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Foreword

Artificial Intelligence (AI) has the power to improve the educational experience for staff and learners alike. From chatbots and digital assistants to adaptive learning platforms and predictive analytics, carefully implemented, AI has real potential to help educators better understand and meet the needs of their learners.

Adopting AI can be a daunting challenge for institutions who lack the time, expertise and resources to explore its many uses. This is why Jisc is taking the lead in helping universities and colleges understand and leverage the benefits of AI as they focus on their digital strategies and transformations. We believe we can help reduce risk, cost and complexity, as well as accelerate the adoption of this enabling new technology across the sector.

A key pillar of the UK's National AI Strategy¹ is to ensure that all sectors benefit from increased use of AI as it becomes mainstream in much of the economy. Education cannot afford to fall behind.

At Jisc, we are uniquely placed to work together with the education sector to meet this goal. Through a programme of pilots, research and sharing of results, our national centre for AI in tertiary education enables institutions to use AI effectively.

This report is aimed at those at the start of their AI education journey, acting as a primer on what AI can do, and what to consider in order to implement it ethically. We hope you find it a useful starting place.

Heidi Fraser-Krauss
Chief executive officer

¹ gov.uk/government/publications/national-ai-strategy
1. Introduction

Artificial intelligence (AI) is transforming the world and education is no exception. AI could 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 needed 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 report has three aims: to summarise the types of AI applications that are available in education today, to provide insights into current and emerging use cases, and to provide guidance on ethical considerations.

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, which could either be viewed as an important timesaving device, or something sideling an important element of an educator’s work. We discuss the various roles AI could take and, in the ethics section, provide some tools to help assess its suitability.

AI is a fast-moving area: we see technology advances, new use cases emerging, and work in areas such as ethics maturing. Changes to core concepts, however, move much more slowly. This second edition of the report therefore is updated with our latest case studies and information around ethical use of AI, whilst still aiming to provide a general introduction to AI in education.
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 and deep learning

In discussions around AI, the terms machine learning and deep learning are commonly used.

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 which aim to spot patterns in data and then perform actions based on these patterns.

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

Deep learning is a specific type of machine learning, utilising a more advanced type of neural network. It is becoming the most common type of machine learning, and typically requires large data sets and more computing power than more traditional machine learning. Most advanced AI systems in areas such as vision and language processing that you come across will use deep learning.

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.

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.

2.5 AI and bias

When considering the use of AI it’s important to understand the concept of bias. 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. It can also occur if the training set is not sufficiently broad and representative of the intended use cases.

2.6 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 step 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 arrived at, 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.
3. AI maturity

Maturity models can help us understand emerging technology. For example, they are well established in the analytics space and helpful in discussing learning analytics. A typical data maturity 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 being around 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 a maturity model focused on our sector might look like.

Adapting existing models for AI maturity to the education sector

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

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 and their Ada chatbot, which has formed part of their 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: Arizona State University, for instance, has been using an adaptive learning platform, CogBooks, since 2014. We have seen even more significant transformation in China, for example with 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 http://squirrelai.com/our-story
4. What role is AI taking?

It’s worth considering what role the AI system is attempting to play in the teaching and learning experience. It might seem obvious that the aim is to support the teacher 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.

More 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.

We noted in the introduction that personalisation was a potential goal and it’s worth briefly considering what this could mean. Here are some examples:

<table>
<thead>
<tr>
<th>Potential use of AI</th>
<th>Description of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalisation of route through a program of study</td>
<td>AI suggests module courses and ordering based on prior learning, interests and career goals</td>
</tr>
<tr>
<td>Personalisation of route through an individual course</td>
<td>AI guides you through an individual course, showing more or less material based on your learning progress. This is usually considered adaptive learning</td>
</tr>
<tr>
<td>Personalisation of content</td>
<td>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</td>
</tr>
</tbody>
</table>
4.1 Extending Capability and Increasing Capacity

One way to think in more detail about the role of AI is to consider it in terms of extending capabilities or increasing capacity. So – is the AI increasing capacity by allowing a task to be done in a similar way, but faster, or providing the educator with new tools to extend their capability, perhaps by providing new insights?

