West Partnership

Artificial Intelligence and Education: A Scoping Review

November 2023

GLASGOW CITY REGION Education

Alex Evans and James Bowness
November 2023

Contents

Executive Summary 3
What is AI and what are its uses? 4
Why do we need to know about AI and what are its future implications? 5
How can AI support the developing of curriculum, learning, teaching, and assessment? 6
AI as a tool for learning 6
Increasing students' confidence through AI 7
Supporting Inclusion and Accessibility 9
Promoting collaboration and team building 10
Monitoring learning and performance 11
How can AI enhance teacher workloads? 11
Saving Time 11
Shifting Time 12
What are the challenges and risks posed by AI? 13
Bias 13
Privacy Concerns 13
Accuracy 14
Conclusion 14
Appendix 1: Scoping Review Methodology 15
Appendix 2: References 16

Executive Summary

This scoping review provides a non-exhaustive overview of literature which looks at the potential impact of Artificial Intelligence (AI) on education. We begin by discussing what AI is (and is not) and discuss some of its uses. We also consider what the potential implications of AI could be and explore how incorporating AI could improve curriculum, learning, teaching and assessment and develop learners' skills to meet the needs of our advancing 21st century. Later in the review, we explore how AI could be used to reduce teacher workload – a process which we believe could shift the allocation of time away from planning towards more learner focused activity. We end by considering some of the potential challenges and risks that AI poses to our education system. Throughout this review we draw on evidence and opinion from a range of academic and non-academic sources. All of this evidence is presented in our bibliography.

What is AI and what are its uses?

Schools have adopted digital technologies to support with learning and teaching since the first generation of computers. These technologies have continued to evolve with time, leading to the development and use of Artificial Intelligence (AI). Currently, there are no national regulations of this technology, and universities have only recently begun reviewing their own assessment and moderation policies in light of its development (1). With AI becoming more prominent across sectors, it is important teachers are aware of and consider the opportunities and challenges it can bring both in and out of the classroom.

Although there are a variety of definitions for this concept, computer scientists generally agree that AI is the culmination of computers, machines, and other information technologies that enable them to perform human-like functions (2). These functions include, but are not limited to problem-solving, pattern recognition, adapting to new situations, and devising plans. AI is often associated with processing and producing information through text (for example, through ChatGPT), but it can also be applied to data from a wide variety of sources, including eye tracking data (3), visualisations (4), and speech recognition (5). The section below summarises some key terms that are important for understanding AI and its potential use in education.

Term	**Definition**
Traditional AI	Technology that processes large amounts of data to run analyses or make predictions
Generative AI	Goes a step further than traditional AI by processing data and producing new content from this in the form of text, audio, images, etc.
Deep Learning	A method that is used in AI where a computer is trained to process data in a similar way to humans, by analysing any form of data and identifying complex patterns within these.
Generative Adversarial Network (GAN)	A form of GAI that consists of two neural networks (generator and discriminator) that compete with one another through deep learning to produce increasingly more accurate content over time.
Generative Pre-Trained Transformative Network (GPT)	A form of GAI that processes large amounts of data to carry out a wide variety of tasks such as answering questions, summarising text, or generating lines of code.
Natural Language Processing	A sub-field of AI that enables computers to understand, manipulate, and generate human language.
Transformer Architecture	A type of neural network that is used in NLP tasks. The computer is trained on a large amount of data to generate a response one word at a time, as the model will predict the next words based on both the data, and the words it has already produced.
AI Literacy	The knowledge, skills, and confidence to use and evaluate AI technologies.

While **traditional AI** systems usually analyse data to make predictions, recent advancements have led to the development of **Generative AI**: a collection of algorithms that can create what appears to be new content in the form of text, audio, or images (6). To do this, the software is trained on an existing set of data, where it can learn their patterns and distribution over time. This process is

known as **deep learning**, and is what enables this technology to look at data in a similar way to humans through identifying complex and intricate patterns. There are two major types of GAI: **Generative Adversarial Network** (GAN), and **Generative Pre-Trained Transformer Network** (GPT).

GAN is the most commonly used form of GAI, and consists of a generator network that produces synthetic data, and a discriminator network that examines the authenticity of this content (6). The discriminator network will continue to process the content produced by the generator network until it can no longer decipher between what is artificial and what is real. For example, GANs are often used for generating images such as human faces, realistic photographs, or 3D objects.

GPT uses a large amount of data to produce content in several different languages, and on almost any subject area (7). The most recent version of this network is GPT-3, which has become the current **natural language processing** (NLP) engine that runs ChatGPT by OpenAI. NLP is a sub-field of AI, and allows computers to process and understand human language to then perform a particular task such as spell checking, essay writing, or summarising large amounts of text. This involves a **transformer architecture**, which is trained on a large dataset of text (6). The model will process any data it is provided with and generate its response one word at a time, as it predicts the next word based on the input and words it has already generated.

With AI posing a number of opportunities and challenges in education, it is important for both teachers and learners to develop **AI literacy**. This term evolved from “digital literacy” as more people began to rely on computers in their everyday lives. In summary, AI literacy refers to the skills and knowledge required to understand and use AI (8). As this technology becomes increasingly more common, it is necessary that individuals can critically evaluate, communicate, and collaborate using AI so they can use it effectively online, at home, and in the classroom. This report aims to provide a comprehensive overview of how AI can be used in schools, the challenges teachers and pupils should be aware of, and what impact this technology can have on learning moving forwards.

Why do we need to know about AI and what are its future implications?

