Jisc

AI in tertiary education

A summary of the current state of play

April 2021

Contents

1 Introduction

Artificial intelligence (AI) is transforming the world and education is no exception. In 2019, $3.67bn was invested in AI edtech start-ups, up from $2.89bn in 2018[1]. AI education solutions are attracting this investment because they offer considerable benefits to learners, teachers, and education institutions.

AI can transform students' education outcomes – for example, by providing a personalised learning experience that improves social mobility and student wellbeing.

AI-powered personalised learning could support every learner to choose the right education for their career pathway, reach their highest potential and acquire the skills required to thrive in a digital workplace. Data is often the critical foundation for this kind of change and AI projects are likely to build on existing innovations such as learning analytics.

This has never been more important than as colleges and universities emerge from the Covid-19 pandemic into a world where technology will play a greater role in the delivery of education, and the demand for digital skills from both employer and students alike, has increased.

This report has two main aims: to summarise the types of AI applications that are available in education today and to provide a number of case studies where they have already demonstrated impact.

We also consider legal and ethical issues and briefly speculate on what AI applications might be available in the near future. There is, of course, much discussion about whether automation or use of AI for any given task is in any way desirable. For example, AI can be used to automate or semi-automate marking. This could be considered an inappropriate use of the technology, with marking being a key dialogue between the learner and teacher. This debate is outside the scope of this document. Here, we simply aim to describe what is currently possible, explain briefly how it works and, where we can, give evidence about its effectiveness and maturity.

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[1] https://markets.businessinsider.com/news/stocks/2019-global-edtech-investments-reach-a-staggering-18-66-billion-1028800669

2 What is AI?

2.1 Definitions of AI

There is no standard definition for artificial intelligence. It is usually defined around how the user would perceive what is happening, for example:

> "Theories and techniques developed to allow computer systems to perform tasks normally requiring human or biological intelligence"[2]

The terms AI and machine learning are often used interchangeably, although machine learning is really a particular field of AI. However, almost all AI applications today are built on machine learning, so we will investigate that in a little more detail.

Jisc has created a site, ExploreAI[3], that contains a range of AI demos. This is a good place to start if you want to experiment with AI and explore the possibilities.

2.2 Machine learning

Machine learning is one of the main techniques used to perform tasks intelligently. Originally it had a fairly broad definition around computers learning without human intervention, although now it tends to refer to a fairly specific set of statistical techniques aiming to spot patterns in data and then perform actions based on these patterns.

Typically, a system is provided with a training set of data from which a model will be created, and this will be used to perform a task on new data. It will usually use a statistical method such as neural networks, decision trees or logistic regression.

Any machine learning model is only as good as the training set and, importantly, will replicate any bias within the training set.

The systems we consider below nearly all use machine learning, whether it's to extract meaning from text or predict something based on available data.

2.3 Narrow vs general AI

All AI that we use today is considered 'narrow AI'. This is an AI solution that is trained to complete one specific task whether that is play a game, translate text, identify a face or predict student success.

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2   The Dstl Biscuit Book: *Artificial Intelligence, Data Science and (mostly) Machine Learning* 1st edition revised v1_2
3   https://exploreai.jisc.ac.uk

Most people believe 'general' or 'strong' AI, ie an AI solution that can undertake any task, is a very long way off. This report therefore only considers the kind of narrow AI solutions that we see today.

2.4 Everyday AI

AI tools are all around us, and many tools that we use in education and take for granted are built on AI, including search engines, grammar checkers, voice transcription services and so on. In this report we are going to focus more on tools that are specific to education.
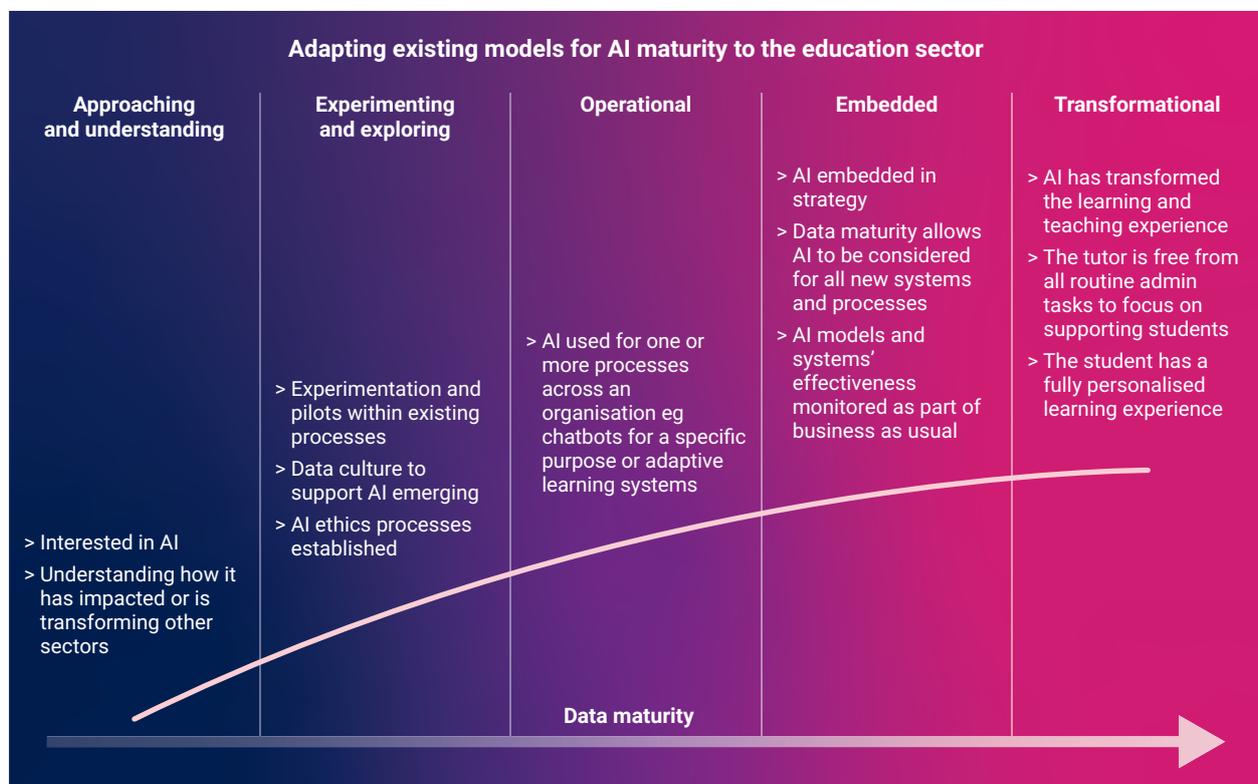
3 AI maturity

