AI based Assessment in Education (AIBA) : evidence review

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Purpose
A review of the research and evidence relating to the use of AI tools for assessment in education, identifying key themes and practices.

Summary

- The history of research into assessment in education is a long one, encompassing both formative and summative approaches, with a wide variation in practice, depending upon the context and the ways in which assessment is being implemented
- AI based systems for assessment include services such as intelligent tutoring systems (ITS), automated scoring tools, computerised adaptive tests, essay scoring systems, chatbots, AI robots, augmented and virtual reality systems, all of which have been developed over a number of years
- More recently Generative AI (GAI) has received much publicity, with media reporting tending to focus on the ways in which such tools could enable learners to circumvent assessment processes
- Many researchers highlight:
    - the complexity of assessment practices
    - a need for AI developers to recognise this, as opposed to attempting a 'one-size-fits-all' solution
    - along with solutions that focus on educators/teachers working with the technology as opposed to being replaced by it
- Whilst acknowledging that speed of change is an issue, there is a general recognition around a need for support for educators and learners where AI is being used for assessment purposes

Methodology

- Eric, Google Scholar and Elicit services were used to identify relevant papers, presentations, thought pieces and case studies
- The following search terms were applied: *artificial intelligence, education, assessment, evaluation*
- All of the sources used are open source and freely accessible (Appendix 1 and 3):
    - All content was published in the time period 2020-2024
    - The vast majority of content was published in English, with the exception of one Spanish language paper that explored AI and assessment within the context of a primary and secondary school setting
    - Many papers dealt with AI and assessment in the context of further and higher education, with only some using primary/secondary/K-12 education as a focus
    - Many papers dealt with the broader aspects of AIED, within which assessment was but one element

Chapters from the recently published Handbook of AI in Education (2023) were also consulted[1].

[1] Benedict du Boulay (ed), Antonija Mitrovic (ed), Kalina Yacef (ed). 2023. Handbook of Artificial Intelligence in Education. Edward Elgar Publishing. Cheltenham, UK.

Definitions

- There are a range of definitions for the term artificial intelligence. For the purposes of this paper the Scottish AI Strategy (2021) definition has been used:

    - 'Technologies used to allow computers to perform tasks that would otherwise require human intelligence, such as visual perception, speech recognition, and language translation. AI is a broad discipline. Think of it as a group of complementary technologies, including data-driven techniques, which are evolving constantly'

    - A glossary of terms used in relation to AI can be found in the strategy documentation

Assessment

The Scottish Qualifications Authority (SQA) describes assessment in the following way:

> The purposes of assessment in education are to gather data upon which to make informed decisions and to support learning……..**Summative assessment** has several purposes including informing pupils and parents of levels of achievement, calculating grades, determining access to special or advanced education, making comparisons among pupils, schools, universities, or systems, monitoring the effects of policies, evaluating curricula, and allocating resources…….**formative assessment** may be defined as those activities undertaken by teachers and pupils that provide feedback to immediately modify teaching and learning activities.[2]

Scottish Government and its executive agency Education Scotland (ES) has published a large body of information and advice relating to assessment[3].

Background

- Development of AI enabled tools to support learning and teaching has taken place over a number of years

- Research and practice suggests the educational benefits of these include the streamlining of administrative tasks, more effective assessment practices and approaches to personalised learning

[2] Assessment: a review of practice. SQA. 2007. Last accessed 10/4/24

[3] What is assessment, and when and how does it take place? | Assessment and achievement | Curriculum in Scotland | Parentzone Scotland | Parentzone Scotland (education.gov.scot) BtC5 Framework (education.gov.scot); Updated guidance on assessment within the broad general education; National Standardised Assessments for Scotland; Assessment in the Senior Phase | Curriculum in Scotland | Parentzone Scotland | Parentzone Scotland (education.gov.scot) Last accessed 12/4/24

- Since the launch of ChatGPT in November 2022, there has been much interest in GAI in relation to its potential and the risks it poses across all sectors of society, including education

- Media reporting of GAI use for learning has tended to focus on aspects such as 'student cheating'

- There is a long history of research into assessment in education, covering both formative and summative approaches, with a wide variation in practice, depending upon the context and the ways in which assessment is being undertaken

- AI enabled systems for assessment include intelligent tutoring systems (ITS), automated scoring tools, computerised adaptive tests, essay scoring systems, chatbots, AI robots, augmented and virtual reality systems, all of which have been developed over the past ten to twenty years. Some developers are integrating GAI into tools for use in education (for example essay evaluation and feedback)