Since its development, AI has spread across industries and sectors to both enhance users’ experiences and improve efficiency. It is predicted that by 2030, 15% of all global working hours will be automated, and 47% of jobs in the US will be at risk of automation (9). These are expected to have a disproportionate impact on women, and those of a lower socioeconomic status (SES). Therefore, AI literacy can be viewed as a new skill that everyone should learn, as many sectors will require their workforce to be AI literate and possess skills that go beyond what this technology is capable of. This applies to pupils of all ages and stages, to ensure children and families (especially those from more disadvantaged backgrounds) have access to AI education.

A major obstacle teachers must consider with the development of AI is the impact of deprivation, and how this could lead to another digital divide (10). Research suggests that students from more disadvantaged backgrounds are more likely to perform worse on AI tasks than other students, which could be influenced by their prior access to these technologies at home (11). This could prevent students from advancing in their use of these devices, and lead to further inequalities in learning and skills development in future years. To avoid this, teachers should scaffold all students’ learning with appropriate AI tools that can not only improve their academic performance, but also prepare them for an AI world.

Students and teachers would also benefit from developing their AI literacy due to the lack of regulations of this technology. As mentioned previously, there are currently no national regulations in Scotland for using AI and its ethics are often overlooked (12). With a lack of accountability for users and software developers, teachers and students need to be aware of the potential risks

posed by AI (**see section**: 'What are the challenges and risks posed by AI?'). We all have a social responsibility to consider the ethics involved, as well as how inclusion and diversity can be incorporated into its everyday use to ensure it continues to develop for the greater good (13).

In addition to losing jobs to automation, 32% of remaining jobs are expected to change drastically in the next 15-20 years as AI becomes more embedded in society (14). Although AI can complete many human tasks such as summarising text, identifying patterns, and producing visualisations, this technology still requires human input. AI is dependent on the data it is trained with, meaning the quality of any content it produces relies on the quality and quantity of data provided by its users (7). Therefore, there needs to be an increased focus on students' computational (15) and critical thinking (16). This will not only enable students to optimise their use of AI in and out of school, but it will also enable them to evaluate its effectiveness and differentiate between content that is man-made, and content that is artificial.

AI does not only pose risks to future jobs however, as it may also bring new opportunities in education. In a report on AI in education by UNESCO (17), it was concluded that this technology has the potential to improve access to learning through eliminating barriers experienced by students, automating administrative departments, and optimising the distribution of learning materials to improve learning outcomes. For this to happen, UNESCO (18) have stated that educators should focus on:

- Prioritising inclusive and equitable use of AI;
- Adopting AI technologies in ways that enhance pupils' learning;
- Promoting the skills children and young people need for an AI future; and
- Making pupils aware of the potential risks with AI and demonstrating how it can be used safely.

Indeed, the benefits of developing AI literacy can extend beyond STEM subjects to support learning throughout the curriculum, as shown through a positive relationship between computational thinking and pupils' academic performance in school (19). This suggests that AI literacy is an important skill not only for teachers in STEM, but across all levels and subject areas. Research has also emphasised the importance of developing higher order thinking skills such as problem solving and creativity, in addition to understanding the mechanisms behind the technology – which can provide overarching benefits for pupils with their learning and understanding of the curriculum as a whole (20).

How can AI support the developing of curriculum, learning, teaching, and assessment?

AI technologies can be adopted by both teachers and students in ways that support learning, teaching, and assessment. When supporting students with understanding AI, it is important that teachers prioritise the development of problem solving and critical thinking skills, as this is what will allow them to lead in their own learning and evaluate their use of AI applications in the future.

AI as a tool for learning

One of the most recent concerns regarding the use of AI in education is ChatGPT, and the impact this may have on assessments and potential plagiarising. Indeed, ChatGPT has already been banned in multiple countries, and several school districts in the US have restricted access for students due to concerns of cheating (21). However, while this application can compose any form of text from essays to poems in just seconds, its abilities are not infallible and can be picked up by both humans and other software such as Turnitin. Therefore, rather than not trusting pupils with their use of AI, teachers can scaffold their learning to help them develop the skills required to critically evaluate these tools, ask questions, and manipulate it safely in ways that can help them to reach their learning outcomes (22). Research suggests that using AI in this way can not only help

learners prepare for its use in the workplace and further education, but also lead to improvements in student motivation, academic outcomes, and learning interest (23).

An example of how teachers can support students to evaluate the use of ChatGPT is to allow them to examine the limits of its use for themselves (24). To do this, students can be asked to generate their own essay question and submit this to an NLP engine such as ChatGPT. Once a response has been generated, students should take some time to examine the answer it has provided. This will allow students to identify any errors the software may have made such as generating false references or generic phrases and see how it can often lack the originality or creativity of assignments created by humans. Although AI tools can process and produce large amounts of information in a short period of time, they can only do so to assist with the learning process and provide a framework for pupils' learning.

Once pupils are aware of how AI works and the limitations of its use, generative AI tools such as ChatGPT can be used to support their knowledge of a subject as opposed to plagiarising. These tools can help pupils to understand course content on a deeper level through reorganising this information, retrieving existing information, and linking these together. For example, by providing the technology with a prompt, pupils can ask AI to connect new concepts with what they have learned in class already, to help them develop a more holistic understanding of the subject (25). Pupils can also learn the concepts they have acquired in class in greater depth by exploring these through different analogies. Asking NLP engines to explain a concept within an analogy that pupils can relate to will not only improve their understanding, but also promote active learning.