Extends capability

Increases capacity

4.1.1. Increasing capacity

Where it is used to complete tasks such as marking assignments, automating timetabling and responding to student queries -via chatbots, perhaps – AI is primarily adding value by increasing the capacity of educational institutions. Each of these tasks can be (and usually is) performed by educators or other members of staff. All educational institutions have the expertise and skillsets needed to ensure that student assignments get marked, but institutions may lack the capacity to mark a very high volume of assignments. A student preparing for an exam by writing multiple practice essays, for instance, is unlikely to expect every single essay to get marked. If AI can be used to help mark their essays or provide feedback, however, then this becomes possible.

With the above example, increased capacity translates into increased quantity of provision. But as well as increasing the total volume of assignments that can get marked, assignment-marking resources could also reduce the total number of hours that educators spend marking. With a reduction in their workload, educators’ time can be freed up to concentrate on higher-impact tasks, leading to better outcomes and a more fulfilling, effective experience for learners.
4.1.2. Extending capabilities
Complementing its powers of automation, AI can add value because it can analyse and draw insights from data. Examples include learning analytics solutions which provide indications of students at risk of failure or dropping out, academic integrity solutions, and systems that analyse learning knowledge against a domain and provide feedback to the lecturer.

It's worth noting, however, that AI isn't the only way of drawing this type of value from this data – more traditional statistical approaches may also be used, and may in many instances be more appropriate.

4.1.3. The overlap
Systems that perform analysis and then automate sit in the overlap of these concepts.

To give an example, adaptive learning platforms are able to analyse learning data, ascertain learners’ needs, and thus provide learning material that should help meet those needs. There have also been examples of learning analytics systems that use machine learning to identify students at risk of failure, and then automate an intervention, for example by emailing a student to check if they are ok.

The appropriateness of using AI in this way should be considered carefully. Section 8 gives some guidance about the kind of issues to consider.
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 on 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 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 i.e. 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, 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 it’s the ability to answer a range of questions with personalised responses that makes it more a digital assistant than a pure chatbot.

Using AI and chatbot technology, Leeds Beckett University’s Becky provides an instantaneous response and information 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. The AI Becky takes the user through the whole application process, including making offers.

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2. [leedsbeckett.ac.uk/blogs/student-blog-squad/2020/07/how-i-used-becky-the-chatbot-to-apply-through-clearing](leedsbeckett.ac.uk/blogs/student-blog-squad/2020/07/how-i-used-becky-the-chatbot-to-apply-through-clearing)
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 algorithms.

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. Their understanding of a portion of the knowledge will be evaluated, for example by a test, and they will then 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 learner 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

One feature of this type of system is that the learner is working at their own pace and this makes 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, here we are drawing a slightly false 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 handle 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® project, requires the tutor to provide model answers or phrases. The AI model then maps the student answer to the model answer. The FirstPass system 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

Online grading application Gradescope Complete® 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® and Versant® 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.

5.3.3. 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).³³
6. Potential uses of AI in education

In this section we'll explore some other potential uses cases for AI in education. These are either ideas from Jisc’s national AI centre’s deep dive activity, examples that are in the early stages of development, or techniques that have shown value in other domains.

6.1 Automating common tasks such as sending emails

Time saved on mundane or common tasks could free up educators’ time for more valuable activities. Tasks such as spending time handling emails are often mentioned in discussions in this area. We are seeing tools in this space come into mainstream use: for example, Microsoft’s Viva provides users with a daily briefing on potential actions from emails. Elsewhere, messaging software solutions can often suggest responses. Tools are also emerging to help automate the email and other communications in systems like customer support service desk software.
6.2 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\(^\text{14}\) and Watson Tutor\(^\text{15}\).

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 facilitates 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\(^\text{16}\) augmented online textbooks on the Pearson Revel platform across the domains of sociology, US government and public speaking. Thousands of undergraduate students trialed using 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.

6.3 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\(^\text{17}\) 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\(^\text{18}\).

6.4 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.

We are already seeing the emergence of AI-driven tools that create questions from existing content, such as Quillionz and Quizbot\(^\text{19}\). At Jisc, we have produced a simple example of this technology on our demo site at [https://exploreai.jisc.ac.uk\(^\text{20}\)](https://exploreai.jisc.ac.uk/tool/question-generation).