Maturity models can help us understand emerging technology. For example, they are well established in the analytics space and proved helpful in discussing learning analytics. A typical data maturity model looks like this:

Descriptive > Diagnostic > Predictive > Prescriptive

A number of maturity models for AI have been proposed, including by Microsoft[4] and Gartner[5]. These follow a similar pattern, with the early stages regarding understanding and experimentation, moving towards AI as part of business as usual and onwards to AI transforming the business or area of activity. We have taken aspects of these types of models to show what an education-focused maturity model might look like.

Adapting existing models for AI maturity to the education sector

Approaching and understanding	Experimenting and exploring	Operational	Embedded	Transformational
			> AI embedded in strategy > Data maturity allows AI to be considered for all new systems and processes > AI models and systems' effectiveness monitored as part of business as usual	> AI has transformed the learning and teaching experience > The tutor is free from all routine admin tasks to focus on supporting students > The student has a fully personalised learning experience
		> AI used for one or more processes across an organisation eg chatbots for a specific purpose or adaptive learning systems		
	> Experimentation and pilots within existing processes > Data culture to support AI emerging > AI ethics processes established			
> Interested in AI > Understanding how it has impacted or is transforming other sectors				

Data maturity

Most education institutions in the UK are at the early stages in the maturity model, looking to understand how AI can be used and what its potential is. We also see a small number of institutions with embedded AI-driven services. Examples of this include Bolton College's Ada chatbot, which has formed part of the college's service for around three years, and Basingstoke College of Technology (BCoT) where AI services, including CENTURY Tech's adaptive learning system, have been used since 2018. Outside the UK we have seen signs of AI-driven services supporting transformational changes. For example Arizona State University has been using an adaptive learning platform, CogBooks, since 2014. We have seen even more significant transformation in China, such as SquirrelAi, which is providing AI-driven learning at scale and has opened more than 1,700 schools and has 3,000 teaching staff in more than 200 cities in China.[6]

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4 https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE4DIvg
5 gartner.com/en/documents/3982174/artificial-intelligence-maturity-model
6 http://squirrelai.com/our-story

4 What role is AI taking?

It's worth considering what role we want the AI system to play in the teaching and learning experience. It might seem obvious that the aim is to support the teacher rather than replace them and this is the direction that is most often discussed. However, it could be argued that earlier attempts to use AI for education were actually trying to replicate or replace the teacher. This is most often seen in *adaptive learning* or *intelligent tutor* systems, where AI is determining the learning activities for the student, including delivery and providing feedback – activities that are more often associated with the teacher.

Recently we have seen tools take more of a supporting role, aiming to assist the teacher or the learner rather than to control the whole process.

As we noted in the introduction, personalisation is a potential goal and it's worth briefly considering what this could mean. Here are some examples:

Potential use of AI	Description of use
Personalisation of route through a programme of study	AI suggests module courses and ordering based on prior learning, interests and career goals
Personalisation of route through an individual course	AI guides you through an individual course, showing more or less material based on your learning progress. This is usually considered adaptive learning
Personalisation of content	AI produces content within a course, tailored to your needs. This could be to support a disability, to recommend additional material, or to provide very personalised feedback
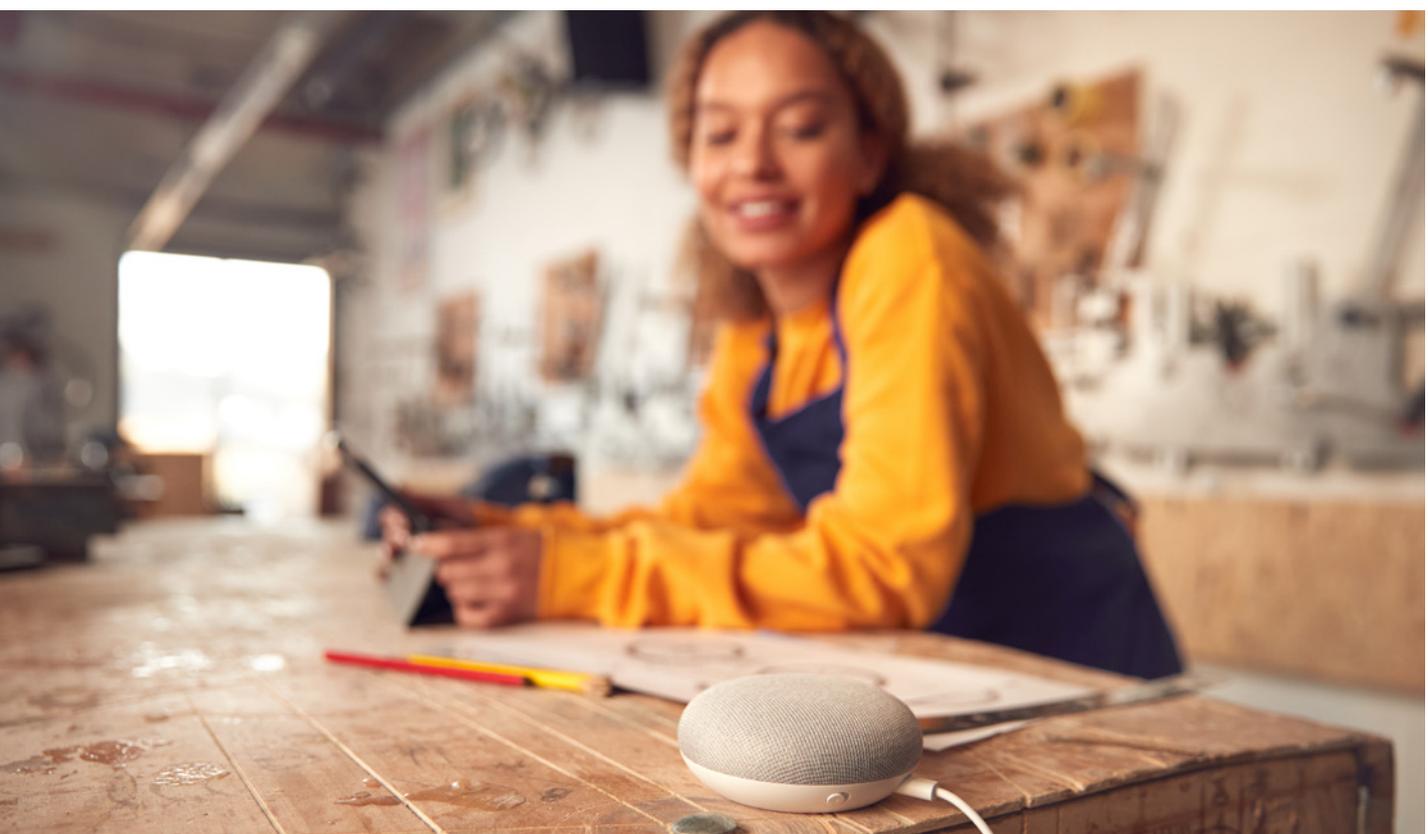
5 Examples of AI in tertiary education today

