



Advancing Education Journal
Issue 4 | Spring 2026
ISSN: 2050-1331



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LEARNING BEYOND BOUNDARIES



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Editorial

Welcome to this edition of *Advancing Education*, where we explore how educators, researchers and institutions are reimagining learning beyond boundaries in a period of change. The articles in this issue explore crossing traditional geographical, technological, institutional and pedagogical boundaries.

As digital tools become increasingly embedded within teaching and learning, educators are challenged to adopt new technologies while critically evaluating their impact on learners and educational practice. This conversation begins with Gemma Zeeman, Emma Richards, Lauren Riella and Mathew Jones, whose exploration of immersive 360° learning environments demonstrates how digital innovation can enhance accessibility within Religious Education in Wales. Their work illustrates how technology can transcend physical constraints, creating rich educational experiences that might otherwise remain out of reach for some learners.

Artificial intelligence is another key theme running through this issue. Contributions from Andra-Mihaela Abu Ghuwaleh, Martin Richards, Simon Lea and Sarah Gleave examine AI from different perspectives, reflecting the opportunities and challenges associated with its growing presence. These articles encourage educators to move beyond simplistic narratives of technological optimism or resistance to engage thoughtfully with questions of ethics, assessment, professional development and implementation. Complementing these discussions, the examination of technology-enhanced learning experiences among students with specific learning differences and their lecturers by Abass Isiaka, Alexia Achtypi, Jeremy Schildt and Fabio Arico highlights the importance of ensuring that technological innovation remains responsive to diverse learner needs.

This edition also celebrates the power of collaboration and creative pedagogies. Gamification features prominently, with Simon Chapman examining its developing significance within primary physical education and Laura Hutchings, Glyn Jenkins and Robyn Griffiths demonstrating how gameplay can foster meaningful collaboration across institutional boundaries. These contributions demonstrate that the value of innovation lies in the quality of the learning experiences it creates. Aidan O'Brien's critical examination of Times Tables Rock Stars enriches this conversation by encouraging educators to look beyond simple motivation to consider how popular digital tools can be used thoughtfully to support mathematical understanding.

The theme of connection extends beyond digital platforms and classroom walls. Frederik De Laere's reflections on shaping Europe's classrooms in the heart of Bruges provide a compelling reminder of the value of international collaboration and intercultural exchange. At a time when educational systems face shared global challenges, opportunities to learn across borders continue to enrich both educators and learners.

Taken together, the articles in this edition demonstrate that educational innovation is most effective when it is grounded in a reflective approach to improving learning outcomes. Whether exploring immersive technologies, artificial intelligence, gamification, collaborative practice or international partnerships, the contributors encourage us to consider how educational boundaries can be expanded while remaining attentive to the needs of learners and communities.

Furthermore, this issue provides an opportunity to recognise individuals who have had a lasting impact on education. Christina Preston's tribute to Lawrence Williams reflects on his influence within the educational community and the legacy of his work. We are also delighted to celebrate Theo Kuechel, recipient of a Lifetime Achievement Award, in recognition of his longstanding commitment to the *Advancing Education* journal. Such acknowledgements remind us that progress in the field depends as much on the people who share their expertise and support others as it does on new technologies.

As you engage with this collection of articles, we hope you will find inspiration and insight into how learning with technology can connect people and offer opportunities beyond traditional boundaries.

Dr Helen Caldwell and Dr Emma Whewell



Editorial Team (L to R): Dr Christina Preston, Dr Helen Caldwell, Dr Emma Whewell, Yasemin Oezcelik

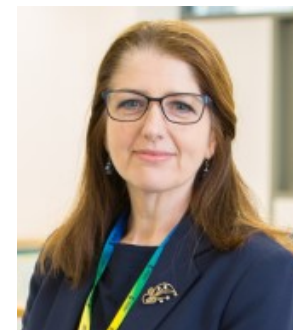
Chairs' welcome



Welcome to the latest edition of the *Advancing Education* journal (AEJ). At NAACE, the Education Technology Association, it is great to be working with our friends at the Technology, Pedagogy and Education Association (TPEA) to bring you the journal. Two organisations with similar interests but slightly different member perspectives provide an amazing spectrum of ideas and interests to share with our members.