One of the key advantages to using AI as a learning tool is that the responses can be individualised to each learner (25), and support them to inquire, evaluate, and communicate the ideas they develop in class. For example, if an answer provided by AI is too complex or lacks sufficient challenge, follow-up prompts can be given so the answers are adjusted accordingly. Some of these follow-up prompts can include:

- How would you explain this concept to a beginner?
- Can you explain this in more detail?
- Could you provide some examples of this?
- How does this relate to ___?

Increasing students' confidence through AI

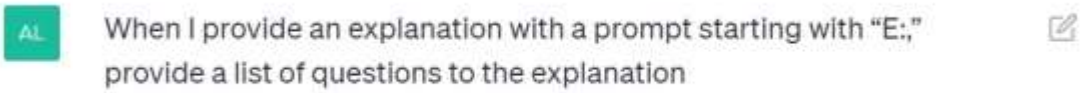
Through tailoring each response based on the prompts provided, AI can provide answers that are more suitable for the age and stage of each learner, which can help increase their confidence in a subject area. Helping students to feel more confident will not only enable them to reach their learning outcomes, but also make them less inclined to use AI technologies inappropriately in upcoming assignments (26). As this software will adapt responses based on how requests are framed, students can use these to prompt for additional information on any topic. This means that over time, these applications can take a proactive approach to learning by anticipating any difficulties pupils might have, and altering its responses based on this (27).

AI can be used to offer personalised support to students in the classroom, through developing a study schedule, and providing more flexible options for learning. This can be particularly helpful for pupils with upcoming examinations, to assist with covering large amounts of course content. For example, AI voice assistants can be used by pupils to schedule study sessions, listen to lessons on the go, or to provide instant answers to any questions they may have (28). Tasks that may be challenging for some pupils can also be broken down into smaller chunks until they are more comfortable in the subject and avoid feeling overwhelmed by important deadlines or assignments they have approaching.

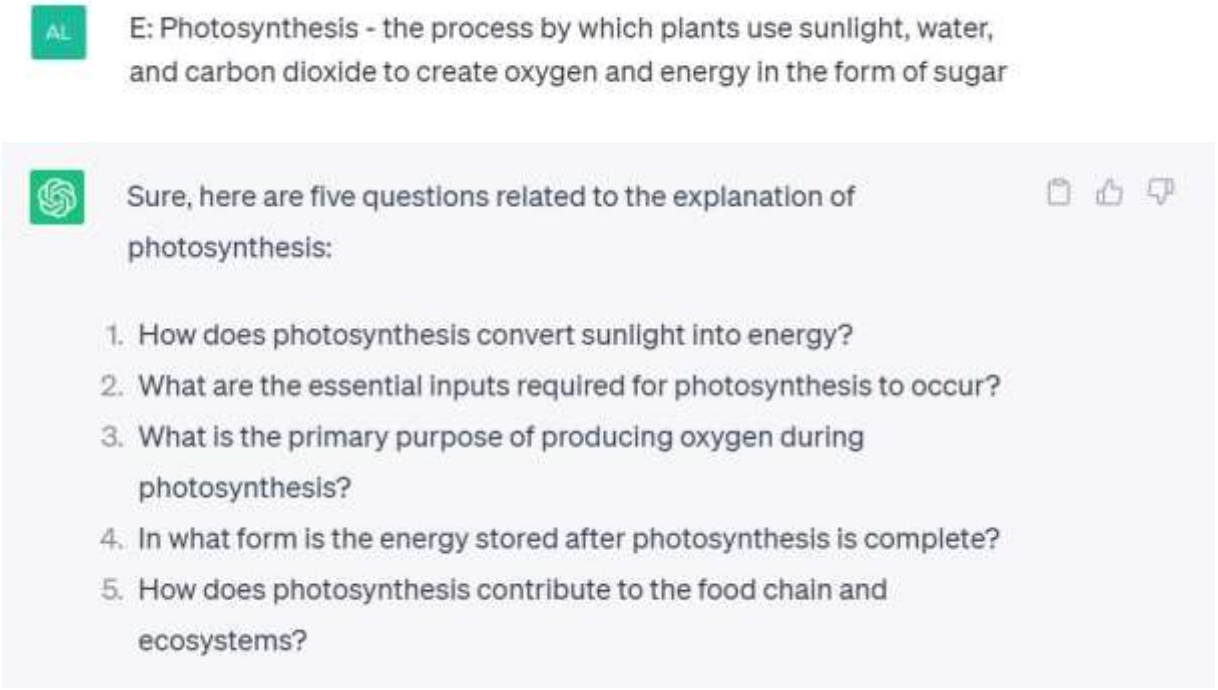
An example of how generative AI can be used to break down information involves the Feynman Technique: a strategy for learning where complex concepts are shaped into simpler definitions, which can then be prompted to increase learners' understanding and help them identify any gaps in their knowledge (29). The key stages of this technique involve:

1. Identifying the topic
2. Teaching this topic to someone with no prior knowledge
3. Identifying any knowledge gaps
4. Simplifying this knowledge.

When using this in an NLP engine such as ChatGPT, a prompt such as the one below can be given:



A desired number of questions can also be given in this prompt (e.g., '*provide a list of five questions to this explanation*'). Once the engine is ready, it can then be provided with a concept:



Now that the software has designed the questions, pupils can use these to test their own knowledge of the topic and identify areas in need of greater focus. The final step of this technique then requires students to reorganise their answers to these questions, so the explanation flows more smoothly, and any complex ideas are broken down into simpler examples. This can be completed individually, or in groups, to increase students' confidence and encourage them to explore the content further.