5.1 Chatbots and digital assistants

Chatbots and digital assistants are related technologies, and the terms are often confused or used interchangeably. There is no formal definition of either, and they share very similar technology at their core – the ability to understand a question from a human in spoken or written form and act on it.

The most common explanation of the difference is that a chatbot aims to perform a fairly narrow task, such as answering a customer query, and typically sits somewhere like a company or institution's website. A digital, intelligent or virtual assistant, such as Siri or Cortana, is a general-purpose assistant that can carry out a range of tasks and is built into a smart speaker or phone.

Chatbots are a relatively mature application of AI and they are used in many domains. The AI aspects of chatbots include the ability to understand speech (natural language processing [NLP]) and use of machine learning models to match the intention of the question to answers or actions.

Typically, a chatbot interface will sit on a website and a user will type questions, then the system will either answer or ask further clarification questions. We often see a hybrid model in scenarios such as customer support, where simple or initial questions are answered by the chatbot but a human picks up the conversation for more complex dialogue.

In reality, there is no clear dividing line between chatbots and assistants and, in an education context, an application with a chat and voice interface that can carry out a range of actions relating to a college or university could be described as either a chatbot or a digital assistant. Generally, the wider the range of functions, the more likely it is to be considered a digital assistant.

5.1.1 How chatbots work

There are many providers of chatbot services. These range from services by the major cloud providers (who offer tools that allow developers to create their own chatbots more easily by handling the natural language elements) to dedicated chatbot creation tools. Nearly all these tools share common aspects:

> **Intents**: This is the intention of the user in asking the question – ie what they want to achieve

> **Example questions**: Examples of ways the user may ask the question

> **Data slots**: Additional data that might be needed to answer the question

For example:

> **Intent**: "Find out library open times"

> **Example questions**: "What time does the library open?", "When is the library open?", "What are the library open times?"

> **Example questions with a data slot**: "What time does the library open on *<<day>>*?", "Tell me when the library opens on *<<day>>*?"

The chatbot creator would provide the chatbot with a number of intents, example questions and data slot requirements. Then the system would train a model so that, when the user asked a question, it could match it to an intent even if the question wasn't phrased in a way that exactly matches one of the example queries. The chatbot system could retrieve the answer from the database and respond to the user.

5.1.2 Examples

Bolton College has developed a service called Ada[7], which uses chatbot technology to provide students with an assistant to answer questions about the college, as well as personalised responses to questions such as "what is my timetable?", and "what are my grades?". It could be argued that the ability to answer a range of questions with personalised responses makes it more a digital assistant than a pure chatbot.

Using AI and chatbot technology, Leeds Beckett University's Becky provides an instantaneous response to prospective students through clearing. Becky was developed (in two months and for £30 initially!) to provide a better experience for clearing students by allowing them to be made an offer via an online channel. The development was based on research that showed the target student audience is largely uncomfortable talking to universities on the phone. Becky takes the user through the whole application process, including making offers[8].

At its introduction in September 2017, 89 students who were made an offer via the chatbot then enrolled, which represents a 46.6% conversion of offers to enrolment. This compared to a general conversion rate of 26%. The university estimated a return on investment in Becky representing £2.4m in tuition fees.

Keele University has also introduced a clearing chatbot. Prospective students can use this to find out more information about the university. The chatbot will answer FAQs and provide information about accommodation, open days, grade requirements and courses.

5.2 Adaptive learning systems

We often see references to adaptive learning and personalised learning but use of these terms varies, particularly around adaptive learning.

Adaptive learning system: There is a class of systems known as 'adaptive learning systems' or 'intelligent tutor systems'. These are fairly specific types of system that change the pace, order or level of the learning based on some algorithm.

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7 jisc.ac.uk/news/chatbot-talks-up-a-storm-for-bolton-college-26-mar-2019
8 leedsbeckett.ac.uk/blogs/student-blog-squad/2020/07/how-i-used-becky-the-chatbot-to-apply-through-clearing

Adaptive learning: We will sometimes see *adaptive learning* used to describe adapting any aspect of the learning experience to suit the learner. In this case it is not referring to a specific class of system but rather the overall aim or design of the learning experience.

Adaptive learning systems are some of the most mature AI-based education technology systems and have been shown to be very effective in some domains. However, they are not suitable for all types of courses or domain areas. They are most suitable when the domain knowledge can be very clearly defined and can be learned in a step-by-step way.

These systems are usually self-contained online systems, where the learner takes the course at their own pace.

Typically, the learner will be presented with a learning activity, which may be reading material, an activity or a video. Then, their understanding of a portion of the knowledge will be evaluated, for example via a test, and then they will be guided onto the next step based on the result of the test.

