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Generative AI in the classroom: From hype to reality?

Launch meeting of the Schools+ Network
22-23 May 2023, Boulogne

This background paper serves as input to the discussions to be held during the OECD Schools+ Network meeting in May 2023. It aims to provide an overview of the major issues which Generative AI has raised for classrooms and schools.
Participants are invited to:

- COMMENT on the potential implications in and outside the classroom.
- SHARE emerging evidence and examples on responses to the opportunities and challenges raised.
- IDENTIFY key questions for schools' consideration in going forward.

Anna Pons, Anna.Pons@oecd.org

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1. Introduction[1]

Artificial intelligence (AI) is now at the fingertips of every teacher and student. They can see first-hand the power of AI to generate sophisticated content in text, images, code, speech, music and video. The potential ramifications for education are considerable and wide-ranging. This background paper outlines what GenAI is capable of doing and how it has evolved, provides a very initial assessment of the potential implications in and outside classrooms, and presents some pointers for teachers, school leaders and policy-makers from around the world to consider in unlocking the potential of GenAI while safeguarding against its potential pitfalls.

1.1. All smoke and no fire?

Despite the hype with artificial intelligence, robotics, virtual reality, and blockchain, among others, the reality is that the education sector has been slower to jump onto the technological bandwagon compared to other sectors. While less powerful 'large language models' have already been used in education for some years, some argue that shockwave created by making a sophisticated form universally available for free through a simple interface could finally turn the hype into reality.

Generative AI (GenAI) has the potential to provide personalised and engaging learning experiences, shifting teachers' workload to more meaningful tasks and changing how and what is taught in schools. It could also democratise access to quality learning opportunities, most notably for students for whom the "one-size-fits-all" approach of schooling might not work.

In combination with other technological developments, GenAI can turn classrooms into spaces where learning is more dynamic, flexible, collaborative and individualised. In particular, it could help accelerate what many see as a much-needed transformation of traditional education systems – one survey in the United States, the majority of teachers (72%) and students (63%) found that "ChatGPT is just another example of why we can't keep doing things the old way for schools in the modern world (Walton Family Foundation, 2023[1])[2]".

As we have seen in the exponential growth in the versions of GPT since December 2022, GenAI capabilities compared to humans will only continue to improve. It is therefore critical to understand how to tap its potential and address its multiple challenges, including the potential for bias, cheating and plagiarism, privacy and data security issues. While some of these drawbacks will already be resolved through new technological progress, others will require humans to be smarter and overrule artificial intelligence.

1.2. How intelligent is GenAI?

Unlike traditional predictive models, GenAI models enable machine learning to not only identify and classify content, but also to create it. Consequently, GenAI can produce realistic images, short movies, or compose well-structured essays, offering unprecedented creative capabilities. Notably, the introduction of OpenAI's GPT series, including ChatGPT, signaled a significant leap in AI language model capabilities. Pre-trained on a

[1] The Schools+ Secretariat wishes to acknowledge with thanks the contribution made to this document by Professor Rose Luckin, University College of London.

[2] Survey carried out on 1000 teachers and 1000 students from primary and secondary education by the Walton Family Foundation.

wealth of text data, these models generate coherent, contextually accurate, and imaginative language.

AI capabilities are improving at a faster pace than ever before (see Box 1). With no specific training, the latest version of OpenAI's GPT-4 shows human-level performance on various professional and academic benchmarks, including passing a simulated bar exam with a score around the top 10% of test takers as well as getting about 90% of responses correct in multiple choice and free response questions on bachelor and university entrance exams like the Scholastic Assessment Test (SAT) and the Graduate Record Examinations (GRE) (See Table 1).

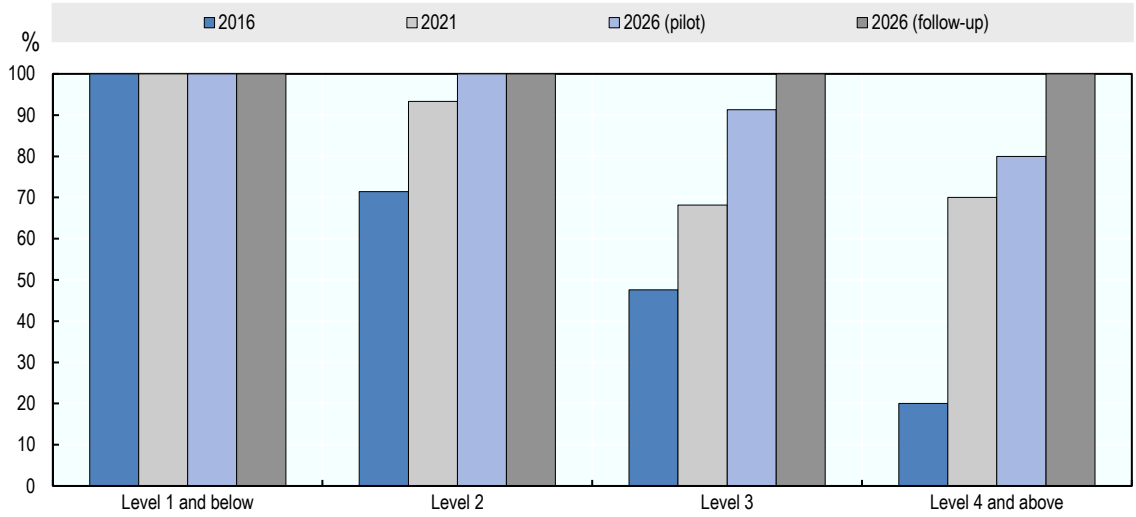
Table 1. Performance of OpenAI's GenAI system

Exam	GPT-4	GPT-4 (no vision)	GPT-3.5
Uniform Bar Exam (MBE+MEE+MPT)	298/400 (~90th)	298/400 (~90th)	213/400 (~10th)
LSAT	163 (~88th)	161 (~83rd)	149 (~40th)
SAT Evidence-Based Reading & Writing	710/800 (~93rd)	710/800 (~93rd)	670/800 (~87th)
SAT Math	700/800 (~89th)	690/800 (~89th)	590/800 (~70th)
Graduate Record Examination (GRE) Quantitative	163/ 170 (~80th)	157/ 170 (~62nd)	147/ 170 (~25th)
Graduate Record Examination (GRE) Verbal	169/ 170 (~99th)	165/ 170 (~96th)	154/ 170 (~63rd)
Graduate Record Examination (GRE) Writing	4/ 6 (~54th)	4/ 6 (~54th)	4/ 6 (~54th)

