our homes?" or "What materials can we use to reduce noise?" Oriented towards achieving greater instructional coherence from the students' perspective, this method leads to experiences where students see their inquiries not just as school tasks but as meaningful activities with clear rationale. Incorporating this perspective bolsters engagement by connecting lessons to authentic contexts, enabling students to see themselves as capable thinkers who use science to address relevant issues for themselves and their communities.

Source: Reiser et al. (2021), "Storyline units: An instructional model to support coherence from the students' perspective", https://doi.org/10.1080/1046560X.2021.1884784.

Science learning could build on having students and teachers engage deeply with simple but challenging questions like "how does *this* work?" and "how do you know?" Such in-depth work would facilitate:

- linking science learning to real-world phenomena to make the *relevance of scientific knowledge* visible to learners. This could involve exploring everyday elements with younger learners (e.g. why are bicycles designed a certain way?), progressing to a focus on understanding as well as tackling significant societal challenges, like climate change, with older students.

- a greater emphasis on *ethics* and *civic responsibility* in science education as students grow older and mature and begin to engage with social controversies to understand how scientific and non-scientific knowledge intersect, how expertise is dynamically reshaped during deliberations, and which practices (e.g. rhetorical, involving AI) foster productive conversations.
- the *exploration of technical and social issues* linked to technological development, such as AI and robots, their capabilities, development processes and societal impacts, which offers a context to incorporate such technologies into the learning process in developmentally appropriate ways to support students' inquiry and reflection while helping them *understand how technology works and how to use it*, safely and ethically.

Not all students need to learn everything nor the same things all the time

Experts recognised that education plays a key social role to introducing citizens to:

- *issues of social relevance*: experts stressed the importance of familiarising students with matters of public importance, such as climate change and sustainability;
- *major scientific paradigms*: referring to scientific theories serving as a foundational framework for science-related work, like evolution;
- *issues beyond immediate familiarity:* such as relevant aspects of the human and natural world that are not immediately apparent (e.g. structures at the molecular level).

Such a responsibility notwithstanding, the group converged on the idea that learners do not need to master every scientific discipline in detail. As one participant succinctly put it, "which science students learn may matter less than how they learn it." This perspective emphasises the importance of understanding cross-cutting concepts across science and engineering fields, which provide a robust foundation for processing scientific information and continuing to learn throughout life, while abandoning the notion that all students should cover all disciplinary ideas exhaustively for every discipline. Instead, the focus would be on engaging ideas flexibly across disciplines to introduce students to the underlying concepts they all share.

> *"Think in terms of systems rather than disciplines"*

From this perspective, a principle for curriculum revision could be to focus on various systems, including human-designed systems, ecological and biological systems, earth and space systems and their interconnections. This approach allows for greater flexibility in learning: because the key ideas and methods from different disciplines are relevant to all these systems, they are accessible through the study of systems and engaged to the extent that teachers and students find appropriate. This setup facilitates both disciplinary-specific and interdisciplinary reflection, a balance that the experts considered important.

A focus on systems necessitates making sense of their complex behaviours, which is why experts:

- Stressed the need of reinforcing students' *probabilistic and covariational reasoning*. These relate to being able to analyse the likelihood of various outcomes based on known variables, useful for predicting phenomena within systems, and recognising how changes in one variable influence changes in another, key to modelling system dynamics.
- Recognised that understanding how science and engineering approximate reality through *fallible but improvable models* is a basic epistemic lesson all students should learn.
- Highlighted that an understanding of complex systems is not complete without considering the influence humans have on them, including through individual behaviours and social structures. Experts acknowledged the need to integrate concepts and methods from the behavioural and

social sciences to add depth to students' understanding of systems. Issues to be considered could include the study of social structures of power as well as known biases in how humans process information and make decisions.

Support joyful learning with flexible education pathways

Experts emphasised the importance of introducing science topics and inquiry in the early years to tap into children's inherent curiosity. They pointed out that childhood and adolescence are critical phases for identity development, noting that suggestive science education activities based on questions that are relevant to students can showcase the joy of learning new things and make the desire to learn a central component of students' identity.

Additionally, participants flagged several ways to evolve educational processes and structures to transform the science curriculum in the directions outlined above. The group:

- Identified traditional *subject boundaries and student groupings* by grade as barriers, suggesting more flexible learning pathways that align with the interests of students and their communities.
- Highlighted the need to rethink the *connections between formal and informal learning*, aiming for a greater integration of diverse learning sources and community resources.
- Considered *personalised learning* through choice, identifying individual student decisions within a structured but diverse teaching offer and collective decisions through classroom deliberation as two ways to empower students in shaping their learning trajectories.
- Expressed concerns over system-wide prescriptive standards and standardised *assessments* as obstacles to flexibility and local discretion. Conversely, they valued assessments as tools for mapping knowledge and resources, informing educational choices and resource allocation.