- The number of research and conference papers in relation to GAI has increased during 2023. Most acknowledge key issues relating to the safe and ethical use of data in such systems; many identify a need for collaboration between designers, developers and educators in the creation of tools that will be used with learners in education systems

- Whilst acknowledging speed of change as an issue, there is a general recognition around a need for support for educators and learners where AI is being used for assessment purposes

Themes and practices

Tools and services

- The range of AI enabled tools and services for assessment in education is diverse and includes intelligent tutoring systems[4] (ITS)[5], automated scoring tools, chatbots[6], educational games, AI robots, augmented and virtual reality, dialogue based tutoring systems[7], etc

- The launch and ongoing development of GAI (ChatGPT, Goggle Gemini, Microsoft Copilot) has seen these tools being used and adapted for assessment purposes

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[4] UNESCO has described these systems as the most researched, having been around for over 40 years. AI and education: guidance for policy-makers - UNESCO Digital Library

[5] An intelligent tutoring system is a computer system that aims to provide immediate and customized instruction or feedback to learners, usually without requiring intervention from a human teacher. Systematic review of research on artificial intelligence in K-12 education (2017–2022) - ScienceDirect

[6] A chatbot or chatterbot is a software application used to conduct an on-line chat conversation via text or text-to-speech, in lieu of providing direct contact with a live human agent. Systematic review of research on artificial intelligence in K-12 education (2017–2022) - ScienceDirect

[7] State of the art and practice in AI in education - Holmes - 2022 - European Journal of Education - Wiley Online Library

- The majority of these tools are developed in the private sector, with free and paid for (enhanced) versions available (with subsequent concerns around equity of access where charges are being incurred for more advanced versions of these tools)

- The UK government has funded Oak Academy to develop, amongst other services, AI based lesson planner and quiz applications for use in schools[8]

- 'In the United States, resources and grants are being provided to designated institutions and organisations for researching and developing AI driven personalised learning platforms that have great potential to boost academic performance by deepening students' cognitive engagement and to reduce educational inequalities by assisting under privileged students'. Source: (PDF) Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education (researchgate.net)

  Tools for Summative Assessment
  - 'There have long been hopes that AI could save teachers time and effort by automating the labour intensive - and hence costly - marking of student assignments, homework and assessments. For this reason, automatic summative assessment is a well funded area of research, second only to ITS, and extensively commercialised. Autograders have been used for the assessment of written tasks, and in computer science and mathematics courses. Some state-of-the-art autograders also claim to diagnose the type of error and suggest to the student how to correct it, while others, depending on the domain, claim to score student answers correctly with about 90% accuracy. Nonetheless, the use of automatic scoring, especially when the assessment is high stakes, remains controversial' (Holmes, 2022)

  Tools for Formative Assessment
  - 'AI in educational assessment has changed little in its basic precepts and functions – that is machine learning and actions based on the results of intelligent analysis of large-scale data – over the last 10 years or so but its technological efficiency, speed and sophistication has advanced on all counts, especially in the analysis of large-scale assessment process data being channelled for formative purposes' (Gardner, 2021)

Research

- 'Research and development in AI for education (AIED) has to a large extent been driven by computer scientists ….. Over the past decade, the situation has changed, and AIED is now also a focus of commercial interests' (Holmes, 2022)
  - 'Over the last three decades a key conceptual starting point for student focused AIED has been mastery learning, a pedagogic model advanced by Benjamin Bloom. This model underpins most ITS…… The

[8] New support for teachers powered by Artificial Intelligence - GOV.UK (www.gov.uk)

objective of mastery learning is to get all students to a level of competence that allows them to effectively move ahead, along the learning path described in the curriculum……. Bloom later showed the individualised tutoring combined with mastery learning leads to two standard deviations higher learning gains than traditional whole class teaching. This huge potential improvement, known as the two sigma effect, have been a key inspiration of AIED researchers for more than 40 years' (Holmes, 2022)

- Given the recent launch of GAI, research into such tools and services is limited although emerging

- Much of the research takes a generalist approach to AIED, with limited focus on individual tools or approaches or contexts and a tendency to evaluate the efficiency of a tool as opposed to the learning outcomes generated

- Much of the research explores the landscape in higher education

    - Given the complexity of approaches to learning and assessment, and the critical influence of context, combined with the nature of the AI landscape, current research methodology may not be a best fit for evaluating impacts and outcomes in education. Fang, Roscoe and McNamara propose a framework to support a common dialogue between 'researchers, educators and designers' in the development of applications for AI based assessment (Handbook of AI in Education; Appendix 4)