Pupils can also benefit from using AI technologies as part of their language courses. Not only can ChatGPT translate information and conversations, but it can also provide more information on how certain phrases and terms are applied and in what contexts. Using this technology in a group context can also facilitate an ongoing dialogue, improving their communication skills in the language they are learning and practicing how these phrases are applied in different situations (23). For pupils with English as an additional language, AI technologies can serve as a useful

language aid, to assist with coursework and day-to-day interactions in and out of the classroom (7).

To increase children and young people's confidence with using AI, teachers can work with them to understand the mechanisms behind this technology. **Gamification** is a process that aims to increase learners' motivation and engagement by including gaming elements such as points and badges (30). Research suggests this strategy is important for supporting pupils to interact with technology, as it can improve engagement, participation and lead to improved outcomes in learning (31). There are a number of open-access AI applications online that use this strategy to develop young people's problem solving and critical thinking skills while also learning about how AI technologies work. For example:

- AI for Oceans is game that enables students to train their own machine learning models. This involves exploring how to train, model, and classify data as well as understand how human biases play a role in machine learning systems.
- Zhorai is a conversational agent that can allow children to explore machine learning concepts. Targeted towards children aged 8-11 years, they can train the agent through conversation to understand how the knowledge is represented through visualisations.

Teachers with experience of supporting students with AI have also found that focussing on students' data literacy (i.e., an understanding of the collecting, processing, analysing, evaluating, and managing of data) is crucial (32). This will allow students to understand how generative AI technologies produce their information, and why these might sometimes be inaccurate, inappropriate, or biased. Through building their confidence with data, pupils will better understand the limits of what AI can and can't do, and can actively develop solutions to address any issues they may experience in the future.

Supporting Inclusion and Accessibility

Through personalising learning to meet the needs of each learner, AI could be used to support pupils with additional support needs in a variety of ways. Many applications that are already available to use could be adopted in classrooms to help create inclusive learning environments.

As mentioned previously, voice assistants are useful applications that can help pupils to breakdown learning content, and organise deadlines around their own schedules. These could be valuable tools for neurodivergent pupils, through organising their learning content in a way that is more accessible and manageable for them, and scheduling deadlines into smaller chunks (28). These applications can also allow pupils to synthesise content into a variety of ways including bullet points, reports, presentations, or mindmaps, to ensure they can engage with the learning material in a way that suits their needs.

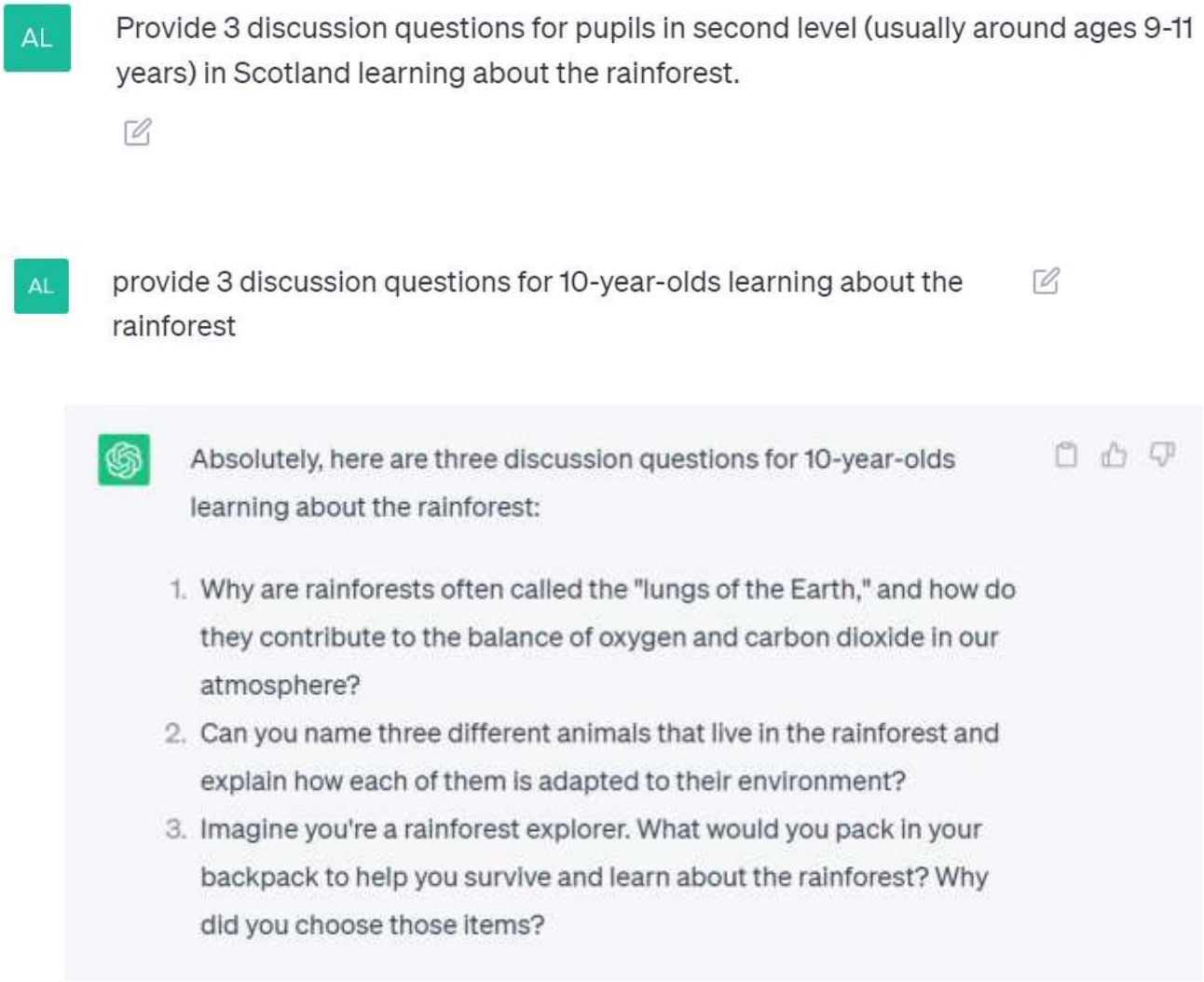
A number of speech and language tools could also be used to support inclusion in the classroom, such as the Presentation Translator on Microsoft Powerpoint. This application can produce subtitles automatically, and lets the audience view these from their own device in over 60 different languages. Such a tool can be useful not only for pupils with English as an additional language, but also for pupils who may be deaf or hard of hearing. Additionally, text-to-speech applications could also support those with a visual impairment or dyslexia, ensuring all learners have full access to the curriculum (33).