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14 https://link.springer.com/article/10.3758/BF03195563
15 researchgate.net/publication/330429090_The_Personality_of_AI_Systems_in_Education_Experiences_with_the_Watson_Tutor_a_one-on-one_virtual_tutoring_system/link/5c485ade92851c22a38abd5a/download
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://learningtools.donjohnston.com/product/quizbot
20 https://exploreai.jisc.ac.uk/tool/question-generation
Content selection and summarisation tools are used in other fields. For example, Microsoft uses AI tools to select and summarise news stories for its news aggregation services. 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 is an AI-based 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 a cost that was just 10% of the cost of more traditional methods.

6.5 Emotion and sentiment analysis

There are a number of AI techniques that aim to understand human emotion. For example, sentiment analysis systems look at text, and AI systems 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 and it is likely that these kinds of tools will be built into video conferencing solutions in the future. Education sector organisations may want to start thinking and talking about what place (if any) these kinds of tools have in education.

AI could be used to read survey results, social media channels, forums and student group work to identify sentiment and emotional dimension of student communications. This data could then be used to ascertain university performance and areas for improvement. This is a task that is often undertaken manually at the moment, so this would be an example of AI increasing capacity.

6.6 Employability

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, we see that AI is being used to read CVs so students will need to understand and be prepared for this as they enter the workforce.

We are also seeing a range of tools emerge to help students prepare for interviews, such as Bodyswaps which uses a mix of AI and VR, and to help students with career planning, such as Microsoft’s Career Coach.

Others have looked at this from a much broader perspective, for instance Professor Rose Luckin considers how education can prepare humans for an AI world and the skills people will need in an AI-augmented world.

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21 https://www.bbc.co.uk/news/world-us-canada-52860247
22 Clark, D (2020) Artificial Intelligence for Learning: How to use AI to Support Employee Development
23 bbc.co.uk/news/technology-55133141
24 bbc.co.uk/news/business-55932977
25 https://bodyswaps.co/
26 microsoft.com/en-gb/education/products/career-coach
6.7 Recommendation engines

We are all used to being provided with recommendations from AI-driven services on a daily basis, whether it’s 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, 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. We see this approach used in systems such as CENTURY, where a recommender system is trained on student behaviour in order to suggest learning options tailored to every student.

6.8 Student enrolment and induction

Jisc’s deep dives have highlighted the use of AI to support enrollment and induction as a potential use case for AI.

The enrolment and induction journey for students can often be manual, complicated and take a long time to complete successfully. The data captured during this time is essential for future student journeys and processes. Any data errors could cause issues for both students and staff throughout the student journey. Having a smooth and clear journey will help support students and prevent early drop outs.

We can see examples from other sectors, fintech companies such as Monzo and Starling Bank use AI for identity validation, resulting in a fast and seamless signup process. AI could also be used to support the student, for example by smart assistants guiding them through the process.

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28 emerald.com/insight/content/doi/10.1016/j.aci.2020.03.001/full
29 century.tech/news/how-does-centurys-ai-work/
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, which can be seen on Jisc’s explore AI. 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 is not an AI technology but it might well have a place in AI projects. An admissions chatbot could use RPA to automatically book a place on an open day on behalf of prospective students – although it’s worth noting that RPA isn’t the only way of achieving this and application programming interfaces (APIs) might be more appropriate.

30 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.

In this chapter we summarise the key legal and regulatory frameworks for the use of AI; we then discuss guidance designed to support the ethical use of AI.

8.1 Legal and Regulatory Frameworks

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.31

These cover the following areas:

> Accountability implications of AI

> Ensuring lawfulness, fairness and transparency in AI systems

31 Guidance on AI and data protection | ICO
> Assessing security and data minimisation in AI

> Ensuring individual rights in AI systems

The European Union is also developing a regulatory framework for the use of artificial intelligence\(^{32}\). Whilst this will not directly impact the UK, this framework may influence how AI is regulated, and what products and services are available outside the European Union.

The draft regulations are based around the principle of categorising uses of AI based on how risky they are perceived to be.