Source: OpenAI (2023[2])

Similarly, the results shown in Figure 5.8 of the OECD's *Is Education Losing the Race with Technology: AI's Progress in Maths and Reading* (OECD, 2023[3]) illustrate the past, present and future according to expert predictions. Between 2016 and 2021, the estimated capability of AI to respond to literacy test of the OECD's Survey of Adult Skills has increased about 25 percentage points. The performance is similar to that of 90% of adults currently. This figure is expected to jump to 100% by 2026. This means that by 2026 large shares of the workforce will be working with reading and writing proficiency comparable or lower than that of computers (OECD, 2023[3]). Similar to the findings in other assessments (Table 1), the numeracy performance is estimated to be lower, being similar to that of 57% of adults on easy questions and to that of 88% of adults on harder ones. Education systems will therefore need to strengthen these foundation skills but also prepare learners for a future in which they will be working alongside AI.

Figure 1. Predicted AI literacy performance in the OECD Survey of Adult Skills



Note: This figure shows the percentage share of literacy questions that AI can answer correctly by level of difficulty, according to a simple majority of experts; measures use Yes/No-ratings, Maybe.
Source: OECD (2023[3])

The latest developments of new generative AI tools are part of a profound transformation of society which has already begun and will have wide-reaching percussions for the future of work and education. As robots and machines have allowed for the automatisation of different sorts of physical labour performed by humans, AI is now capable of replacing humans in intellectual and creative tasks. This can have a large impact not only on the jobs that might soon be automated as well as the new skills needs to prepare students for an unknown future, but also on the role of teachers and the act of teaching and learning.

Box 1. The exponential rise of generative AI

The first steps in the development of Artificial Intelligence date back to the 1950s, when researchers tried to construct machines that mimicked human intelligence. Language models of that era were restricted in comprehending language patterns and adapting to new information. The 1990s and 2000s saw the rise of machine learning, when computers acquired the ability to discern patterns and relationships in data without explicit programming. The advent of deep learning and neural networks in the 2010s brought about the creation of neural language models that could learn and represent complex language patterns more effectively.

Large Language Models (LLMs), such as ChatGPT are types of Generative AI (GenAI) which are technologies that leverage cutting-edge deep neural network technology, vast data sets, and immense computing power to revolutionize information processing. A deep neural network is a type of machine learning technology that is designed to recognize patterns in data, to process and learn from these patterns and make predictions or decisions based on that learning. The use of the word 'deep' refers to the number of layers in the network. The more layers a network has, the more powerful it is and the more accurately it can identify patterns in data. Neural network technology is inspired

by the way that human brains learn from experience and make decisions based on what they have learned.

The introduction of OpenAI's GPT was a significant leap in AI language models capabilities. The GPT model is pre-trained on text data, and by breaking down texts into small units and then analysing the relationships between these units, is capable of generating new texts that are similar to human writing. Apart from ChatGPT, which is a chat interface of GPT-3 and its successors, there are other equivalent LLMs such as Anthropic/Claude, DeepMind/Sparrow, Google/LaMDA/Bard. Also, a bunch of specific applications and integrations have been developed (e.g., Lex for writing, DuoLingo for foreign languages) and this is rapidly evolving.

The pace of the progress of AI's development is exponential, moving at a much faster pace than previous technological advances and doubling every 6 months (Sevilla et al., 2022[4]), leading to fears that AI will soon exceed the abilities of our human intelligence and our understanding, and is uncontrollable (Future of Life Institute, 22 March 2023[5]).

2. The impact on how teachers teach and students learn in the classroom

Over many decades, a rich body of evidence has developed showing the significant and unparalleled influence that teachers have on students in schools. It is thus imperative to understand how GenAI can support teachers in and outside the classroom. Indeed, the teaching profession is expected to be one of the professions that will be the most impacted by GenAI. One recent study found that in the 20 occupations most exposed to AI language modelling, there are 14 teaching subcategories including English language and literature, foreign language and literature, and history teachers ((Felten, Raj and Seamans, 2023[6])). How can the teaching profession reinvent itself?

This section looks at current practices and provides a very initial framework to explore what GenAI specifically might change in and outside the classroom. The broader transformative potential of general AI and other technologies has been explored in other OECD reports. In particular, the OECD Digital Education Outlook (2021) provide a state-of-the-art perspective of technology in education and point to the potential of not just technology but teachology. The following example can illustrate the power of embracing technology in teaching and learning: "While we study mathematics on a computer, the computer can now study how we study and then make our learning experience so much more granular, adaptive and interactive. Together with sensors and learning management systems, AI can give teachers a real sense of how different students learn differently, where students get interested and where they get bored, where they advance and where they get stuck".

Teachology can help adapt learning to different student needs and give learners greater ownership over what they learn, how they learn, where they learn and when they learn. This opens a whole new world of possibilities for education. The OECD report Back to the Future (OECD, 2020[7]) explored four scenarios for schooling from marginal changes to the status-quo to radically reimagining what education might look like in the future.

2.1. Enhancing and transforming classroom practices

Teaching is complex and multi-faceted, demanding that teachers draw upon multiple practices simultaneously while remaining attentive to the evolving demands of the specific classroom context. It is therefore unsurprising that the implications of GenAI are also

difficult to ascertain. In spite of this, it seems clear that the potential impact is likely to be in the direction of accelerating the shift of teachers' role from transmission to facilitation of student learning.