While there is significant potential for AI to support with inclusion, a recent survey by UNESCO showed that only 4 countries globally (China, Jordan, Malaysia, and Qatar) reported that their governmental agencies have approved and recommended AI-assisted tools to improve access for learners with additional support needs (33). As such, there needs to be an increased focus on how this technology could be used to support inclusion, and what tools would be most suitable for this.

Promoting collaboration and team building

Research suggests that students are more likely to cheat on assignments when they perceive there is a pressure to achieve a high grade or outperform their peers (34). With the move to AI, teachers can avoid potential misuse of this technology by shifting away from perceived competition to collaboration.

AI itself can be a useful tool for encouraging pupils to work as a team in the classroom. Indeed, research suggests that using AI in the classroom can encourage collaborative learning and enhance peer communication skills. For example, NLP engines such as ChatGPT can be used to request for distinct scenarios for children to collaborate and solve problems – enabling them to learn from one another. We gave ChatGPT a prompt to generate group discussion questions about the rainforest that were targeted towards 10-year-old pupils:



Once the discussion questions have been generated, the software can continue to be prompted for further information as each group requires to brainstorm ideas, and to discuss the pros and cons of any decisions they make within the task. This use of AI will change the focus of the lesson away from achieving a certain grade and toward working effectively as a team and expanding their knowledge.

As mentioned previously, AI technologies have their own limitations that users must be aware of. For example, AI is unable to adopt human abilities such as regulating and experiencing emotions such as negotiation, empathy, or conflict resolution (32). These tools can therefore support the

development of social skills that are necessary for collaboration with peers – something that will be increasingly more important as AI is adopted more frequently for automated tasks.

Monitoring learning and performance

It is predicted that as AI technology becomes increasingly more embedded in education, learning analytics will be used more frequently to assist with monitoring children and young people's learning. Learning analytics can be defined as the measurement, gathering, analysis and reporting of data about pupils and the classroom environment (35). This can allow teachers to capture and analyse pupils' learning activity to understand how this can be optimised. This data can be used for descriptive purposes, such as for visualising and tracking pupils' progress, attendance, or performance in assessments. Alternatively, AI tools can be applied to this data to make predictions. For example, learning analytics could be applied to develop warning systems that flag those who may need additional support in a subject (16). It can also be used to combine data from various sources to identify who might be at risk of dropping out, not attending class, or failing in a course, and suggest actions that can be taken to remedy this (36).

Further, learning analytics can be used to support adaptive learning, whereby resources and materials are distributed to pupils individually based on their level of understanding of a subject and unique interests (37). Many learning platforms such as Duolingo and Khan Academy's tutoring bot Khanmigo already take this approach to provide learners with a more personalised experience and ensure the materials they access are suitable for their level of learning.

How can AI enhance teacher workloads?

An emerging area in the literature relates to how AI could be used to enhance teacher workloads. This is broadly expressed in two ways; 1) saving time and 2) shifting time. These two ideas are interconnected as the saving of time is often presented as freeing up time for activities that are more impactful on learners.

Saving Time

Within a teacher's workload, tasks such as grading, designing resources, and producing assessment materials are considered some of the most time-consuming aspects of teaching, which can take away time spent engaging directly with students. This section will provide a summary of both current applications that can be used by teachers, and predictions of how this technology could save time in future years as it continues to evolve.

Computer scientists have highlighted AI as a potential tool for designing automated grading systems – also known as 'autograding' (38). These applications operate through producing algorithms that can be applied to pupils' assessments and coursework. Such tools could not only reduce teacher workload so they can spend more time interacting with their class, but also allow for a quick turnover of grades so that pupils receive immediate feedback on their work – which is often recognised as one of the key components of successful learning (39).

Autograding has already been adopted in several countries worldwide. In China for example, 1 in 4 schools now use autograding platforms that can assess coursework at almost the same level as teachers (40). Twenty-one states in the US have now also shifted towards autograding systems, with no intention of returning to grading by hand (38). This suggests autograding could become increasingly more common across the globe as these systems continue to develop and become more effective at providing instant feedback to children and young people.

The use of autograding may not be available in Scotland, but AI can be used to assist with the design and production of classroom resources and materials. Although teachers will remain the

director of these, AI applications can be used to cut down on the time it may take to generate resources that are engaging and provide pupils with a better understanding of the subject material.