5.2.1 How adaptive learning systems work

These systems are often considered to have three parts:

> *A domain model* – a representation of the knowledge within that domain, including connections between the knowledge. These are often based on a concept inventory

> *A learning model* – a representation of the current state of the learner's understanding of the topic. A system could, for example, include assumptions about a student's understanding based on previous learning and then update the data based on the results of assessments or how a student has tackled a test

> *A pedagogy or tutor model* – an underlying model determining what strategy will be used to help the student gain the knowledge

Within this type of system, the learner is working at their own pace and this can make incorporating group activities a challenge.

5.2.2 Examples

In 2014 the Arizona State University (ASU) School of Life Sciences began working with four adaptive learning vendors to explore new ways to help students learn. ASU faculty used different courseware across courses in biology, micro- and macroeconomics, history, mathematics, physics and psychology. Since then, they have developed the world's first adaptive learning biology degree. They first tried out the adaptive learning format on a problem area known for poor performance and high dropout rates: students taking biology courses to fulfil a science requirement for their degree course.

The textbook was replaced with an online experience delivered through BioSpine adaptive learning courseware provided by CogBooks, which is similar to a textbook but responsive to a student's needs. Staff link learning activities to the platform, which then allows students to progress through more challenging coursework when they are ready. If they need to, they can step back and get further support for work from a previous lesson.

"In its first semester, we saw student pass rates, in a nonmajors' biology 100 course called The Living World, improve by 24% and dropout rates reduce by 90%," CogBooks CEO Jim Thompson said. "This level of success from such a modest investment convinced us we were doing something right."

In the UK, Basingstoke College of Technology has been using CENTURY's AI solution, which creates an individual path for each learner with personalised learning steps. We look at this in more detail in a case study in section 9.

5.3 AI-assisted marking and feedback

AI-assisted marking software aims to help with marking beyond what has previously been possible with multi-choice software. Although the technology can be similar, there is a distinction between automated marking software (which aims to assist with providing a student with a grade or mark) and automated feedback software, which could be used to help the student with writing an assignment.

This is a relatively immature space, although several commercial software applications do offer automated marking features that can either provide the marker with an estimated mark to aid the process or release the mark directly to the student to automate it fully.

5.3.1 How AI-assisted marking and feedback systems work

There is no single approach to AI-assisted marking and/or feedback systems.

At its most basic level, this software will simply use a word-matching algorithm. This is only of value for very specific and – it could be argued – simple question types, and it would not be considered AI.

Other systems, such as Edgenuity, aim to mark longer-form answers by requiring a marker to mark a subset of the submitted work manually. Edgenuity uses this as training data to create a model which will recommend marks for other submitted work.

Another approach, such as the one being developed by Bolton College as part of its FirstPass[9] project, requires the tutor to provide model answers or phrases. The AI system then maps the student answer to the model answer. The FirstPass program uses this to give students feedback as they write their essay, although a similar approach could be used for assisted marking.

All such systems need to use a range of natural language processing techniques so there is no need to match the exact wording; instead, they match phrases, sentences or paragraphs with similar meaning.

5.3.2 Examples

China is experimenting with machine intelligence to mark essays on a large scale. According to the South China Morning Post[10], technology has been developed to interpret the general logic and meaning of the text in essays and is being implemented in a quarter of all schools, around 60,000 institutions. The platform undertakes a human-like judgment into an essay's overall quality and assigns a grade. The platform can also provide recommendations for improvement, selecting from categories such as writing style, sentence structure and overall theme.

9   theboltonnews.co.uk/news/18229981.bolton-college-leads-way-developing-automated-marking-technology

10 scmp.com/news/china/society/article/2147833/chinas-schools-are-quietly-using-ai-mark-students-essays-do

In the US similar projects have achieved success on a smaller scale. For example, online grading application Gradescope Complete[11], developed at the University of California, Berkeley and now owned by Turnitin, claims to reduce marking times by as much as 75%. One of the particular features is that the AI groups similar answers together so they can all be given a consistent grade at the same time.

Pearson has developed PTE Academic[12] and Versant[13] tests to provide unbiased, fair and fast automated scoring for speaking and writing exams. The AI is built on the foundations of consistent expert human judgments irrespective of where the students live or their accent, background or gender. PTE Academic is the only secure English language test for overseas students that is evaluated with the help of AI, and it is accepted by 98% of UK universities.

In January 2020 England's qualifications agency Ofqual set up a study and competition[14] to investigate the use of AI in marking. The ongoing study focuses on opportunities for improvement, not by replacing human judgement but by using AI to support markers in the role they play. The competitive element is to use a set of expertly marked and moderated papers to train various AIs and then test them against a further cohort of essays. AI used as a monitoring tool in this context could improve marking and consistency overall, and spot errors.

5.4 Other areas

We have focused on the use of AI to enhance learning and teaching, but it is also worth exploring other areas.

AI is already in use in tools aimed at ensuring academic integrity. For example, proctoring solutions for remote assessment make use of tools such as face identification, and AI is being used to help with tools to detect contract cheating (essay mills)[15].

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11 gradescope.com
12 https://pearsonpte.com/
13 pearson.com/english/versant
14 https://ofqual.blog.gov.uk/2020/01/09/exploring-the-potential-use-of-ai-in-marking
15 turnitin.com/blog/artificial-intelligence-and-machine-learning-at-turnitin

6 Potential uses of AI in education

There are a number of potential uses of AI that haven't progressed beyond proof of concept or the idea stage, or that have only limited relevance to our sector. These are some of the most promising:

6.1 Dialogue-based tutors

There have been several attempts to create dialogue-based tutor systems. These combine concepts from adaptive learning systems and chatbots with the aim of helping students learn through conversation rather than working through text or video-based content. Examples of these include AutoTutor and Watson Tutor.