Supported but not supplanted by AI, teachers can draw on GenAI to enhance and transform teaching and learning in the classroom. Teachers use different pedagogical practices to ensure that students develop desired education outcomes. These pedagogical practices and approaches can be broken down into five broad dimensions:

- engaging with rich subject content.
- supporting students' social-emotional development,
- fostering cognitive engagement,
- encouraging interactions and dialogue,
- providing feedback and support,

Table 2 proposes an initial attempt to map the potential impact of GenAI on what teachers currently do in the classroom to help students learn and grow. It builds upon the Substitution, Augmentation, Modification Redefinition (SAMR) model (Puentedura, 2010[8])which delineates the potential impact of technology on tasks into four types: mere substitution with no functional changes (e.g., calculators, online readers); augmenting the tools with functional improvements (e.g., digital editors, search engines); allowing for significant task redesign (e.g., gaming, collaboration spaces); and, finally the creation of new, previously inconceivable tasks. Each of the above five broad pedagogical dimensions are examined in greater detail below.

Table 2. An initial assessment of how teachers' might use GenAI in the classroom

Teaching goals	Potential impact of GenAI				
	Limited	Enhance		Transform	
		Substitution	Augmenting	Redesign	New approaches
Providing feedback and support			Setting more granular learning goals More regular and deeper formative feedback	Eliciting student thinking and depth of understanding Aligning instruction to understanding	Personalised learning
Encouraging interactions and dialogue		Easy, closed and superficial questions and explanations	Deeper and more detailed questions, discussion, and explanations	Facilitating collaborative learning	Classroom structures and dynamics
Fostering cognitive engagement	Metacognition Experiential learning		Engaging in sense-making strategies	Analysing multiple representations and perspectives Opportunities to practice and build fluency	
Engaging in rich subject content	Engaging with epistemic knowledge			Making connections, patterns and generalisations	

	Understanding procedures and methods Ensuring clarity and accuracy				
Socio-emotional development	Developing social-emotional skills Relationship building Providing a supportive climate		Encouraging risk-taking, open-mindness and curiosity		

2.2. Providing feedback and support

Teachers continuously - minute-by-minute and day-by-day - assess what students know and are able to do in relation to the learning goal. This helps teachers provide instruction that is sensitive to the specific needs and ideas in the classroom and thus guides students to new understandings.

More regular and granular feedback

This is often very challenging not only because the class sizes and heterogeneity within them, but also because it is often hard to discern from merely observing students' behaviour whether they are cognitively engaged or if they have fully understood a previous misconception. Teachers need to use a variety of strategies to elicit student thinking, provide appropriate feedback and align instruction with students' levels of understanding. Strikingly, each of these could be enhanced by GenAI and even transformed into personalised learning opportunities in conjunction with other broader technological developments.

On the one hand, teachers could gain a valuable tool to support them to gain insight into the levels of student understanding. One current application of GenAI is the development of quizzes that can assess students' understanding of the learning material in a much faster way than has been possible until now. This can help to highlight the depth of a student's mastery of content, providing teachers with more granular information with which to provide feedback and prepare interventions or support.

Teachers may also be able to better streamline the demanding and intensive process of providing feedback to provide more regular and granular feedback to students. A teacher can ask GenAI to generate step-by-step feedback on students' homework, in a variety of styles and tones. It can provide ideas to correct submitted texts, identify gaps in student understanding and suggests further development and personalised follow up through the following prompts: "How can this Introduction be improved?", "What is missing from this assignment?", "Provide feedback on the language, structure and flow of arguments in this paper".

Additionally, teachers can make use of GenAI as a tool for both providing extension and support. Teachers may be able to cater to those students that need extra help whilst allowing other students to engage in more self-directed learning. For example, teachers can work with students who have not understood the fundamental causes of acid rain in the context

of climate change, while asking those students who are more comfortable to use GenAI to find alternative examples and to more deeply explore the underlying chemical reactions.

The promise of personalised learning

This could eventually lead to the greatest promise of technology: more personalised learning experiences. With powerful learning analytics behind, feedback and assessment could become far more continuous and accurate processes. Learning analytics leverages real-time data that can assess how much students have learnt but also provide insight on how they learn drawing on how students perform on pop quizzes, formal assessments and individual problems; the pace at which they learn and master new concepts; and how they conduct their self-regulated learning to track each student's progress (OECD, 2021). It can provide more questions or skip them depending on students' mastery level or reintroduce old contents at optimum intervals to refresh their memory.

Beyond supporting learning in specific topics, learning analytics could go so far as to guide student's learning trajectories, determining that students are ready to move on to learn new topics in the subject. While teachers' professional judgement on the progression and sequencing of practice opportunities will remain essential, this could be a radical departure from one-size-fits-all teaching and learning where everyone is expected to progress at the same pace, leaving some students bored and others left behind. It has the potential of changing not only classroom dynamics but also the way in which students are grouped by ages and levels and even reshape what schools look like.

Fostering cognitive engagement

Cognitive engagement is critical to developing the knowledge and skills to thrive in school and life. Cognitive engagement is a psychological state in which learners put forth a sufficient and sustained effort to persist in understanding a difficult idea, make sense of a complex phenomenon, or solve challenging, novel problems. Teachers can foster these higher-order, flexible thinking skills by engaging students in thoughtful analysis, creation or evaluation work.

More and more meaningful learning opportunities

Ensuring high levels of cognitive engagement is challenging. In a video study of teaching, a common finding across participating countries was that students could be given more cognitively engaging work (OECD, 2020[9]). GenAI could be a tool that supports teachers in:

- Generating multiple representations: When a teacher uses multiple representations (i.e., text, graphical, models, plays), students have more opportunities to make connections and develop deeper, more useable knowledge. Using multiple representations also helps students to see things from different perspectives. For instance, GenAI could help expose students to alternative ways in which an explanation could be formulated and allow students to focus more on comparing and contrasting them in an evaluative way. With the potential to develop the same contents in different mediums or chosen contexts, teachers can save a considerable amount of lesson preparation time.
- Adapting to more meaningful contexts: Engagement often depends on whether students find the learning being taught meaningful and relevant to them, creating a sense of wonder and curiosity to know more. Teachers may be able to develop a more flexible bank of instructional resources, generating them "on the fly" to respond to interests of different groups of students. For example, teachers may generate several examples of geographical phenomena or of poems, and then give

students the choice of which they focus on whilst maintaining the same rigour of analytical questions across the examples.