When generating questions for assessments or everyday classroom activities, NLP engines can be used to instantly generate as many questions as required based on a template it has been trained on. By providing applications such as ChatGPT with prompts related to the learning goals and success criteria of the class, they can instantly generate and regenerate as many items as the teacher requires. ChatGPT can also be used for creating close ended questions, through randomly generating questions based on the specifications provided by the teacher. For example, ChatGPT can create suggestions for spelling words, multiplication problems, or equations, based on the learning stage of the pupils, and the type of words the teacher wishes to assess.

AI can also be applied to create instant images that teachers know and want to apply to their lessons but are unsure of where to find these. For example, Craiyon is a text-to-art generator that uses AI to produce images based on any prompt it is provided with. Rather than continuously searching for the exact picture in mind, apps such as these are an effective alternative that can produce the outputs teachers require straight away.

In addition to assisting with designing lesson plans and coursework materials, AI can also be a practical tool for more timely and effective communication between students. Software such as PowerAutomate (which is already available for those with a Glow account) can be used to automate communications across email, teams, forms, and SharePoint to ensure pupils receive the right information at the right time, without teachers having to spend long periods of time on these administrative tasks each week. For example, this can include sending posts between teams channels, distributing emails or resources based on students' results on a forms quiz, or creating an assessment calendar for teachers to organise across departments.

Shifting Time

Through using AI to assist with lesson planning, grading, and producing learning materials, teachers should see a shift in the volume of time they spend on administrative duties, compared with academic time that focusses on the needs of individual pupils (41). This section will cover how teachers can use their time with AI effectively to maximise the benefits of this technology, and provide them with more capacity to engage with learners.

When using AI to support with creating classroom materials, teachers will remain the director of these resources through their own expertise and ability to critically evaluate any outputs it produces. Indeed, this technology can be prone to error and as such should only be used in areas that teachers know deeply and where they are able to spot any mistakes (42). Through using curricular frameworks and success criteria however, software such as ChatGPT can effectively create lesson plans, assessments, or coursework that meets the needs of pupils and saves teachers time to focus on engaging with their class.

As mentioned previously in the section 'Monitoring Learning and Performance,' the use of adaptive learning systems can support the differentiation of learning materials that match each pupil's age and stage of learning. These systems can also be complemented with the use of learning analytics by enabling teachers to track pupils' progress in assessments and coursework without having to spend long periods of time entering data by hand or analysing this by themselves. With this free time, teachers can explore the data produced by AI systems to predict performance in future assessments and prioritise those in need of extra support. It can also reduce the number of repetitive tasks within their day-to-day routines so that their skills can be optimised within the classroom, and generate more evidence to support the feedback teachers provide to each pupil.

For example, applications such as quizalize can be used by teachers to assess pupils' learning and monitor their progress over time. This tool uses ChatGPT to create quizzes from scratch,

through templates on Google Forms. Teachers also have access to a bank of quizzes readily available on the platform from a wide range of subject areas, which can be completed by students on their own devices in the classroom. Additionally, this platform uses learning analytics within its mystery dashboard, by providing live results of how pupils performed, and who may require more support. Based on these results, the platform will then assign new quizzes that are altered to their level of understanding, as they continue to monitor their learning over time.

What are the challenges and risks posed by AI?

While AI has the potential to support learning and teaching in the classroom, there are a number of ethical issues that both teachers and pupils must be aware of before using this technology in the classroom. International organisations such as the OECD have called for greater transparency and explanability of AI to better understand their systems and societal impacts (8). This section will cover some of the most important issues that need to be considered, and how teachers and learners can both use this technology responsibly and keep themselves safe while doing so.

Bias

As AI technologies make predictions and produce content through analysing information from a large set of data, this will ultimately reflect the type of data it is provided with (7). Indeed, AI algorithms largely reflect the values of their creators, who tend to be in positions of power and hold societal biases across gender, race, class, and disability (43). Examples of this can be seen in everyday use of AI software, such as image generators that are more likely to produce characters who are white, older, and/or male when requested to create images of people in specialised roles, or who work in particular sectors (44). These biases can also have significant consequences, particularly when they are being used to make decisions in employment, healthcare, or admission to higher education (45).

With AI being used more frequently across sectors and industries – including education – teachers must make pupils aware of the biases that exist within these technologies. Additionally, this issue can be actively challenged, through broadening participation for everyone, and ensuring AI software, activities, and lessons are inclusive for all (46). By addressing the learning needs of under-represented groups in computer science including women, ethnic minorities, and those of a lower socioeconomic background, pupils can continue to contribute to and thereby influence these algorithms, to avoid them relying on historical and systemic stereotypes.

Privacy Concerns

AI technologies can track and monitor pupils' actions and performance to determine their progress and identify whether they require additional support (32). However, these technologies will collate large amounts of data on each pupil every time they engage, so the decisions they make become more refined over time. Therefore, pupils must be made aware of this before they start accessing this technology themselves. Indeed, with certain platforms such as ChatGPT, users might think they are simply talking to a real person rather than an NLP engine and pay little attention to ethical concerns such as data protection and confidentiality. This could become an even more significant concern as tracking systems may be used in the future to gather more detailed information that determines users' future thoughts and actions – leading to issues related to autonomy (43).
When teaching children and young people about AI, there needs to be a focus on accountability and transparency as opposed to simply enhancing their AI skills and abilities (46). This will prevent users from exposing excessive amounts of personal information and understand the differences between communicating with a human and engaging with AI software, as well as the precautions they need to take with this.