![Risk Categorisation Diagram]

With this taxonomy, uses of AI where there are unacceptable risks are prohibited, whilst cases where there is a high level of risk are subject to ‘strict obligations’ which include: appropriate levels of human oversight, conditions for data sets to avoid biases, and a high level of robustness, security and accuracy.

Notably, using AI in high-stakes assessment is deemed high risk. Here, ‘high-stakes’ can be understood as cases where the outcome of the assessment could determine whether a student is admitted onto a further course of study, or whether they have the qualifications needed for a particular career path.

### 8.2 Using AI ethically

From privacy concerns to the risk of bias, institutions want assurances that their uses of AI are responsible and ethical.

In order to help colleges and universities navigate such issues with confidence, Jisc has published “a pathway towards responsible, ethical AI” – a tool designed to help institutions decide whether a particular use of AI is right for them and their learners.

The pathway recommends that institutions proceed by asking four questions:

- Does this proposal fit our institution’s objectives?
- Does using AI fit our institution’s purpose and culture?
- Are we ready for it?
- Does using AI raise particular issues?

The first question prompts institutions to think about the rationale and intended benefits of using AI. The second encourages reflection on how well an AI use case aligns with institutional values and priorities. The third relates to an institution’s skillsets, mindsets and infrastructural readiness.

There are also a number of specific ethical issues that institutions should consider once they have thought through each of the first three points in sequence. These include:

**Autonomy and Control**
- Is the AI making high-stakes decisions without oversight, or is there a human in the loop?
- Can the AI learn and ‘evolve’ so that its behaviours become unpredictable (and possibly dangerous)?
- Can the AI identify its limitations so that it can caveat its decisions and/or hand over to a human where needed?

**Explainability and Transparency**
- What kind of explanation would stakeholders expect in any particular context?
- Is explainability of outcomes more or less important than performance?

**Bias**
- Will the AI perform better for some groups in society (will it produce dangerous outcomes for other groups)?
- Was the AI designed and developed by diverse teams of people?
- Have biases arisen from the training data, including how the data was sampled? How has this been assessed?
- How can biases (including those that may emerge during use) be monitored and addressed?

**Privacy**
- How does the system obtain, capture, store and use data?

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33 jisc.ac.uk/reports/a-pathway-towards-responsible-ethical-ai
> What inferences does the AI make based on raw data?
> How can the AI use these inferences to influence users?

The work of The Institute for Ethical AI in Education provides information about how these issues manifest themselves in educational contexts.

### 8.3 An example: Jisc’s Responsible Design Forums

When implementing an AI solution, it is important to consider how stakeholders can be involved in discussions and decisions about ethical issues. As part of Jisc's AI pilots, the concept of responsible design forums was used. In this section we will look at this in more detail as an example of how to embed ethics within a project.

For our chatbot pilot, we brought together a diverse range of students and staff from the pilot colleges in a series of responsible design forums to deliberate on key questions around the ethical use of chatbots.

These include:

> What are the implications (both positive and negative) of the chatbot presenting itself as having/not having a gender?
> What are the implications (both positive and negative) of the chatbot presenting itself as having a personality?
> How should the chatbot respond to critical issues (e.g. around depression, bullying, social problems)?

Some of the key conclusions from these forums were:

On balance, it is inappropriate for the chatbot to present itself as having a gender (this could reinforce gender stereotypes or binary norms).

That said, it is important for the chatbot to express some personality – as opposed to being cold and devoid of humour – as this could improve the user experience.

A range of views were given on the question of how the chatbot should respond to critical issues. Some felt that the chatbot should not attempt to directly advise students on high-stakes issues, such as depression, preferring instead for the chatbot to signpost users to the appropriate member of staff.

Others felt that, either now or in the future, it would be beneficial to use chatbots to support users with their pastoral needs.

Most participants, however, agreed that chatbots should draw possible high-stakes issues to the attention of an appropriate member of staff.

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34 buckingham.ac.uk/research-the-institute-for-ethical-ai-in-education
9. Case studies

9.1 Basingstoke College of Technology

“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.”

Scott Hayden, Digital Innovation Specialist.

At Basingstoke College of Technology (BCoT), students and staff are using CENTURY to achieve a two-pronged approach to personalised learning.