- Providing endless opportunities to practice and develop fluency: Through repetitive practice, where students repeatedly engage in the same computations and processes, they develop fluency and the ability to perform tasks quickly and effectively. This is a building block for engaging in more and more demanding work. Teachers can offer limitless practice opportunities efficiently generating exercises that can help to build fluency more tailored to students' needs; developing practice exercises that are more granular to better capture the different challenges students may be encountering on a topic.

The impact might be more limited on other important cognitive engagement strategies. For example, involving students with first-hand, hands-on experiences that involve exploration, discussion, and manipulation are ways to foster cognitive engagement. While GenAI could facilitate student collaboration on project-based learning (see 2.3 below), other technologies like augmented or virtual reality are likely to offer more immersive experiences and opportunities for experiential learning.

Metacognition becomes ever more important

The underlying skill related to cognitive engagement that might become ever more important is students' metacognition. Metacognition is essentially about reflecting on how to learn, reflecting on their own thinking processes, which is a crucial skill for students to develop as they become self-directed learners. With the powerful tools of GenAI at their disposal, it will be important that students develop a heightened sense of metacognition to appreciate their potential reliance and their level of understanding to effectively utilize them while maintaining their autonomy, critical thinking, and reasoning abilities.

2.3. Encouraging interactions and dialogue

Classroom interaction between and among teachers and students lies at the heart of pedagogy. Education is fundamentally a relational activity and interactions between students as well as with the teacher play a key role in supporting students learning, self-efficacy and interest (Alexander, 2018[10]). The social relationships (both with the teacher and other students) also expose students to the social educational purpose of learning to live together as individual citizens and member of communities.

Facilitating collaborative learning

Collaborative learning requires careful planning and facilitation by the teacher (Webb, N. et al, 2021[11])and GenAI could serve as a valuable aide for groups of students working on a shared learning goal. It could serve as a resource for student-led enquiry or as tool for self-monitoring towards their shared goal. The process of collectively developing a hypothesis, refining prompts and questions towards this, and then evaluating outputs as a group could be a rich collaborative activity with high levels of student agency. In particular, teachers may be able to use GenAI in collaborative learning to offer feedback that pushes students to provide more detailed and complete work, or that ensures that there is equitable participation among groups through the division and collation of tasks.

Amplifying the depth and meaning of whole-class conversations

Teachers may be able to focus classroom talk on deeper forms of questioning and explanation, that have been associated with greater students' gains, whilst engaging students with GenAI for lower-value interactions (e.g., closed questions, recalling facts, providing short explanations). Whole-class dialogue could be focused on more demanding

skills such as exchanging and juxtaposing viewpoints, probing and elaborating responses, and evidence-informed argumentations and deliberations. For example, engaging students in further levels of understanding requires using of more complex, open questions that challenge students to articulate the deep features of the topic. In this way, GenAI could free up time to focus on the type of interactions that can be more valuable for learning.

Changing classroom dynamics

The potential for classroom interaction seems largely untapped in many classrooms. In today's classrooms, frontal teaching prevails and every student moves at the same pace (OECD, 2020[9]). There are times when such a classroom structure can be very effective and beneficial, but there may also be times when greater interaction could be impactful for students' learning and the development of certain skills.

It is unclear what the impact of an increase in technology in the classroom could mean for the nature of interactions and dialogue. It is not unthinkable though to imagine a teacher using GenAI to provide further support to students who are struggling to understand a concept, while engaging the rest of the class in extensions or further examples for ten minutes.

Yet, classroom interactions and dialogue, these back-and-forth exchanges, underpin students' cognitive engagement whilst also furnishing teachers with information on students' progress. Students' digressions, errors, or misconceptions are invaluable inputs for teachers. When teachers actively listen and comprehend the meaning behind learners' explanations of their thinking, they can gain insight into students' ideas. This enables them to respond effectively, rephrase questions, and establish meaningful connections between students' perspectives, interests, and the content being taught. If students are not given opportunities to express their thoughts and there is a reliance on student-GenAI interactions, teachers will remain unaware of how their ideas align or diverge from the curriculum, and they might miss out on valuable perspectives or ideas that could benefit the entire class.

2.4. Engaging students with rich subject content

Closely linked to students' cognitive engagement is the nature of the content that they are learning. It is not enough for students to be learning something: what they are learning must be of a high quality. Teachers are expected to have deep knowledge of the subjects they teach (Coe et al., 2014[12]). To help their students to learn more, teachers should understand the content they are teaching and how it is learnt. GenAI could help teachers' stay abreast of new developments in their field, supporting their content knowledge, pedagogical content knowledge, subject knowledge, and subject knowledge for teaching. But, it might also have significant implications in how students engage with the content itself.

Building and making sense of connections

The introduction of calculators in schools opened up new possibilities for engaging students in more complex computing and applications. GenAI excels at identifying connections, establishing patterns and making generalisations. This is at the heart of how these systems operate; building and learning through neurons of patterns and connections from vast amounts of data. Thus, teachers could tap into the richness of the connections suggested and engage students in exploring. interrogating their strength and making sense of them. For example, GenAI could provide a wealth of background information about two authors and two of their texts that students have been studying, with students then undertaking an analysis of the deeper similarities and differences between these.

The risk of offloading

Would human or artificial intelligence be better at making explicit, detailed and elaborate connections between subject matter content? Even if GenAI gets better than humans, these processes are critical for developing a deep understanding of a subject matter. The ability of a student to understand and spot relationships between multiple areas of knowledge, including making connections within a subject, generalising from specific examples, lies at the heart of the difference between 'surface' and 'deep learning'.

While information might become more accessible and digestible, building and retaining core bodies of knowledge remains of utmost importance. There is a risk of cognitive offloading due to an overreliance on GenAI. Some have likened the potential impact of GenAI to that of GPS navigation systems: some studies found that relying on GPS has reduced some people's capacity to form mental maps or representations of their surroundings, leading to decreased ability to navigate (Dahmani and Bohbot, 2020[13]). The challenge therefore is to ensure that GenAI is being used to complement learning, but not replacing learning processes or being detrimental to the development of core cognitive functions.