Accuracy

As mentioned previously, AI technologies are not infallible, and as such are prone to error. This can be seen in NLP engines such as ChatGPT, that will often create fake references to justify an argument they make. Challenges can also be seen through the exam results that took place in Scotland and the rest of the UK in 2020, where an algorithm was produced to predict what grades pupils would have received despite not sitting any exams (47). Although designed to prevent grade inflation, over 124,000 young people were found to have their results downgraded (48)– with a disproportionate number of these coming from more disadvantaged areas (49). This demonstrates that when using AI, teachers and pupils need to remain critical of this, especially when many of these applications are still under development.

Conclusion

The findings from this review demonstrate that any use of AI in education requires a human-centred approach. This means its use should be to expand and support pupils' learning as opposed to undermining, disrupting, or replacing key components of the curriculum. By viewing AI as a tool, it has the potential to be integrated with other technologies in the classroom to create an inclusive learning environment and maximise teachers' time with pupils. All educators must have a clear understanding of the risks that must be considered however, to support pupils with using this technology safely, and ensure they are prepared for the digital future. This includes not only the risks to privacy and confidentiality, but also an awareness of any bias or inaccuracies within the content it generates.

After reading this review, we recommend viewing the 'AI toolkit'. In line with the content of this review, the toolkit contains a bank of evaluative questions grouped under the same sections to allow you assess and reflect your own understanding of this technology, and what this would mean for your class moving forward. There are also a number of resources cited in the toolkit that can be used by both teachers and pupils, as well as additional sources that can be explored for further reading.

Appendix 1: Scoping Review Methodology

This scoping review followed a six-step process. Firstly, we began by specifying an overarching review question to direct our search for literature. We were most interested in understanding what impact artificial intelligence might have on education and what potential benefits/challenges could it bring. Secondly, we quickly identified relevant literature from academic and non-academic sources. This ranged from academic systematic reviews to policy documents and media opinion pieces. Thirdly, we identified primary and secondary themes from each of our articles and also rated their credibility on a 3 point scale which essentially moved between opinion pieces at the lowest end of the scale to more robust academic papers at the higher end. In total 33 articles were reviewed. Fourthly, the two researchers working on this review independently produced a thematic map of our data. After comparing our individual maps, we produced a final outline. Fifthly, we co-wrote the review to present an overview of the key areas of discussion in this field. Finally, our colleagues within the West Partnership provided feedback as practitioners. This focused on ensuring the review was accessible.

Appendix 2: References

1. **Russel Group.** *Russell Group principles on the use of generative AI tools in education.* 2023.
2. *Artificial Intelligence in Education: A Review.* **Chen, L, Chen, P and Lin, Z.** 2000, Ieee Access , pp. 75264-78.
3. *Eye-tracking and artificial intelligence to enhance motivation and learning.* **Sharma, K, Giannakos, M and Dillenbourg, P.** 2020, Smart Learning Environments, pp. 1-19.
4. *AI technologies for education: Recent research & future directions.* **Zhang, K and Aslan, A B.** 2021, Computers and Education: Artificial Intelligence, p. 100025.
5. **Scarff, Robbie.** Artificial Intelligence and Education. *The Scottish Parliament.* [Online] 31 May 2023. https://www.scotlandfutureforum.org/artificial-intelligence-and-education/.
6. **Hu, Luhui.** Generative AI and the Future. *Medium.* [Online] 10 August 2023. https://pub.towardsai.net/generative-ai-and-future-c3b1695876f2.
7. *Education in the Era of Generative Artificial Intelligence (AI): Understanding the Potential Benefits of ChatGPT in Promoting Teaching and Learning.* **Baidoo-Anu, D and Ansah, L O.** 2023, SSRN.
8. *Conceptualizing AI literacy: An exploratory review.* **Ng, Tsz Kit and Leung, Jac Ka Lok.** 2021, Computers and Education: Artificial Intelligence 2, p. 100041.
9. **Manyika, J, et al.** *Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages.* 2017.
10. *Using Early Childhood Education to Bridge the Digital Divide.* **Daugherty, L, et al.** 2014, Rand Corporation.
11. *Inclusive AI literacy for kids around the world.* **Druga, Y k, et al.** 2019, Association for Computing Machinery.
12. *Conceptualizing AI literacy: An exploratory review.* **Ng, DT, et al.** 2021, Computers and Education: Artificial Intelligence 2, p. 100041.
13. **Dignum, V.** *Responsible artificial intelligence: How to develop and use AI in a.* s.l. : Springer Nature, 2019.
14. *Trustworthy Artificial Intelligence (AI) in Education: Promises and Challenges.* **OECD.** 2020.
15. *Demystifying computational thinking.* **Shute, V J, Sun, C and Asbell-Clarke, J.** s.l. : Educational Research Review, 2017, Vol. 22.
16. **OECD.** *TRUSTWORTHY ARTIFICIAL INTELLIGENCE IN EDUCATION: PROMISES AND CHALLENGES.* 2020.
17. **UNESCO.** How can artificial intelligence enhance education? [Online] 2019. https://www.unesco.org/en/articles/how-can-artificial-intelligence-enhance-education.
18. —. *Beijing Consensus on Artificial Intelligence and Education.* 2019.
19. *). Can computational thinking help.* **Rodrigues, R S, Andrade, W L and Campos, L M.S.** s.l. : Frontiers in Education Conference, 2016.
20. **Kafai, Y B and Burke, Q.** Connected code: Why children need to learn programming. s.l. : MIT Press, 2006.
21. **Johnson, Arianna.** ChatGPT In Schools: Here's Where It's Banned—And How It Could Potentially Help Students. *Forbes.* [Online] 31 January 2023.
22. *Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation.* **Yang, Weipeng.** 2022, Computers and Education: Artificial Intelligence, p. 100061.
23. *Revolutionizing education with AI: Exploring the transformative potential of ChatGPT.* **Adiguzel, T, Kaya, M H and Cansu, F K.** 2023, Contemporary Educational Technology, p. 429.
24. **Howell, C W.** Don't Want Students to Rely on ChatGPT? Have Them Use It. *Wired.* [Online] 6 June 2023. https://www.wired.com/story/dont-want-students-to-rely-on-chatgpt-have-them-use-it/.
25. **University of Sydney.** Prompts to help you learn. *AI in Education.* [Online] 2023. https://canvas.sydney.edu.au/courses/51655/pages/prompts-to-help-you-learn-2.
26. *Motivational Perspectives on Student Cheating: Toward an Integrated Model of Academic Dishonesty.* **Murdock, T B and Anderman, Eric M.** 2006, Educational Psychologist, pp. 129-145.