The Watson Tutor is an intelligent tutoring system designed to improve student outcomes and engagement. It uses AI software building on IBM's Watson platform with learning and content expertise from Pearson Education. The Tutor creates an interactive dialogue in chat that replicates the questions and feedback responses of a good human teacher. The tutoring strategy is adaptive, so students are
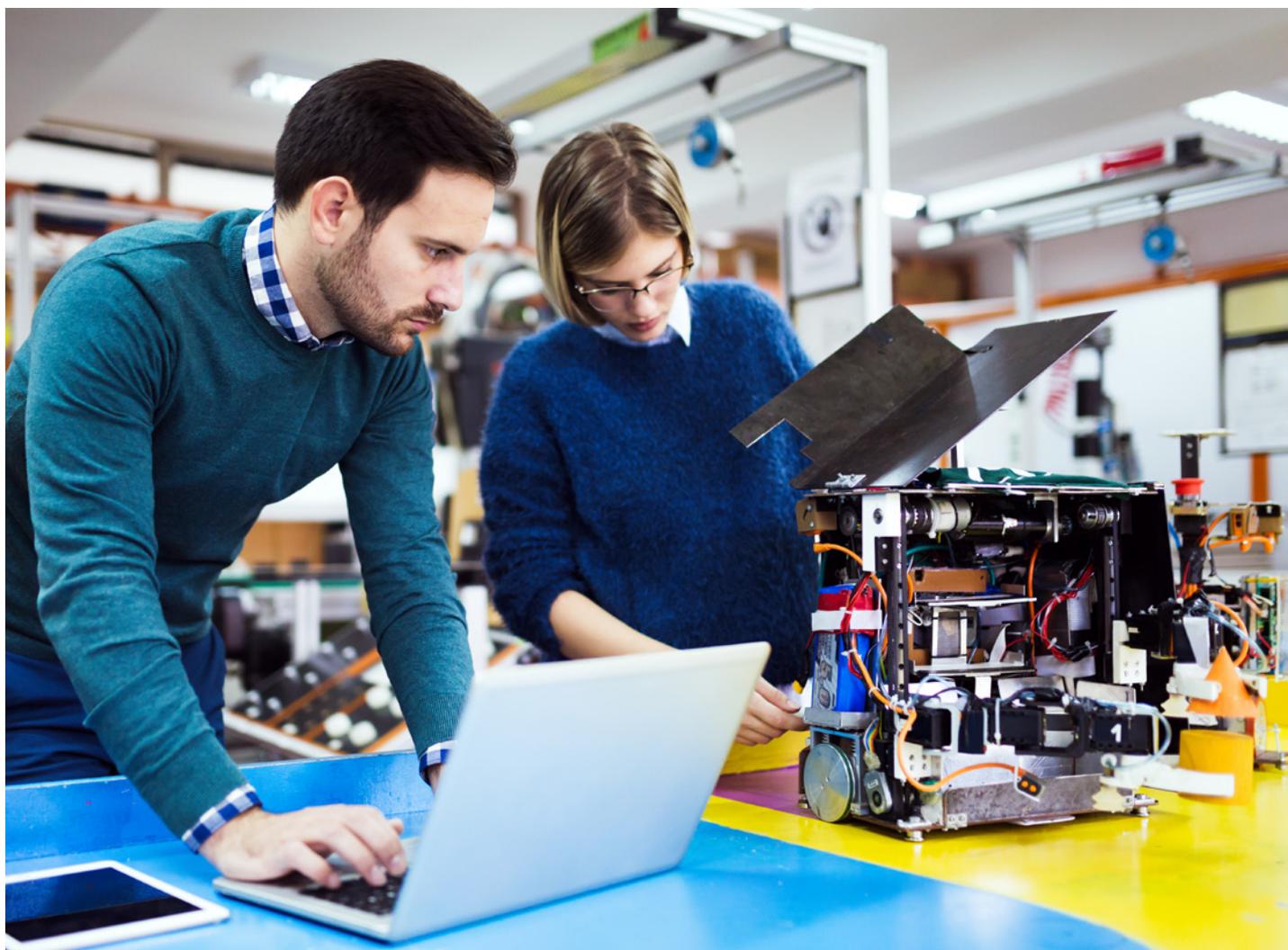
guided through different concepts using multiple learning activities, questions and hints depending on their mastery. Watson Tutor tracks each student's understanding of an objective using a mastery score, which is updated when assessing their answers. The developers found that students often anthropomorphised the Tutor, so they crafted its tone and personality to be genuine, engaging and non-judgmental. The framework for Watson Tutor is designed to scale up efficiently to a large number of domains. The first large-scale application[16] is augmented online textbooks on the Pearson Revel platform, across the domains of sociology, US government and public speaking. Thousands of undergraduate students trialled Watson Tutor on Revel in late 2018 and more than half of those surveyed said it helped them understand the content more than reading alone.

6.2 Collaborative learning with AI

A more speculative idea is the concept that AI could be used to support collaborative learning – for example, Holmes, Bialik and Fadel[17] suggest that AI could be used to aid group formation, moderate, or monitor groups, or participate as an active agent in group discussions. We have not seen any real-world examples of this, but it seems plausible given that it combines existing technologies[18].

6.3 Recommendation engines

We are all used to being provided with recommendations from AI-driven services on a daily basis, whether it's recommending purchases from shopping sites, films to watch on streaming services or books to read.

Recommendation engines are also used in academic settings. For example CORE,[19] the open access research paper service, uses a recommendation engine to suggest other articles to read.

Recommendation engines typically make their recommendations based on a combination of approaches known as collaborative filtering (what other similar people read) and connect-based filtering (other content that's similar). Such an approach could be used, for example, in a virtual learning environment (VLE) to personalise learning by recommending content from within the VLE. Such a system has been proposed by Monsalve Pulido[20] et al, where they propose modelling the student, the course, the resources and context to produce recommendations.

6.4 AI-assisted content creation

When looking at AI-assisted content creation we are not suggesting that AI solutions will soon be able to create courses from scratch. There is, however, a range of technologies that can be used to help with creating courses from existing material.