By using the platform directly, students benefit from a unique learning pathway, tailored to their individual needs. Based on a data-driven assessment of students’ strengths and areas for improvement, the platform will recommend granular learning modules (known as nuggets), so that they can achieve immediate goals, such as, plugging gaps in their knowledge, revisiting forgotten content, or pushing themselves further in particular topic areas.

Meanwhile, CENTURY also equips educators with rich, actionable insights into students’ needs, allowing educators to fine-tune their instruction and interventions – both for individual students and for whole cohorts. As well as informing educators of where students are struggling or where they are excelling, the platform also gives insights into the levels of effort students are exerting, allowing educators to give more holistic, personable feedback to students.

At BCoT, students resitting their English or maths GCSEs have been the main beneficiaries of this two-pronged personalisation of learning. Since implementing CENTURY, BCoT has seen an increase in the number of students securing a ‘good pass’ in their GCSEs, alongside a further increase in the number of students making at least one grade’s progress. As emphasised by BCoT’s Digital Innovation Specialist, Scott Hayden, key to this success is the fact that CENTURY frees up staff time, so they have more capacity (along with more fine-grained insights) to give students the help they need.

BCoT are continually looking for new ways to enhance learning through innovation. As well as using CENTURY, the college is also benefiting from BodySwaps, a platform that combines virtual reality with artificial intelligence to support students with employability and core skills. BCoT even have their own Artificial Intelligence lead to spearhead innovative practice.
9.2 Bolton College

Since 2017, Bolton College has been using Ada, a general-purpose chatbot that utilises natural language processing to provide answers to queries that are posed by students, teachers and campus support teams.

![Image 1: Student using the digital avatar interface of the Ada service.](image)

At its inception, Ada was primarily used to 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 many more.

By supporting students with these types of queries – whilst also responding to staff questions, such as “who is out on work placement next week?” – Ada has become a mainstay of the Bolton College community.

Inspired by Ada, Jisc has developed its own general-purpose chatbot, which is currently being piloted in four further education colleges. Through this pilot, Jisc aims to establish whether Ada's successes in improving the student experience whilst reducing workloads for staff (who no longer have to respond to high volumes of queries on recurring themes) can be replicated across the sector.

As Ada has continued to have a positive impact on staff and students, Bolton College has looked for new and exciting ways to harness this innovation. As well as supporting students with queries about life at college and progress through their courses, chatbots are now also being used to help students with their learning in specific subject areas.

Through the Ada Goes to School platform, Bolton College is facilitating the rapid development of subject specific chatbots. Taking a crowdsourcing approach, the platform brings together teachers across multiple disciplines to teach Ada about their subjects or industries. The platform enables teachers in different colleges to co-curate questions and answers relating to their areas of expertise. The subject
chatbot can then be embedded within a college’s learning management system; enabling students to garner on-demand information about their subjects. So far, chatbots have been created for numerous topics, such as employability, gun and knife crime, and sexual violence and harassment.

Bolton College is also pioneering the use of artificial intelligence to support formative assessment. The College’s First Pass platform has been designed to give real-time feedback to students as they compose their answers to open-ended questions. The service analyses student free form text responses, and then offers textual and graphical feedback in real-time. The College will continue to engage with students and teachers to refine how FirstPass delivers real-time feedback.

**Image 2**: In this screenshot FirstPass highlights what parts of the question have been successfully answered.

The FirstPass platform has also demonstrated that it can analyse student answers in different languages. The platform has been successfully tested in Portuguese and Welsh.

After completing a small-scale internal pilot, Bolton College are now planning a much wider external roll out of FirstPass for the 2022-23 academic year.
9.3 Staffordshire University

“Staffordshire University has a high proportion of commuter and ‘non-traditional’ students: those who have responsibilities and face additional challenges (part-time work, childcare, adult carers) beyond their studies. As a result, the need for a personalised student experience with ‘on-demand’ access to help and support 24/7 has grown dramatically, particularly throughout the pandemic.”

Alison Phillips, Director of Digital and Technology Services

Since 2019, students at Staffordshire University have benefited from Beacon, a pioneering digital coach that ‘guides and helps’ students through their studies and along their wider student journey.