The growing importance of epistemic knowledge

Moreover, GenAI speaks with authority from a position of ignorance. While the immediate access to information is one of its most powerful capacities, it can present incorrect, illogical, inconsistent and unconscious responses. As one commentator notes, "Incorrect responses come in pretty packages (Chen, 9 March 2023[14])"– in other words, it can create perfectly written responses which are completely false. This could potentially mislead students and hinder their learning. It remains unclear how long such a technical limitation may remain, or how the nature of the limitation may evolve.

Because of the risks of such technical limitations, the following aspects of teaching may grow in importance too:

- Helping students develop a deeper understanding of what constitutes 'knowledge' in a subject and the processes through which it is produced and refined. Being able to understand the nature of the subject is key for students to be able to critically engage on what counts as knowledge and how this has been developed and accepted (e.g., theory of knowledge, ways of reasoning, disciplinary thinking and disciplinary discourse). For example, teachers might facilitate critical discussions around who or what is not included in the responses of GenAI to better understand its bias. When information is abundant, the ability to discern how it is produced, legitimated, and what is certain is more important than ever to turn this overabundance into worthy knowledge.
- Providing opportunities for students to engage with procedures and methods to understand them better as well as to be able to use and apply them. For instance, in Mathematics, one way to make sense of the rationales for procedures or processes is by proving and explaining why a procedure or solution is correct or incorrect. Much like calculators, GenAI cannot provide such an explanation; it simply follows procedures and processes without really understanding the underlying mathematics. In this respect there is the opportunity to focus students' attention more on providing or crituiqing explanations of procedures and processes.
- Presenting clear, accurate and coherent knowledge base of ideas and concepts that do not lead students to misconceptions, unintentional errors, and build a strong understanding of a given topic. These can potentially be very detrimental for foundational knowledge as when students' understandings are being formed,

incorrect, insufficient beliefs or misconceptions can have a lasting impact on students' memories (McGaugh, 2000[15]).

2.5. Supporting students' social-emotional development

In the 21st Century, the rise of technology has increased the importance of developing socio-emotional skills, as they are increasingly recognised as valuable assets. Building a supportive classroom environment is crucial for both cognitive and non-cognitive outcomes. Teachers must nurture this positive type of environment whilst also creating explicit learning opportunities for students to practise and develop their socio-emotional skills.

A playing field

The implications of GenAI for the development of social-emotional skills is not fully clear. On the one hand, GenAI could help students take risks without a fear of failure by providing a safe space for them to test their ideas. In a classroom setting, students need to feel comfortable enough to make mistakes and learn from them in front of their peers and teachers. Whilst teachers often say that "there is no such thing as a stupid question", GenAI would never pass judgement on the questions that a student shared. Teachers could use it as a sounding board for students to make use of to foster their confidence and their experimentation. Similarly, it can be a very powerful tool to foster students' curiosity and open-mindedness.

Strengthening student-to-teacher relationships

Secondly, teachers may be able to direct more of their time and energy to fostering deeper relationships with students. The quality of the relationships in a classroom, both at the student-to-student and teacher-to-student level, are essential in shaping how social-emotional skills develop. As previously outlined, the process of providing feedback to students may become more streamlined and this may allow teachers to dedicate greater time to personalising feedback for students' needs. Similarly, a more personalised learning experience for students will furnish teachers with more granular and specific information on students to add greater depth to their relationships.

But not replacing humans

There are though several important limitations for the development of other socio-emotional skills. For example, it is unclear what might be the impact on students' perseverance and resilience. Struggles and failures provide students with opportunities to develop these two skills and to grow as independent learners. At times, teachers intentionally allow students to grapple with their own errors or leave mistakes uncorrected for a period to foster their ability to persevere through challenges and learn independently. There is a concern that relying too heavily on tutoring could lead students to seek quick fixes or become complacent in their tasks, and determining when to respond or withhold support in response to students' requests would require sophisticated learning analytics.

There are also risks of negative effects. The previous decade has seen technology become far more integrated into our lives, and new powerful tools such as those of GenAI could accelerate this further. What will be the impact of these technologies on students' socio-emotional skills and well-being? What would be the implications for how students learn to regulate the instant gratification that such tools can bring and to handle particularly complex and difficult tasks? What would be the impact on students' sociability and their sense of trust and empathy? These risks demand that teachers, and systems more broadly, consider attentively how best to continue to nurture these important skills.

3. The potential impact on teachers and students outside the classroom

In recent years the traditional boundaries of the classroom's walls have been increasingly challenged, and GenAI may be a new catalyst that transforms our historic conceptions of where, when and how learning happens.

3.1. How students can learn outside of the classroom

While on-line tools have already been transforming how students learn and their relationship with information, GenAI can potentially have deeper repercussions with how students work outside the classroom. It can help students to tap into their authentic curiosity, give them opportunities for self-directed learning and support them throughout their learning process. In this way, it provides opportunities to exercise agency over learning, playing an active role in deciding what and how they will learn, which tends to be associated with greater engagement and interest in learning (OECD, 2019[16]). Specifically, these support roles could include:

- **Inquiry:** Giving students access to an endless world of information to be explored at any time on-line in digestible formats, tailored exactly to their specific questions, interests and needs. Students can engage conversations to deep dive in a topic of their interest, ask for summaries of articles and research, and let their curiosity flow in never ending ways.
- **Ideation:** Providing suggestions, ideas, and helping them brainstorm on given topics or challenges. It can provide for a giant crowd curation of possibilities through different formats and perspectives which can inspire students and spark creative thinking. Also, it can stimulate students to think differently through novel, unexpected or unconventional perspectives.
- **Language and comprehension support**: Helping students develop their reading and writing skills, by providing feedback on written texts and helping summarise complex texts which may be hard to understand. For example, by analysing a student's writing, GenAI can provide suggestions for improving grammar, syntax, and word choice. This can help students become better writers and improve their overall academic performance and confidence.
- **Adaptive learning:** Acting as a personal tutor, responding to specific questions, providing feedback to work, making suggestions for improvements, providing tools to develop critical and problem-solving skills. Less powerful already existing adaptive tutoring systems have shown mixed results on students' learning so far, their effectiveness depending on a range of factors, such as the quality of the instructional materials, the design of the system, and the context in which it is used (du Boulay, 2015[17]).