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16 researchgate.net/publication/333828640_INTERACTIVE_LEARNING_IN_A_CONVERSATIONAL_INTELLIGENT_ TUTORING_SYSTEM_USING_STUDENT_FEEDBACK_CONCEPT_GROUPING_AND_TEXT_LINKING

17 Holmes, Bialik and Fadel (2019) *Artificial Intelligence In Education: Promises and Implications for Teaching and Learning*

18 allerin.com/blog/how-ai-can-be-a-key-enabler-of-collaborative-learning

19 https://core.ac.uk/

20 emerald.com/insight/content/doi/10.1016/j.aci.2020.03.001/full

We are already seeing the emergence of AI-driven tools that create questions from existing content, such as Quillionz and Quizbot[21]. At Jisc, we have produced a simple example of this technology[22].

Content selection and summarisation tools are used in other fields. For example, Microsoft uses AI for its news aggregation services with AI tools that select and summarise news stories[23]. It is possible to see how these tools could be used to automate learning content in the same way.

Although it is more focused on corporate training, WildFire claims to be the world's first content creation service, automating the whole process of creating online learning courses. WildFire has been used to automate the production of 138 modules of learning, delivering this in eight weeks and at just 10% of the cost of more traditional methods[24].

6.5 Other ideas

So far in this section we have expanded on some of the most promising potential uses of AI in education, but it is worth briefly noting others.

There are a number of AI techniques that aim to understand human emotion. For example, sentiment analysis systems look at text and AI can be trained to detect emotion in human expressions and speech. Microsoft has considered how such tools could be used to measure the effectiveness of meetings[25] and it is likely that these kinds of tools will be built into videoconferencing solutions in the future. Education sector organisations need to start thinking and talking about what place (if any) these kinds of tools have in education.

Although we have focused on the use of AI to support learning and teaching we also need to consider what to teach and how AI is likely to affect the workplace and student employability. At a practical level, for example, AI is being used to read CVs[26] so students will need to understand and be prepared for this as they enter the workforce. Others have looked at this from a much broader perspective, for instance Rosemary Luckin considers how education can prepare humans with the skills they will need in an AI-augmented world[27].

21 https://learningtools.donjohnston.com/product/quizbot

22 https://exploreai.jisc.ac.uk/tool/question-generation

23 bbc.co.uk/news/world-us-canada-52860247

24 Clark, D (2020) *Artificial Intelligence for Learning: How to use AI to Support Employee Development*

25 bbc.co.uk/news/technology-55133141

26 bbc.co.uk/news/business-55932977

27 Luckin, R (2018) *Machine Learning and Human Intelligence: The Future of Education for the 21st Century*

7 Related technologies

7.1 AR and VR

Augmented reality (AR) and virtual reality (VR) are often mentioned when AI systems are considered, although there is no direct connection between them. There are few, if any, case studies in education today but we can see examples of how the technologies connect. For example, you can embed an avatar driven by chatbot technology in Amazon Web Services' Amazon Sumerian service, an example that can be seen on Jisc's explore AI website[28]. This could be used for training around customer support and other applications.

7.2 Robotic process automation

We also often see mention of robotic process automation (RPA). This is a technology to automate processes by use of 'bots', usually to automate data entry or processes directly via the user interface.

RPA itself isn't an AI technology but it might well have a place in AI projects – as an example, an admissions chatbot could use RPA to automatically book a place on an open day on behalf of prospective students. It's worth noting that RPA isn't the only way of achieving this – application programming interfaces (APIs) might be more appropriate.

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28 https://exploreai.jisc.ac.uk/tool/chatbots

8 Legal and ethical considerations

As with any use of new technology it's important to think about legal compliance and ethical considerations. These will vary across the range of AI techniques and applications: a chatbot is very different, both legally and ethically, from facial sentiment analysis. Here, we briefly summarise:

8.1 An overview of key activities and reports

As almost all AI includes some form of personal data, the General Data Protection Regulation (GDPR) is a key consideration and the Information Commissioner's Office (ICO) has produced guidelines aimed specifically at AI[29]. They cover the following areas:

> Accountability implications of AI
> Ensuring lawfulness, fairness and transparency in AI systems
> Assessing security and data minimisation in AI
> Ensuring individual rights in AI systems

There is some work aimed at producing AI guidance, especially around education. In the UK The Institute for Ethical AI in Education[30] has developed an ethical framework that will enable learners to benefit from artificial intelligence while also being protected against its risks. The Institute published **The Ethical Framework for AI in Education**[31] in March 2021.

A number of other groups are looking more broadly at AI and ethics, for example the EU High-Level Expert Group on Artificial Intelligence has two main deliverables:

> Ethics guidelines for trustworthy AI[32]
> Policy and investment recommendations for trustworthy artificial intelligence[33]

This group has produced the following principles in its guidelines report[34]:

> Respect for autonomy
> Prevention of harm
> Fairness
> Explicability

29 https://ico.org.uk/for-organisations/guide-to-data-protection/key-data-protection-themes/guidance-on-ai-and-data-protection/about-this-guidance

30 buckingham.ac.uk/research-the-institute-for-ethical-ai-in-education/

31 https://fb77c667c4d6e21c1e06.b-cdn.net/wp-content/uploads/2021/03/The-Institute-for-Ethical-AI-in-Education-The-Ethical-Framework-for-AI-in-Education.pdf

32 https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai

33 https://ec.europa.eu/digital-single-market/en/news/policy-and-investment-recommendations-trustworthy-artificial-intelligence

34 https://ec.europa.eu/futurium/en/ai-alliance-consultation

The Alan Turing Institute has produced a report 'Understanding artificial intelligence ethics and safety: a guide for the responsible design and implementation of AI systems in the public sector'[35] and defines AI ethics as 'a set of values, principles and techniques that employ widely accepted standards of right and wrong to guide moral conduct in the development and use of AI technologies.' They note the following as potential harm caused by AI systems:

> Bias and discrimination
> Denial of individual autonomy, recourse and rights
> Non-transparent, unexplainable or unjustified outcomes
> Invasion of privacy
> Isolation and disintegration of social connection
> Unreliable, unsafe or poor-quality outcomes

Institutions are also looking to embed AI ethics in research and teaching. This is noted as a priority, for example, by the Institute for Ethics in AI[36] at the University of Oxford.

Jisc has also produced a number of blog posts that delve into these areas in more detail[37].