Experts pointed at research in arts education and non-formal and informal learning as a useful source to derive lessons for adapting educational processes and structures to promote student motivation and joy. Simultaneously, they cautioned that framing science as a liberal art might risk it being perceived as a lower priority, competing with subjects traditionally viewed as less conducive to important socioeconomic outcomes such as growth and employment.

How to think about a powerful AI future? Lessons from the workshop itself

The workshop was designed as a pilot to learn how to structure conversations about AI-induced curriculum redesign in productive ways. The following sections summarise valuable lessons from this perspective.

A focus on knowledge mobilisation from square one

Because the project aims to develop a shared understanding of how a set of AI capabilities indicators can be used to analyse AI's implications for education, the workshop purposely sought to involve a diverse set of actors reflecting different types of expertise. Workshop participants included seven science education experts from across the United States, two of whom had contributed to the development of NASEM's 2012 Framework. They were joined by four invited observers and the organising teams from NASEM and OECD.

Box 4. List of workshop participants

Invited experts included **Noah W. Feinstein** (Professor of Curriculum & Instruction and Community & Environmental Sociology, University of Wisconsin Madison), **Victor R. Lee** (Associate Professor and faculty lead for 'AI + Education', Stanford University), **Christine M. Massey** (Senior Researcher focusing on cognitive science and learning, University of California Los Angeles), **William R. Penuel** (Distinguished Professor of Learning Sciences and Human Development, University of Colorado Boulder), **Helen Quinn** (Professor Emerita of Particle Physics and Astrophysics, SLAC National Accelerator Laboratory), **Brian Reiser** (Orrington Lunt Professor of Learning Sciences, Northwestern University) and **Darryl N. Williams** (Senior Vice President of Science, Education and Human Resources, Franklin Institute).

Invited observers included **Tracey Burns** (Chief Research Officer, National Centre on Education and the Economy), **Christina Chhin** (Program Officer, National Center for Education Research, Institute of Education Sciences), **Janet Coffey** (Program Director, Gordon and Betty Moore Foundation) and **Morten Rosenkvist** (Director, Norwegian Directorate for Education and Training).

Alongside the OECD team, organisers included **Heidi Schweingruber** and **Tiffany E. Taylor***,* Director and Senior Program Officer of NASEM's Board on Science Education.

The participation of observers was strategic in terms of knowledge mobilisation. Observers were to:

- represent the *end-user perspective* in the meeting, in particular policymakers and research funders who may use the workshop's conclusions – and the indicators eventually – to inform their actions;
- *bring other types of expertise in*, such as expertise in educational futures thinking; and
- be well-positioned to *disseminate* the workshop's results, and the OECD project more broadly, in circles different than those of experts, including policy circles related to curriculum development in various subjects and countries.

On the context and relevance of the discussion: The policymaker's view

As an end-user of the workshop results, the policymaker in attendance was invited to share his views on the policy relevance and expected outcomes of the exercise at the beginning of the workshop:

- *Immediate solutions vs. Long-term challenges*: There is a need to balance urgent AI-related educational responses with deep, strategic discussions about AI's broader implications. Long-term planning must go beyond the integration of current technology in instruction and assessment and consider AI's impact on the knowledge and skills that student ought to learn through schooling.
- *Need for more knowledge and agility*: The traditional, consensus-driven curriculum development process is inclusive but slow. It struggles to keep up with the rapid pace of technological change. Greater agility is required – relying on knowledge generated with practical needs in mind and focusing on implementing "good solutions now rather than great solutions later".
- *Revisiting "conventional wisdom"*: as AI begins to transform how knowledge and skills are learned and applied, there is a need to reassess common curriculum assumptions. For instance, do we need to teach reading as usual when emerging large language models can summarise and explain text comprehensively in multiple modes? What are the opportunities and risks in transforming current approaches and what is the cost of no action?

Finding common ground: Unpacking the starting assumptions

Ahead of the meeting, the OECD provided participants with the description of the scenario reproduced above. This was supplemented by a set of ten written vignettes illustrating possible ways in which science and engineering tasks could have been transformed by AI under the proposed scenario – see one of the vignettes as presented to the experts in Box 5.

Box 5. Example vignette from the workshop's background material

AI-transformed science-related tasks: Healthcare for teenager with diabetes, anxiety, rare allergy

Jane, who has been under treatment for Type 1 diabetes since her early teens, suffers from anxiety and has a rare allergy to sesame seeds. Her personal AI assistant has been a key support in managing her physical and mental health, **monitoring** her vital signs and blood sugar levels while **accessing** her medical records to ensure that her illness is managed effectively and that treatments are administered correctly.