Support and advice

- Some countries have implemented national initiatives around AI in education and provided guidance for educators

    - 'In 2019 the government of China launched a strategic policy of education modernisation to encourage greater integration of intelligent technology into education and more teacher professional development activities related to AI and AIED' (Chiu et al, 2023)

- The speed of technical change, for example in relation to GAI, makes it difficult for education systems to respond quickly, although some advice has been published:

    - In March 2023 the Forth Valley and West Lothian Regional Improvement Collaborative published its initial guidance
    - In October 2023 the UK government published its policy paper on Generative artificial intelligence (AI) in education
    - In November 2023 the Australian government published its Australian Framework for Generative Artificial Intelligence (AI) in Schools

- In March 2023 the International Baccalaureate (IB) issued guidance in relation to the use of ChatGPT by learners[9]

- In 2024 the UK parliament published a research briefing on the **Use of artificial intelligence in education delivery and assessment.** Links to and a summary of that briefing can be found in Appendix 3.

Further and higher education

- Evidence for the use of AI based Assessment (AIBA) in primary/secondary levels in education can be limited and much of existing practice and guidance can be found in further and higher education (this in turn raising questions around the transferability of experiences and what can be learned between different domains)

    - The Quality Assurance Agency for Higher Education (QAA) has published a range of policy and guidance documents from UK universities in relation to the use of AI and GAI in assessment, including advice from Dundee, Edinburgh and Heriot-Watt universities

    - Dr Matt Glanville, Head of Assessment Principles and Practice at the International Baccalaureate, made a presentation on the use and implications of GAI use in assessment at a QAA webinar in 2023 (ChatGPT: What should assessment look like now? - YouTube)

Benefits

Across the literature there are a range of benefits, perceived and actual, relating to AIED and assessment. The following extracts sum up this position.

- 'AI systems can identify knowledge gaps, recommend suitable learning materials, and offer customised feedback, enabling students to learn at their own pace and focus on areas that require improvement. This function can help to ease teachers burden as well as to provide instant feedback about their students needs and they can let their students take charge of their own learning. ……Artificial intelligence is also capable in analysing vast amounts of educational data, including student performance, engagement, and behaviour. This data analysis can provide valuable insights into student learning patterns, identify areas for intervention, and help educators make data-driven decisions to improve teaching strategies and curriculum design. In addition to that, it can also help in automated grading under assessment. AI can automate grading processes for assignments, quizzes and exams. By using machine learning algorithms, AI systems can assess and provide feedback on student work, saving time for educators and offering immediate feedback to learners. This enables teachers to focus more on personalised instruction and supports timely feedback for student growth such as suggesting corrections and identifying learners mistakes' (Memarian, 2023)

[9] Statement from the IB about ChatGPT and artificial intelligence in assessment and education - International Baccalaureate® (ibo.org)

- However, ‘it is not possible either to draw aggregate inferences or, for example, make grand claims about AIED’s efficacy or otherwise. Instead, to facilitate meaningful debate, we need to be clear about which of the multiple variations of AIED applications we are discussing—especially as many remain speculative while some are questionable for ethical, pedagogical, or educational reasons’ (Mintz, 2023)

Educators

- There is some anecdotal evidence to suggest that teachers are influenced by negative coverage in the media and may be wary of using AI to support teaching, learning and assessment without official guidance
- A common theme across research is the need for teacher education in relation to AIED and assessment
- A common request in many papers is the need for teacher involvement in the design of AI tools to ensure that developers better understand the needs of both teachers and learners (Celik, I et al, 2022)
- In ten years the technology has changed/improved/access to data improved etc but our approach to classroom assessment has not changed (Gardner, J et al, 2023)
- ‘Research and development in AI for education has to a large extent been driven by computer scientists. Over the past decade, the situation has changed, and AIED is now also a focus of commercial interests. A teacher overwhelmed by stories about AI miracles may well wonder if the future is defined by yet another attempt to push technology into the classroom.’ (Holmes, 2022)
- The wide-scale availability of GAI could encourage educators to remove certain types of assessments, such as essays, from their curriculum (Kaplan-Rakowski, 2023)

Reliability

- The variables involved in applying AIBA in education can make evaluations of impacts and outcomes problematic; those variables will in themselves vary depending upon context (age and stage, socio-economic factors, locality based and cultural influences, what is being measured and the lack of commonly applied frameworks for evaluation)