8.2 AI and bias

Bias in AI is a significant topic. At its most basic level, the issue to consider is that machine learning models will usually replicate any bias found in their training set. So, for example, if a particular group of people were historically excluded from a particular activity, a model based on that data would more than likely continue to make discussions or recommendations that excluded that group.

8.3 Explainability and interpretability

Most people would agree it's highly desirable to be able to understand why an algorithm makes a particular decision, but this is not straightforward with many machine learning algorithms. With a traditional algorithm it is possible for a human to move through each step in the process and fully understand how it has arrived at an answer. The same is not always true for machine learning. While we might understand the training data and how the training works, we might well not be able to understand exactly why a particular output is decided, other than in a very abstract way. The detail of why this is the case and how it can be mitigated is outside the scope of this report, but it is an area to consider in any AI implementation. The kind of explanation required will vary between applications. Marking or resource allocation needs to demonstrate fairness in advance; a chatbot may need to report no more than how often it failed to deliver what users want.

35 turing.ac.uk/research/publications/understanding-artificial-intelligence-ethics-and-safety
36 schwarzmancentre.ox.ac.uk/ethicsinai
37 https://regulatorydevelopments.jiscinvolve.org/wp/tag/ethics

9 Case studies

9.1 Bolton College

Bolton College's Ada service is a general purpose digital assistant for students, teachers and campus support teams. Ada responds to general questions about the college and campus services, it responds contextually to students and teachers about their studies or work and it also responds to subject topic questions. With the support of the IBM Watson Assistant service Ada can answer a broad range of questions across the student lifecycle such as "what is my timetable?", "when does the library close?", "when is my next exam?", "is there a cash machine on the campus?", "I need some advice about writing a CV" and hundreds more for students, as well as questions such as "who is out on work placement next week?" for staff. The Ada service is available across multiple channels including the web, iOS and Android smartphone apps and smart speaker via the Alexa app.

Ada supports students and staff at the college with everyday questions, and it also supports a growing number of campus activities or workflows. These include nudging students about their studies or events on the campus, enabling the distribution of GCSE exam results and reminding managers when they are on the duty principal rota. As the Ada service develops it will also offer contextualised information, and advice and guidance that is tailored to the needs of individual students and teachers. For students this may include advice about the grade that needs to be achieved in a forthcoming assignment to maintain or increase their grade average.

Ada's ability to support teaching, learning and assessment is a major area for development at Bolton College. For instance, the Ada Goes To School platform takes advantage of crowdsourcing to bring together teachers across multiple vocational subjects to teach Ada about their subjects or industries. The platform enables teachers in different colleges to co-curate subject topic questions and answers for their vocational areas. The subject chatbot can then be embedded within the college's learning management system so students can garner on-demand information about subject topics to support their studies.

Recently, the college received support from Nesta as part of the Department for Education's EdTech Innovation Fund. The college is using it to support the development of FirstPass, an online service that supports teachers and students with the formative assessment of open-ended questions. The service is designed to analyse the freeform text responses that are entered by students and it is designed to offer real-time textual and graphical feedback to students as they compose their answers.

9.2 Cardiff and Vale College

Cardiff and Vale College (CAVC) is implementing a wellbeing chatbot co-created by students for students. This is one of 12 projects across Wales looking at mental wellbeing in further education. The student-focused and student-designed bot, Wellbot/ BotLles, is built in Microsoft Azure and deployed through Microsoft Teams. It is designed to use AI to help students with wellbeing, information and signposting, based on question-and-answer functionality with linguistic capability.

Following a successful bid for funding from the Welsh Government Digital 2030 fund, the college is also developing a personalised learning bot for GCSE English and Maths to help improve retention and attainment. Hannah Mathias, e-learning manager at CAVC told us: "It's really important to us that we are delivering a personalised and accessible end-user approach to everything we do. This is why we are seeing how effective bots can be at meeting the needs of our learners at scale."

The CAVC team are working with a Cardiff-based company, We Build Bots[38], to create a more sophisticated bot using machine learning to provide students with personalised content based on their achievements. The content will be tailored to their needs, focusing on elements they need to improve on following previous teacher-marked assignments. The chatbot will be set up to nudge them to complete further tasks and linked to a dashboard for the tutor so they can see how students are progressing.

9.3 University of Essex

Chart my Path is an extra-curricular opportunity wayfinder and personal development platform for students at the University of Essex. The platform is based on Gradintelligence, already used at Essex and elsewhere to offer the digital Higher Education Achievement Report (HEAR). The Big Essex Award is also hosted on Gradintelligence, as well as some extra-curricular programmes using it as a content management system. Therefore, building Chart my Path on Gradintelligence meant many students would already be familiar with the platform and its password-protected access model offers a simple route to personalisation of features on the platform.

The interface in the platform gives students a familiar Netflix-style navigation, breaking the opportunities into easily browsed blocks with headings such as 'top picks for you' and 'recently added'. There are also more bespoke pathways, encouraging students to try something new or different to develop their skills. They are arranged within an institution-specific framework called Essex Strengths, which addresses areas such as growing confidence, increasing curiosity, being bold, and getting global.

The activities recommended to students are related to data they've previously given the system, either through their enrolment information or via a behavioural survey. The recommendation engine that sits under the interface combines this initial data with data about what they choose to investigate through the platform or which actions they take to dynamically tailor the content further. The team are also building in the facility to improve recommendations based on content, so 'other students who followed a similar pathway to you also found this useful' type opportunities can be raised.

Currently the pilot system is live with students as development continues. Approximately 25% of Essex 2020/21 students have engaged with the platform and the team are starting to collect feedback to improve the interface and underlying recommendations. They are also spending a lot of time increasing staff awareness of the platform and the opportunities it offers them to host content to help students improve their skills.

The material on the platform is not accredited. However, students can build hours and pathways through the content that can lead them to the Big Essex Award, which is a verified extra-curricular qualification. There are also plans to build in self-assessment and reflection for the students on their journey to get them to capture and understand their personal development better.