Jane works with her AI assistant via natural conversations, enabling her to express how she is feeling during high-stress situations that could affect her anxiety (e.g. a trip being planned) and to get immediate and continuous support and **coaching** with coping strategies. It was the system that helped Jane avoid a major hospitalization by **identifying** her rare allergy to sesame seeds early on, based on her reported symptoms and recent diet changes.

Jane's assistant is connected to AIsclepius, the National Healthcare AI System. This connection ensures Jane benefits from the newest insights into medical care, **providing** tailored recommendations and advice based on how current developments might affect her. And because Jane is a proud data donor, her medical data are used by AI research to benefit many other people.

Like most people, Jane seldom requires the services of medical personnel, who typically intervene in the **administration** of some tests, to **treat** wounds and fractures and to **perform** certain surgical procedures. In the last five years, she has only visited Joe, a reservist of the public health brigade, twice. By contrast, she attends meetings of the local anxiety support group more regularly, about twice a month. The meetings provide **comfort** and further help her challenge negative emotions. Her AI assistant can help with that too, and it often does, but Jane likes **talking** to people going through the same issues. Yes, surely this can be rough at times, yet it also feels real, sometimes cathartic. Indeed, where would some of Jane's closest friendships be without such challenging conversations?

And what to say about Joe? Joe is competent and kind. He is a certified nurse, who is trained in clinical practices and the ethics of care and always keeps up with changes in protocol. Joe is always **attentive** to learn more about how to make patients feel comfortable. With two decades of experience in his role, Joe carries out most of his duties without AI assistance – after all, he mostly deals with minor wounds and injuries, aside from leading the arthritis group every other Tuesday. He only needs detailed **guidance** occasionally, for complex tasks requiring quite specific expertise, such as in treating rarer conditions. In such cases, AIsclepius' nursing app is always a reliable source of clear explanations.

In this vignette…

AI and robots:	Humans:
• access, monitor, and analyse data from users and retrieve information from other sources. • use information and knowledge to provide tailored, accurate explanations, predictions and support. • demonstrate applied knowledge of healthcare, including aspects of biology and pharmacology. • understand how systems like the human body and mind operate under variable conditions, key to prevention, diagnosis and treatment functions.	• intervene when physical skills are needed, in tasks involving multiple steps, dynamic environments and some dexterity. • deal with social and emotional aspects where subjective human experience and reciprocity can be important. AI can provide effective support, but some people might prefer support from humans. • do not need an understanding of complex concepts and advanced disciplinary knowledge in the areas of science involved in healthcare. • require some procedural knowledge, particularly for urgent interventions, albeit they have support from AI agents.

Source: OECD team, adapted vignette from Gil and Selman (2019), *A 20-Year Community Roadmap for Artificial Intelligence Research in the US*, https://cra.org/ccc/resources/workshop-reports/.

The scenario and vignettes were designed to establish a common set of assumptions about the level of AI capabilities, allowing experts to focus on curriculum redesign rather than the specifics of what technology can do – a topic participants were neither expected nor required to have expertise in. However, during the workshop, participants voiced concerns with respect to:

- *What AI will be capable of*: Doubts were raised about the assumption that AI could engage in scientific and engineering problem solving as well as humans. For instance, experts questioned that AI can ever develop innovative scientific theories, e.g. coming up with the "new" string theory.
- *Societal structures following leaps in AI capability*: The original scenario was critiqued for portraying an overly simplistic social equilibrium resulting from AI transformation. It overlooks social, economic and political inequalities, where AI regulation (or the lack thereof) and its effects are open to negotiation amid competing interests and ideological views. The scenario also presupposes the continuity of educational structures that could be transformed by AI, like current distinctions between formal and informal learning and primary and secondary education.

Acknowledging the relevance of these comments, the OECD team provided further clarification:

- *Nature and purpose of the scenario*: They noted the speculative nature of the scenario, meant as a starting point for a thought experiment.
- *AI's potential*: While views on the level of capabilities AI might ultimately achieve vary within the computer science community, the field does not rule out the possibility of Artificial General Intelligence (AGI), i.e. a state where machines can perform any intellectual task that a human can.

After this exchange, participants found it useful to acknowledge the scenario as a provocation, and to rearticulate its assumptions in their own terms, resulting in a set of revised assumptions (see Box 6).