Utilising Microsoft’s Azure Cognitive Services, Beacon supports students in a wide variety of ways. As a coach, Beacon helps students to structure their independent study time, whilst also motivating them to achieve key milestones. As an interface between university and student, Beacon can help students get more from life on campus by, for instance, recommending societies they may want to join, or events they may want to attend. Meanwhile, Beacon is also a highly effective personal assistant, capable of ordering new ID cards for students or organising their council tax submissions.

As Director of Digital and Technology Services, Alison Phillips, explains:

“The objective of the coach is to address some of the challenges facing our students, improving retention and attainment by providing 24/7 support and guidance to our students. The coach pro-actively engages with students and starts conversations to ensure they settle into university life and have the best support possible. For example, Beacon can ask students how they are feeling (and take appropriate action depending on the results), and it can nudge students towards activities that may help them integrate into university life.”

Supporting student wellbeing is a top priority for Beacon. Through the use of natural language processing, Beacon can also recognise and respond to student questions on topics such as mental health and safeguarding. As part of the digital coach’s roadmap, Staffordshire University are also exploring ways in which Beacon could help monitor students’ emotional wellbeing so that the university can be even more responsive to students’ needs.

In 2019 Beacon was named the best Not-for-Profit project at the Digital Technology Leaders Awards. Thanks to its wide-ranging skillset, the digital coach is making rapid progress towards fulfilling its founding purpose of supporting student retention and attendance. Student usage has increased year on year. And Beacon is now the primary app used by students at Staffordshire University.

Moving forwards, Staffordshire University also envisages Beacon playing a pivotal role in attracting new applicants. Within this vision, Beacon would be used to underpin a seamless journey, from prospective student to current student.
9.4 Open University

Taylor, a digital assistant used by The Open University, helps students disclose and get support with their disabilities.

As an alternative to filling in forms, students can have a two-way conversation with their digital assistant. Taylor will ask students questions to elicit information relating to their needs (including details of disabilities and areas where additional support is required), and students can, in turn, ask Taylor questions related to university provisions around accessibility.

Taylor was developed in-house, using a combination of different Microsoft Azure services. And it has been designed so that students can have either typed or oral conversations with their digital assistant.

"Taylor can use natural language processing to ‘understand’ what the student has said, for example when identifying which recognised categories their disabilities fit with. This can then lead to appropriate responses, allow the student to use their own terms and result in more useful data being captured from the conversation."

**Dr Tim Coughlan, Senior Lecturer in Education Technology at the Open University**

After a trial, in which 134 disabled students used both Taylor and the pre-existing ‘form-based’ approach, the Open University found that 65% of students preferred using Taylor.

This initial success has motivated the OU to look to the horizon.

"Taylor is really a foundation for achieving a lot more in the future. We’re planning to enhance it in several ways, for example by integrating more information about the student and their study, which will mean it can give more targeted advice, and also looking at how staff can monitor Taylor and contribute to its ongoing improvement."
10. **Summary**

AI is already delivering real value in education. In the UK, we are seeing early adopters successfully use AI services for the benefit of students and the college or university. These include Bolton College’s Ada and FirstPass, adaptive learning with CENTURY Tech at Basingstoke College of Technology, the Beacon digital coach in Staffordshire University, and the Taylor digital assistant in the Open University. Internationally, this is evident with the use of CogBooks in Arizona State University or, at a much larger scale, SquirrelAi in China. We see this accelerating as a result of both rapid growth in global investment in AI and educational technology and being driven by national AI strategies, including the UK’s.

We hope that outlining these key AI educational technologies 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 – and that progress towards digital transformation is likely to be slow if left to a few scattered initiatives. However, that said, it is clear there has already been much progress that can be built on and used to help in addressing these challenges, including Jisc’s “A pathway towards responsible, ethical AI”\(^\text{35}\) report and the ongoing work of the AI centre for tertiary education in piloting and evaluating the effectiveness of new AI solutions.

We are confident that there are now strong foundations to enable further adoption of AI in colleges and universities.

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](https://jisc.ac.uk/rd/projects/national-ai-centre).

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35 [jisc.ac.uk/reports/a-pathway-towards-responsible-ethical-ai](https://jisc.ac.uk/reports/a-pathway-towards-responsible-ethical-ai)