9.4 Basingstoke College of Technology

Basingstoke College of Technology (BCoT) has been using AI in a significant way since 2018, initially using self-marking quizzes and creating their own systems to grade work more easily[39]. Investigating a more personalised approach and seeking ways to save time and workload for their teachers has led to working with and implementing AI and machine learning technologies designed by CENTURY Tech.
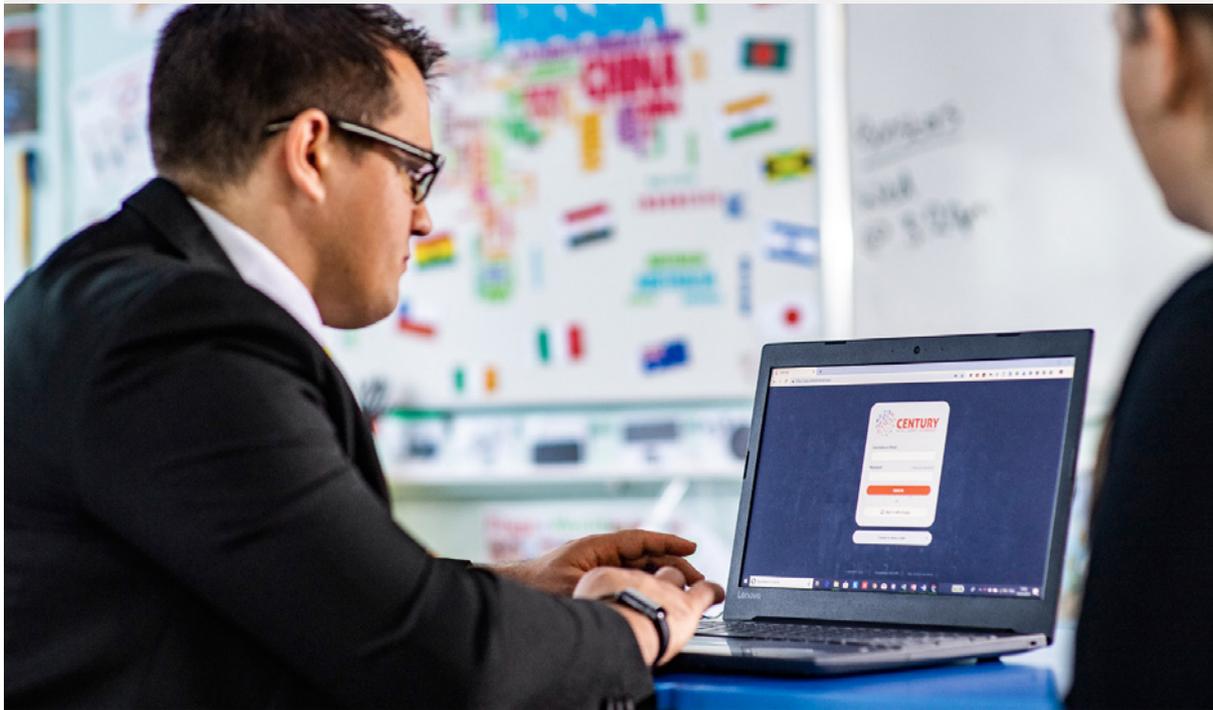
CENTURY's AI creates an individual path for each learner with personalised learning steps. The AI element is the adaptation of learning materials to strengths, weaknesses and behaviours, the data from which is accessible to teachers and parents. BCoT has implemented CENTURY since 2018 for English and Maths resit students, resulting in an increase in pass rates. CENTURY also automates the marking and planning process, saving time so teachers can focus on personal interventions with students.

When a student logs into their CENTURY dashboard they find a learner path allowing them to revise topics the AI has picked up as needing more focused intentional study, or that their teacher has set as a 'stretch and challenge activity'. The platform provides the student with learning materials (in the form of video animations and interactive activities). Data about when the student logs on, how long they spend on each question and what they have got correct and incorrect is all fed back to the teacher.

The AI has helped teachers give tailored learning where students are struggling. Scott Hayden, digital innovation specialist and media lecturer, told us: "AI has freed up time for a human, personal element that can never be automated. Teachers won't be replaced, but AI can enhance the craft of teaching."

There is a strategic drive at the college to engage and use new technologies as much as possible. For certain products the team has worked with developers on contextualising their use and adapting them for UK FE, as was the case with CENTURY Tech.

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39 jisc.ac.uk/news/pioneering-digital-approaches-to-raising-english-and-maths-standards-17-sep-2020

10 Summary

AI is already delivering real value in education. Internationally, this is evident with the use of CogBooks in Arizona State University or, at a much larger scale, SquirrelAi in China. In the UK, we are seeing early adopters successfully use AI services for the benefit of students and the provider, such as Bolton College's Ada and FirstPass; adaptive learning with CENTURY Tech in Basingstoke College of Technology; chatbots in Cardiff and Vale College; and recommendation engines at the University of Essex. We hope that by outlining these key AI educational technologies, this provides the context and ideas for colleges and universities to explore this further, but also recognise that AI adoption follows a maturity model, starting with understanding and experimentation.

We note that AI is not without its challenges, be those legal, ethical or technical, but it is clear there has already been much work that can be built on and used to help in addressing these challenges. Similarly, we know that the skills of teachers and education leaders in deploying such advanced technologies are to be considered in taking a strategic approach in the proliferation of AI. Jisc's Learning and Teaching Re-imagined project revealed that university leaders lack the information required to make decisions on new technologies and are cautious about investing in novel digital technologies. Teachers will need to understand AI and have the skills to use it effectively if AI is to become a mainstream technology.

We are confident that there are now foundations to enable further adoption of AI in colleges and universities but progress towards transformation of tertiary education would be slow if left to a few, scattered initiatives. Levelling up investment in AI on a national scale is required to realise and incentivise the full potential of advanced technologies in education delivery. This would also enable the Government to build back better through the successful delivery of key policy initiatives including the **Lifetime Skills Guarantee** and the recent **National AI Strategy**.

If you would like to follow our work in the areas covered in this report, please sign up to our **Jiscmail list** or visit the project page at **jisc.ac.uk/rd/projects/national-ai-centre**.

AI in tertiary education:
A summary of the current state of play
April 2021