3.2. The losers of the one-size-fits-all model might be the greatest winners

The emergence of GenAI offers new opportunities to provide improved, quality learning experiences for students for whom the prevailing one-size fits all model is not as effective in catering to their specific needs. The following groups of students could particularly benefit from GenAI by accessing:

- Special education needs: personalised and adaptive learning experiences tailored to their unique learning styles, abilities, and needs. For example, students with visual impairments can benefit from speech-to-text or text-to-speech tools and students

with dyscalculia can learn about a mathematical concept through additional aids such as 3D models.

- Immigrant and refugee students: language translation and interpretation tools to overcome language barriers and facilitate their integration into the classroom, allowing students who do not speak the instruction language proficiently to contribute to the classroom or learn in their own language.
- Remote areas: higher quality instructional materials and interactive educational opportunities that bridge the geographical distance.
- Ethnic groups, minorities, and Indigenous populations: culturally responsive and inclusive content that promotes representation, diversity, and fosters a sense of belonging.
- Gifted students: advanced and challenging content, personalised enrichment activities, and opportunities for independent exploration and research.
- Low socio-economic backgrounds: affordable personal tutor and even personalised learning experiences that level the playing field and provide equitable educational opportunities.
- Students who are falling behind: receiving targeted interventions, adaptive feedback, and personalised support to address their specific learning gaps and help them catch up academically.

3.3. Subjects that make great use of language might benefit more

The impact of 'large language model' tools seems particularly apparent in the humanities or language instruction which are largely writing or text-based. Language learning is a case in point. These tools can be used to help students learn a new language by offering instant translation, grammar correction, and pronunciation guidance, and by generating dialogues and interactive activities. These tools are particularly suited because of the conversational nature of the interactions, and they may even provide a more authentic accent than a teacher who is often not a native speaker. While these have already existed for a while and shown positive effects (OECD, 2021[18]), the new developments in GenAI open up even more powerful opportunities. For example, Duolingo, an adaptive tutoring system has now integrated GenAI to generate test items, provide personalised explanations of mistakes and provide opportunities for practice (OpenAI, 2023[19]).

In contrast, Mathematics is the subject in which the applications seem more limited so far. GenAI struggles to solve problems and answer questions involving math and data (von Hippel, 2023[20])are initiatives, however, in experimenting with ways to resolve these technical issues and understand how can it be helpful to students. Khanmigo from the Khan Academy is being piloted in four states in the United States as a virtual tutor and teaching assistant. Wolfram Alpha, a dedicated Maths software, is scheduled to be integrated as plug-in one of the upcoming releases of the dominant GenAI tool.

3.4. Making a more effective use of time outside the classroom

GenAI can take over part of the work that teachers have to do and free them up to do what accelerates and deepens learning best. On average across the OECD, teachers report working a total of 38.8 hours per week, with approximately 20.8 hours devoted to teaching. The most time-consuming non-teaching tasks include: "individual planning or preparation of lessons either at school or out of school" (6.5 hours); "marking/correcting of student

work" (4.2 hours)"; "general administrative work" (2.7 hours); and "team work and dialogue with colleagues within this school" (2.7 hours) (OECD, 2020[21]).

GenAI has the potential to reduce teacher workload by automating tasks such as generating lesson plans, grading assessments, providing feedback, and writing reports and other routine administrative tasks. There is emerging evidence that some of these tasks – particularly in the area of targeting and grading assignments- can be automated effectively leading to more efficient student study efforts and saving teachers' time (Atwood and Singh, n.d.[22]).

These tasks not only take a considerable amount of teachers' time but can also represent a significant source of stress. About 49% of teachers participating in TALIS 2018 (OECD, 2020[21]) responded that they were most stressed about "having too much administrative work to do," with those who spend more time on administrative tasks being more likely to report higher levels of stress.

Focusing on GenAI can liberate teachers from routine administrative and instructional tasks, and provide them with the opportunity and support to become great coaches, mentors, role models, inspirers and leaders. This shift in time allocation holds the potential to provide teachers with more time to focus on more creative and engaging tasks (such as small group work or working individually with students).

3.5. Supporting teachers' professional learning and development

Every teacher – even those with the highest level of practice – has considerable scope to further refine their skills. Mastering practice requires teachers to continually hone their craft as technology, professional skills and knowledge advance as well as when their classrooms present them with new challenges.

GenAI can provide teachers with a tool to help them in their own teaching practice, summarise recent research on education, provide additional resources and materials to develop, as well as ideas on how to improve. It can, for example, provide teachers with support through "Examples of creating a positive learning environment" or "How can I foster critical thinking?". As a teacher coach, GenAI can help teachers stay up-to-date with subject knowledge and provide immediate responses on new teaching methods, resources, techniques.

Moreover, GenAI can also provide some feedback and help teachers become more aware and take perspective on their own teaching by analysing an array of artefacts, including lesson plans, learning resources, homework assignments, assessments or even lesson recordings. Novice teachers who have little classroom experience might particularly benefit from having a broad perspective of patterns in the their teaching. This might provide insight on, for example, how often teachers are using different class arrangements, whether more attention is devoted to particular types of students or topics. Making visible what tends to go unnoticed can help teachers design and enact more compelling learning experiences. There is already some promising evidence from tools like TeachFX and Edthena that analyse teacher classroom interactions and provide personalised insights and feedback to teachers (Kelley, Holsapple and Baker, 2016[23]).

3.6. Building upon each others' strengths

Traditional approaches have confined teaching to the endeavour of a single individual, while mounting research points to the benefits of considering different distribution of roles that build upon each others' strengths as well as professional collaboration and agency. Tapping the potential of GenAI and addressing its shortcoming might accelerate the move

towards more collaborative approaches to teaching, unleash their creativity in facilitating students' learning and, more broadly, empower the profession.

One of the most significant benefits of GenAI is its ability to create content, from book chapters to quizzes and activities, on demand and at a scale in a way that was previously unimaginable with greater ease, speed and at a relatively low cost. However, automated content production will always need strict quality control. This opens up new opportunities for teachers to come together to collaborate, co-design and dialogue with the purview of developing high quality educational resources, using GenAI to do the legwork and focusing on sharing their expertise to enrich them whilst providing safeguards against potential downfalls.