Box 6. Participants taking ownership of the scenario: The starting assumptions revisited

1. **Increased presence of AI:** AI will become significantly more integrated into daily life through its decisions and artifacts, with widespread direct interactions for many people.
2. **Debate on proper AI uses:** Legal and ethical uses of AI will continue to be a controversial topic.
3. **Shift in tasks:** Many tasks currently performed by humans in the fields of STEM will transition to being performed largely by AI.
4. **Transformation of labour markets:** STEM labour markets will undergo substantial changes.
5. **Changing public interaction with STEM:** people's interaction with STEM knowledge and applications will evolve, with some aspects mediated through AI. However, science will maintain its role in social and community contexts.

Participants further identified deep societal implications tied to AI's enhancement and proliferation:

a) **Environmental impacts**: AI's spread could exacerbate environmental challenges and further complicate humanity's ability to meet climate change goals.
b) **Social inequalities**: There may be increased pressure to address profound social inequalities resulting from AI proliferation.
c) **Democratic values**: Need for democratic and deliberative processes where STEM and society intersect.
d) **Education structures**: AI presents challenges to the value and role of human educators and the current balance between formal and informal learning. Leveraging the positive potential of AI for education will require investments to ensure adequately resourced systems.

Participant feedback: What worked, what didn't and how to do it better

The workshop concluded with a session asking participants to reflect about its organisation and relevance to other contexts. The group highlighted the following points:

- *Relevance of the meeting*: participants noted the conversation as challenging but useful, with the policymaker remarking, "the discussion took people in different directions because it is new and we do not yet know how to have it; but the workshop is good training for further conversations."
- *Focus and clarity of tasks*: experts were at times uncertain about expectations, for example with respect to whether the use of AI to enhance instruction was within the scope of the discussion. Organisers appeared to expect a quick understanding of tasks by participants, which was not always the case. Additionally, while vignettes were seen as beneficial, a smaller set of two or three, co-created with experts in the relevant field, was suggested as a possible improvement.
- *Views of the future*: Experts noted that the vignettes assumed an optimistic future trajectory, overlooking how outcomes could vary due to competing ideologies and power structures. They recommended presenting multiple alternative futures for a more balanced perspective.
- *Generalisability*: Similar conversations could be useful in other countries and subjects. Moreover, holding future workshops across a diverse range of contexts will help to identify whether there are common opportunities and challenges across contexts.

One of the participant experts suggested that the organisers consider available research on public engagement with science when planning such workshops (see Box 7).

Box 7. Enhancing clarity and managing diverse perspectives in discussions

Expert suggestions based on research in public engagement

- **Recognise a negotiation period as normal**: Initial stages of engagement typically require lengthy discussions to set objectives, facilitating open dialogue and adjustments in expectations.
- **Acknowledge uncertainties**: when outlining a future scenario, it is important to acknowledge uncertainty and discomfort, particularly with respect to possible negative outcomes. Such an acknowledgement can increase mutual respect and buy-in.
- **Define the decision space clearly**: Transparency about which decisions are open for discussion prevents sessions from being perceived as mere formalities. Setting clear boundaries helps manage expectations and ensures productive engagement.
- **Value diverse knowledge bases**: Because expert/public roles shift during a conversation, a diversity of experiences and expertise makes conversations richer. Acknowledging all contributions fosters a more inclusive dialogue and reveals unique insights.
- **Encourage oscillation between dangers and opportunities**: Alternating discussions between negative and positive outcomes prevents the dominance of a single perspective and encourages a more rounded conversation.
- **Frame challenging scenarios as thought experiments**: Presenting complex issues as hypotheticals facilitates easier engagement, allowing participants to explore controversial topics in a non-confrontational way.
- **Affirm the importance of human agency in shaping futures**: Stressing that human decisions significantly influence technological evolution empowers participants and encourages a proactive approach to technological integration.

The bottom line: AI will transform how we live and work; we must think about its implications for school curricula

Artificial intelligence (AI) is developing fast and its integration into society could be transformational. If AI changes how we live and work, will what we teach in schools remain relevant? In September 2024, an expert workshop conducted a thought experiment to explore the implications of high-performing AI systems – systems imagined to significantly surpass the reasoning capabilities of current technology – for science and engineering education in the United States. The workshop generated initial thinking on how advancements in AI might reshape the goals, content, and organisation of school curricula in the near to long-term future, and how education systems may systematically address such changes. Additionally, the workshop served to pilot a conversation model to facilitate similar reflections in other countries and curricular subjects.

AI and the Future of Skills

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The AI and Future of Skills (AIFS) project is developing a methodology to evaluate AI capabilities and compare them to human skills. It aims to provide policymakers with a clear picture of what AI can and cannot do and how its capabilities will impact the demand for human skills.

For more information

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See: AI and the Future of Skills

References

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