27. *Providing proactive scaffolding during tutorial dialogue using guidance from student model predictions.* **Albacete, P J, et al.** s.l. : International conference on artificial intelligence in education.
28. *Educational use of Voice Assistants and Smart Speakers.* **Tsoukaras, Thanasis.** 2021, Journal of Engineering and Science Review, pp. 1-9.
29. **Ali Abdaal.** The Feynman Technique. *Aliabdaal.* [Online] 10 August 2023. https://aliabdaal.com/the-feynman-technique/.
30. *Kids making AI: Integrating machine learning, gamification, and social context in STEM education.* **Sakulkueakulsuk, B, et al.** 2018, IEEE International conference on teaching, assessment, and learning for engineering .
31. *One game does not ft all. gamifcation and learning: Overview and future directions.* **Caporarello, M M and Pennarola, F.** s.l. : Organizing for digital innovation, 2019.
32. *Learning design to support student-AI collaboration: perspectives of leading teachers for AI in education.* **Kim, J, Lee, H and Cho, Y H.** s.l. : Education and Information Technologies, 2022.
33. **Miao, Fengchun and Holmes, Wayne.** *Guidance for generative AI in education and research.* s.l. : UNESCO, 2023.
34. *Changes in self-reported academic cheating across the transition from middle school to high school.* **Anderman, Eric M and Midgley, Carol.** 2004, Contemporary Educational Psychology.
35. *Artificial Intelligence and Learning Analytics in Teacher Education: A Systematic Review.* **Salas-Pilco, Sdenka Zobeida, Xiao, Kejiang and Hu, Xinyun.** 8, s.l. : Education Sciences, 2022, Vol. 12.
36. *Artificial intelligence in education: A review.* **Chen, L, Pingping, C and Zhijian, L.** 2020, Ieee Access 8, pp. 75264-75278.
37. *AI technologies for education: Recent research & future directions.* **Zhang, K and Aslan, A B.** 2021, Computers and Education: Artificial Intelligence, p. 100025.
38. *AUTOGRADING IN EDUCATION USING ARTIFICIAL INTELLIGENCE.* **Zatsarenko, R, Bruce-Gardyne, Otto and Koo, Timothy.** 2021, Oxjournal.
39. *Provision of Feedback During Preparation For Academic Testing: Learning Is Enhanced by Immediate But Not Delayed Feedback.* **Dihoff, Roberta E, et al.** 2004, The Psychological Record, pp. 207-231.
40. **Wiggers, K.** Chinese schools are testing AI that grades papers almost as well as teachers. *VentureBeat.* [Online] 2018. https://venturebeat.com/ai/chinese-schools-are-testing-ai-that-grades-papers-almost-as-well-as-teachers/.
41. *Academic and Administrative Role of Artificial Intelligence in Education.* **Ahmad, S F, et al.** 2022, Sustainability.
42. *The role of the teacher and AI in education.* **Felix, C V.** s.l. : International perspectives on the role of technology in humanizing higher education, 2020.
43. *Artificial intelligence in education: Addressing ethical challenges in K-12 settings.* **Akgun, S and Greenhow, C.** s.l. : AI and Ethics, 2021.
44. **Thompson, T J and Thomas, Ryan J.** Ageism, sexism, classism and more: 7 examples of bias in AI-generated images. *The Conversation.* [Online] 2023. https://theconversation.com/ageism-sexism-classism-and-more-7-examples-of-bias-in-ai-generated-images-208748.
45. **Denisun, George.** 4 Shocking AI Bias Examples. *Prolific.* [Online] 2023. https://www.prolific.co/blog/shocking-ai-bias.
46. *Conceptualizing AI literacy: An exploratory review.* **Ng, D T, et al.** 2021, Computers in Education: Artificial Intelligence.
47. **Seith, E.** 12 key messages from experts who explored SQA debacle. *TES.* [Online] 2020. https://www.tes.com/magazine/archive/12-key-messages-experts-who-explored-sqa-debacle.
48. **Carrell, S.** SQA under fire after downgrading 124,000 predicted exam results. *The Guardian.* [Online] 2020. https://www.theguardian.com/uk-news/2020/aug/04/sqa-under-fire-after-rejecting-124000-exam-recommendations.
49. **McEnaney, J.** Poorest Scots schools hit four times harder in SQA results scandal. *The National.* [Online] 2020. https://www.thenational.scot/news/18802660.revealed-poorest-scots-schools-hit-four-times-harder-sqa-results-scandal/.