Box 2. Using teachers teams to develop high quality lesson plans

Digital Promise in the United States is actively supporting teachers and school leaders in the integration of GenAI tools in the classroom while at the same time creating safeguards against potential dangers. In one project, teachers learn to engineer prompts for ChatGPT in order to generate sample Computational Thinking (CT) lesson plans as part of their lesson preparation. Computational thinking is an interrelated set of skills and practices for solving complex problems, and is a newer topic that teachers have been asked to integrate into their disciplines to prepare their students for fully participating in a computational world. As they work to incorporate CT in their existing content areas, teachers use ChatGPT to generate examples of what their existing lessons can look like if they include CT skills and practices. The ChatGPT-generated sample lessons are then reviewed by teams of teachers and researchers to ensure that they are accurate in both content and pedagogical approach. The reviewing team also checks that the sample lessons are free from bias. Once all of those checks are completed, the sample lessons are shared with a broader audience of teachers who can then make adjustments for their individual classes before they implement the lessons. The sample CT lessons are also incorporated into teacher professional learning experiences

Source: Digital Promise, work supported by the National Science Foundation under Grant No. 2219350.

4. Learning to teach and learn with GenAI

GenAI offers opportunities for education systems to enhance access to quality teaching and learning. However, these are not guaranteed nor automatic, and these tools also bring with them numerous risks and limitations that practitioners and decision-makers must consider. Some school networks stated that GenAI will be embraced in their schools in an ethical way (International Baccalaureate, 2023[24]), while the immediate reaction of some education authorities in the United States and Australia was to ban the tools entirely or partially for students.

A few months after the initial sudden irruption of universal GenAI, it seems clear that the potential of these technologies to transform teaching and learning will only grow. Thus, the question is, if GenAI tools become prevalent in classrooms, what are the key questions to consider to ensure their correct use?

4.1. Revisiting what students need to learn

The growing call for greater focus on '21st Century Skills' in recent year has received a new impetus with the arrival of GenAI tools. It is now even more urgent to review what is taught and how it is assessed. The previous sections have already outlined how teaching and learning might be transformed in order to better develop mastery of certain skills or knowledge. At the heart of this lies the question of *what* students need to be able to do in an age of GenAI. This means adapting and redesigning curricula to meet societal needs to prepare students for the future (OECD, 2020[25]).

The previous sections have already outlined some skills that might need to be strengthened and what teachers can do in the classroom about it. In the age of GenAI, the following skills might be particularly important:

- **Digital literacy and AI mastery**: This involves providing learners with an understanding of digital tools in general and artificial Intelligence in particular. Students will need to be able to recognise the difference of AI compared to human intelligence and the strengths and weaknesses of each. It will also imply teaching students how to use AI systems effectively, based on the very plausible notion that adults are likely to be working more and more closely with AI systems in the future.
- **Learning mastery**: This covers the questions of how we learn and understand our learning activity (metacognition) as well as how we understand skills such as social intelligence, collaboration and creativity and innovation.
- **Knowledge mastery and self-regulation**: This relates to not only what we know about the world (academic knowledge) but what we know about knowledge (understanding knowledge, what is fact, what is good evidence, how to make judgements based on evidence and context). Knowledge mastery also means being able to accurately assess our abilities, emotions and personal context, encompassing all aspects of human intelligence.

What is striking is that these are areas that our education systems are yet to sufficiently emphasised. In the Programme for International Student Assessment (PISA) 2018, on average, less than half (47%) of students demonstrated being able to distinguish fact from opinion (OECD, 2021[18]). This is likely to only become a more challenging terrain with the arrival of artificial intelligence. Indeed, navigating digital environments is also an increasingly important skill, and yet almost one in five students (19%) on average across OECD countries reported feeling lost when navigating through different pages in the PISA test. There is a risk that some students are left behind as the digital world becomes increasingly present.

However, what is also promising is that these skills are not fixed. PISA 2018 also highlights that education systems with a higher proportion of students who were taught how to detect biased information in school and who have digital access at home were more likely to correctly distinguish fact from opinion. This reiterates the importance of interrogating at a deep level the content and skills students should master, and which practices may be most relevant for achieving this.

4.2. Putting teachers at the centre of its design and supporting them

Teachers, students, and parents need to be at the heart of the design of education solutions based on GenAI to ensure that these are effective. Technology and AI are not magic powers, they are just extraordinary amplifiers and accelerators.

The engagement of teachers is particularly significant. While there have been varied responses, teachers (as well as students) seem mostly positive about GenAI. In a survey of over a thousand of school teachers in the United States, 64% of them reported plans to use GenAI often and in a varied of tasks, from lesson planning to the elaboration of curriculum contents (Walton Family Foundation, 2023[1]). In another survey of over 1000 teachers in the United States, more than half of the participating teachers (54%) reported feeling optimistic or very optimistic about GenAI (Muscanell and Robert, 2023[26]).

Nevertheless, we have learnt from the past that this is unlikely to happen automatically. No matter how good, technology doesn't just insert itself into teaching practices. The OECD TALIS 2018 Survey revealed that only slightly more than half of lower secondary teachers on average let students "frequently" or "always" use ICT for projects or class work (OECD, 2020[21]). Furthermore, the OECD Video Study found that technology is mostly used for communication purposes in the classroom and only very few classrooms used technology to enhance teaching and learning processes (OECD, 2020[9]). If the implications of GenAI are as wide-ranging as some predictions suggest, there is a real need to ensure that the teaching profession and classrooms are supported to keep pace with these developments.

Teachers and school principals need to be trained in a systematic, evidence-informed way on how to use them in their different learning scenarios. The question of teacher support and preparation will be key in any system-wide response to GenAI and education. Ensuring that teachers are prepared to use AI tools, understand their benefits and mitigate their risks is critical. Collaborative models, peer support systems and networks can play a critical role in ensuing that classroom practice is able to swiftly and accurately adapt to the tools.

There is also though a need to work with teachers to encourage and evaluate experimental approaches to the use of GenAI given that the evidence base today is almost non existent. There have already been steps in this direction to shed light on changes in students' behaviours, cognitive processes, and social-emotional feelings in interacting with GenAI. For example, the National Science Foundation, a significant funder of education research in the United States, issued a call for research proposals in May 2023 in the following areas: developing AI tools and environments to advance age-appropriate equitable learning and inclusive teaching; supporting learning about and interest in AI; using AI to teach AI; and, integrating generative AI in education in an ethical, responsible, and effective way (National Science Foundation, 2023[27]).