    - ‘Accordingly, it is not possible either to draw aggregate inferences or, for example, make grand claims about AIED’s efficacy or otherwise. Instead, to facilitate meaningful debate, we need to be clear about which of the multiple variations of AIED applications we are discussing—especially as many remain speculative while some are questionable for ethical, pedagogical, or educational reasons’ (Mintz, J et al. 2023)

- Very often an evaluation of specific tools or services can result in more nuanced outcomes based on context and the ways in which these are being applied

- ‘Assessment and Learning in Knowledge Spaces (ALEKS), a Web-based artificially intelligent assessment and learning system, is widely used in the USA. Yilmaz (2018) investigated the effects of ALEKS on math achievement of middle school students. Results of the analysis showed that ALEKS instruction had a statistically significant positive impact on students’ end–of–year mathematics scores. However, Fang, Ren, Hu, & Graesser (2019) conducted a meta-analysis to assess the effectiveness of ALEKS on learning, and their results revealed that ALEKS was **as good, but not better than traditional classroom teaching,** unless when ALEKS was used for shorter periods rather than longer periods’ (Huang, J. et al. 2021)

- ‘Research…..on students’ assessment of chatbots found both strengths and weaknesses, identifying the chatbots’ difficulties with conversational flow and responding appropriately to nuanced input from users’ (Kaplan-Rakowski, R et al. 2023)

- In relation to the teaching of AI literacy to learners, the following description summarises well the wider range of practices around AIBA.

  - ‘……. there is little alignment from researchers on what to teach students or how to evaluate that learning……We found many examples of summative assessments of AI concepts, construction of AI, and psychological beliefs about AI. Few assessments were formative, activity-based, assessed students’ analysis of AI, assessed students’ AI communication skills, or assessed their critical understanding of AI. This work sheds light on which approaches to use in assessment and what assessment tools are missing’ (Rizvi, S et al. 2023)

- Concerns raised align with many of those that are highlighted across the field of research and practice into AI in education and include technical, ethical and pedagogical issues[10]:
  - transparency around how systems work (and the ways in which commercial privilege can hinder an understanding of this)
  - what data has been mined in the process of assessment; who does this data belong to; what measures are in place to ensure the safety and security of private and personal data; how data is processed to identify bias and ensure fairness; what systems are in place to ensure such transparency
  - who is responsible when an AI supported assessment delivers incorrect or harmful results? Defining lines of accountability and responsibility is essential to address such issues
  - not all learners may have equal access to technologies or the resources needed to benefit from AI supported assessments

[10] Fanning, J. February 2024. Literature Review on the Impact of AI in Education (AIED). Education Scotland.

- learners may not fully understand the implications of AI-driven assessments or may not have the autonomy to consent to their use. Ensuring informed consent is a critical ethical consideration
- whilst AI can enhance aspects of assessment, teacher oversight and intervention are still necessary to contextualise results, provide support, and address issues that AI tools may not detect
- the long term impacts of AI use in education are not understood and longitudinal research in this area is essential to ensure appropriate outcomes
- the use of AI based assessment can influence and alter the professional relationship between teachers-learners-parents/carers i.e. the use of AI tools should complement rather than replace the teacher role in assessment
- the use of AI can have broader implications and unintended consequences, including the ways in which it may impact on the development of school based, local and national educational policies and practices

End Note

- The research landscape highlights the potential benefits and challenges of integrating AIBA in education settings

- There is the promise of greater efficiency in assessment practices, personalisation, deeper insights into the process of learning and new opportunities to tailor teaching and support individual needs

- Ethical considerations around bias, privacy and transparency need to be resolved however, along with ensuring equitable and effective assessment practices across different contexts

- It's worth highlighting one particular statement in the UNESCO Guidance for Policymakers in relation to AI and Education:

    - 'Avoid using AI as the sole means of predicting students' future educational and career development'.[11] (UNESCO, 2021)

[11] AI and education: guidance for policy-makers - UNESCO Digital Library

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Appendix 2

Use of artificial intelligence in education delivery and assessment.

UK parliament POSTnote 712. 23rd January 2024.