4.3. Providing guidance on how to introduce GenAI while avoiding overreliance and misuse

The importance of dialogue across stakeholders is heightened when considering the questions that have surfaced around the boundaries of where GenAI could, or should, operate in education. This is a step that some education authorities have already started to take. One of the earliest to react was the German Lander of Northern Rhein–Westphalia that published in February 2023 a guidebook for schools and teachers to serve as a starting point for those who would like to incorporate GenAI in their practice. The guidebook explains how the technology works and can do, how it can be beneficial for students and teachers, and how to deal with potential overreliance and misuse. On the two latter, the guidebook includes guidance on agreeing with students on norms to mark texts that have been supported by GenAI, setting tasks that cannot be done solely by GenAI, and dealing with students that do not acknowledge its usage.

Overreliance and misuse are perhaps the two topics that have stirred greater controversy in the education debate in the past months. The question of academic integrity and its potential for cheating has represented one of the most immediate concerns expressed by schools and

school districts. This is because GenAI tools have the potential to enable plagiarism and cheating on assignments and exams, with students being able to generate texts which appear to be original but are actually copied from on-line sources. While plagiarism detection tools already exist online (e.g., Turnitin, iThenticate, Ouriginal), new detection tools have been quickly rolled out to mitigate concerns from the teaching community. At the same time, the boundaries of what constitutes academic integrity and plagiarism have been muddied by such powerful tools, demanding a concerted response from multiple stakeholders.

Assessments has been a second area of considerable debate. New assessment methods could shift attention to integrate the use of GenAI in formative assessments, using reviews and intermediary steps in text development to guide student learning. On the one hand, there is a need to shift from assessing memorisation, recalling and applying content knowledge to actually assessing critical thinking, problem solving, and creativity. On the other hand, there are ways in which further questions related to student self-assessment can be built in (e.g., "Why the response chosen is better?", "What steps did you take and why?") or students can be asked to, for example, make predictions, connect the content to personal experiences, share draft versions, engage in social annotation which GenAI would not be able to effectively support. Other options could be using oral exams and analogue formats to counter potential cheating, though this could also put students with disabilities at a disadvantage.

4.4. Trusting GenAI

One of the deepest concerns about the use of GenAI tools and large language models relates to the question of cognitive bias. GenAI comes with bias, diversity and ethical issues. GenAI models have been built on a huge but largely unknown data source which means that teachers and students have no way of knowing what data sources have been used to create the responses it generates. Any errors or bias will be simply reproduced in its answers.

This is the same for gender and diversity at large and is a question pertinent to all forms of AI – that AI can disseminate content which is prone to gender or other stereotypes or harmful and biased content (UNESCO IESALC, 2021[28]). Moreover, there is a growing concern about the lack of cultural diversity in the representations produced, as most of the training data comes from Western, English-speaking countries (Holmes and Tuomi, 2022[29]). This is an important consideration given that teaching and learning are always contextual and culturally sensitive.

Another concern relates to data privacy and security, in particular data of students and minors which is being collected through the use of the tool. This was the rationale behind the ban imposed by the Italian government in April 2023 (McCallum, 2023[30]). Issues include the fact that GenAI has the potential to collect and store large amounts of personal information (including questions asked, conversations, and interaction). Students and teachers may be using the tool without having given informed consent as to how their data is being collected, or without taking any necessary means to protect their data.

GenAI – whether the large language models or new applications- is one of the most rapidly evolving business sectors at the moment. Most of these tools are being developed by private companies in a reduced number of countries. This raises questions on who will control access to knowledge and information should they become widely used in education systems, and how to ensure that these solutions are accountable, inter-operable and affordable.

This touches upon wider issues of the ethics of AI in education. One key challenge for both educators and policy makers is responding to issues in relation to the trustworthiness of AI,

which relates to transparency, explainability and accountability, in addition to protecting and securing personal data. Trust is particularly important seeing as the stakes are high - using AI in education systems could have long-term repercussions in the lives of students (OECD, 2020[31]).While there has been a growing focus on this question in both academic and the international community , there are still are few existing guidelines for teachers or school leaders to assist them in navigating ethical issues in AI. One example is the "*Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators*" published by the European Union in October 2022 (European Commission, 2022[32]).

5. How can schools respond?

Box 3 includes an initial list of discussion questions for practitioners, researchers and policy-makers to consider ways to tap into the potential of Generative AI while safeguarding against its potential risks.

Box 3. An initial list of questions for reflection in school responses to GenAI

Questions for teachers and school leaders:

- How can we effectively integrate AI language models such as ChatGPT into primary and secondary education curricula while maintaining a balance between human-led instruction and AI-driven learning experiences?
- How can we ensure that teachers are adequately trained and supported to understand and help their students to understand the difference between Artificial and human Intelligence?
- What long-term implications might widespread adoption of AI language models have on the role of teachers, and how can we prepare the education workforce for these changes?
- What measures can we take to ensure that AI language models do not inadvertently promote cheating or plagiarism among students, and instead encourage original thinking and creativity?
- How can we mitigate algorithmic biases in AI language models and ensure that they provide fair and inclusive learning experiences for all students, regardless of their background, ethnicity, or gender?
- How can AI language models be leveraged to support students with special needs, learning disabilities, or those from disadvantaged backgrounds or requiring additional support in the classroom?

Questions for policy- and decision-makers

- How can we ensure that teachers are adequately trained and supported in integrating AI language models into their teaching practices, including professional development programs and ongoing support?
- How can we ensure equitable access to AI-driven educational tools, such as ChatGPT, for all students, regardless of their socioeconomic background, geographic location, or language proficiency?
- How can we foster collaboration between AI developers, educators, and policymakers to develop a rigorous and responsive evidence base of best practices for the development and use of AI language models in education?
- Whose voices should be involved in national conversations around the implications for education systems and the development of ethical guidelines? (e.g., private sector, parents, minority groups, students?)

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