Link: Use of artificial intelligence in education delivery and assessment - POST (parliament.uk)

Summary

- The use of AI tools such as ChatGPT risks undermining the validity of some assessment methods
    - Generative AI could compromise multiple forms of assessment, including essays, dissertations, online exams, and applications for courses
    - Generative AI's ability to produce highly graded coursework may also risk putting some learners at a competitive advantage
    - Detecting the use of generative AI is extremely challenging

- Applications including Graide and Progressay assist or automate the marking and grading of student work using, for example, teacher inputs and AI powered marking schemes. Some platforms are also capable of automatically generating feedback for learners

- AI could potentially be used for the setting, marking and grading of exams and assessed coursework, as well as the delivery and invigilation of remote assessments

- These tools are still in the early stages of development

- There is a risk that AI used for marking could draw on a set of viewpoints and biases which were most common in the training data. This could lead to discrimination and/or narrow the range of acceptable answers

- Surveys conducted by Jisc in 2023 showed that some university students are open to the use of AI for marking their short answers and responses in quizzes, but are less comfortable with AI automated marking of other forms of assessment

- Experts in assessment have suggested that there are significant barriers to the marking of exams being fully outsourced to AI, although there may be scope for tools with AI to assist with marking

- There are growing calls on schools, colleges and universities to implement new ways of evaluating learner progress that are less likely to be undermined by AI
    - exams under invigilated conditions
    - oral examinations
    - observed examinations

    - discussing AI with learners and explaining how its exploitation could lead to diminished learning outcomes
    - setting more specialised assignments which are less readily completed by using generative AI

- Implementing radical changes to current assessment systems could cause significant disruption to learners and teaching staff

Despite its growing use, the effectiveness of AI powered Edtech has been assessed only in a small number of studies, and is often constrained to specific use cases. This is particularly the case with tools that use generative AI.

Appendix 3

Further reading/viewing:

GAI

- Bower, M., Torrington, J., Lai, J.W.M. *et al.* How should we change teaching and assessment in response to increasingly powerful generative Artificial Intelligence? Outcomes of the ChatGPT teacher survey. *Educ Inf Technol* (2024). https://doi.org/10.1007/s10639-023-12405-0

OECD

- Generative AI in the classroom: From hype to reality?
- Launch meeting of the Schools+ Network 22-23 May 2023, Boulogne

Quality Assurance Agency for Higher Education

- How can Generative AI be used in learning and teaching (qaa.ac.uk), including guidance on the use of GAI in assessment
- ChatGPT: What should assessment look like now? - YouTube, QAA webinar discussing assessment, including a presentation by DR Matt Glanville on the International Baccalaureate approach to the use of ChatGPT (13.25 minutes in)

Queen's University, Kingston, Canada

- Popular Podagogy Podcast: Using AI in the Classroom with Chris DeLuca. Ways to leverage AI to enhance student learning, why we shouldn't be afraid of it, and how to get started using it
- Popular Podagogy Podcast: Using AI in the Classroom with Chris DeLuca | Faculty of Education (queensu.ca)

United Nations Education Scientific and Cultural Organisation (UNESCO)

- 2023_UNESCO_Guidance-for-generative-AI-in-education-and-research_EN.pdf (teachertaskforce.org). This report contains a short section on 'Rethinking assessment and learning outcomes'.

University of Edinburgh

- Podcast: A student's perspective on Generative AI usage – Episode 2 (17 mins)
- Podcast: A student's perspective on Generative AI usage – Episode 2 (17 mins) – Teaching Matters blog (ed.ac.uk)

Appendix 4

An AI based Assessment (AIBA) framework.

Source: Ying Fang, Rod D. Roscoe and Danielle S. McNamara. Artificial intelligence-based assessment in education. 2023. Handbook of Artificial Intelligence in Education. Edward Elgar Publishing Ltd. Cheltenham, UK. 485-504.

The authors have developed a framework to support a common dialogue between 'researchers, educators and designers' in the development of applications for AI based assessment.

They group and link five related aspects of AIBA under the themes of PURPOSES and PROCEDURES.

PURPOSES cover the aims of assessment, whilst PROCEDURES describe the steps that need to be taken to realise these aims.

PURPOSES include Goals (e.g. personalised instruction and feedback) and Constructs (i.e. the artifacts that will be assessed).

PROCEDURES include Data Sources (i.e. input or output from learners), Computational Methods (i.e. the ways in which data will be processed and analysed) and Visibility (i.e. the ways in which AI based assessment is hidden or obvious).

Purposes		**Procedures**		
Goals	Constructs	Data Sources	Computational Methods	Visibility

The full chapter is available in The Handbook of Artificial Intelligence in Education. 2023. Benedict du Boulay (Editor), Antonija Mitrovic (Editor), Kalina Yacef (Editor). Edward Elgar Publishing Ltd. Cheltenham, UK.

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