I hope you enjoy the spring 2026 edition and that it inspires you to continue or begin your own research into technology and its place in education. If you have any questions for NAACE, please email us at office@naace.org.uk, and we will do our best to help.

Phil Blackburn
Chair, NAACE Board of Management



Welcome to this edition of *Advancing Education*. Here at TPEA, we are delighted to celebrate the fantastic work of practitioners in our field. 2026 is a landmark year for us, as we celebrate our 40th anniversary. Our association was founded in 1986 as the Association for Information Technology in Teacher Education (ITTE). In 2018, we adopted the name TPEA in order to align more closely with our influential Q1 international journal, *Technology, Pedagogy and Education* (TPE).

We all appreciate that digital technologies are changing education quickly. Developments such as artificial intelligence, new expectations for digital skills and shifts in computing education raise important questions about how prepared educators and institutions are for what comes next. Because of this, our annual conference, which takes place on 25 June 2026 at the University of Northampton, is themed "Facing the future: Are we ready for change NOW?". This conference will explore current developments in computing and educational technology and their implications for teaching, learning and curriculum. Our full day also features keynote speakers from the British Computer Society and a Four Nations panel bringing policy and practice perspectives from England, Scotland, Northern Ireland and Wales. There will also be cake!

The next edition of *Advancing Education* will feature articles and updates from the conference, sharing what was learned as widely as possible.

Enjoy this edition, and do consider whether you might like to contribute to a future edition.

Dr Elizabeth Hidson
Chair, TPEA

Welcome to our new sub-editor



Allison Allen

Allison Allen is in her fourth term of office as a STEP Academy Trust Chair of Governors, focusing on standards, safeguarding and inclusion. She was Director of Outstream Consulting and has held a number of education leadership and governance roles in complex multi-stakeholder environments, including as Chair of the London Challenge L2tICT Learning & Teaching pan-London Action Group. She is a Fellow and Trustee of Naace and past Trustee/Director of the London Grid for Learning, a Senior Fellow of MirandaNet and a Founder Member of Chartered College of Teachers. Allison was invited to return to the NAACE Board of Management, and she was re-elected in January 2026.

Allison is joint author of several high-quality books (including Routledge and UCL IOE Press) and publications relevant to education technology, leading on digital safeguarding for various organisations as well as being a lead author of the newly revised NAACE schools' national and international EdTech Review Framework (ERF), including the Element Digital Safeguarding. She is a national Assessor and Moderator of the NaaceMark schools' benchmark accreditation and is a Third Millennium Award judge.

From her early career in teaching in Croydon and North East England, Allison has developed a proven track record at senior level within the education sector, specialising in using education technology to enhance the life chances of children. She supports the moral imperative to develop learners who have the higher thinking skills and confidence that sustains effective, safe, innovative use and creation of technology in the UK and internationally. She works with schools, government and suppliers, helping others gain traction with education technologies to establish meaningful vision and remarkable outcomes.

Lifetime Achievement Award for Theo Keuchel

Dr Christina Preston

An educational consultant and MirandaNet Senior Fellow, Theo Keuchel was active in writing and co-editing the MirandaNet newsletter, maintaining MirandaNet's social media presence and was involved in developing the MirandaMod unconferences. When MirandaNet was archived and members joined TPEA, Theo became a valuable consultant on the production of NAACE's *Advanced Education* journal, which is now jointly produced by NAACE and TPEA.

Now that Theo has retired from this role, NAACE and TPEA are rewarding him with a Lifetime Achievement Award for his work and research over the years, which has covered digital literacies, visual communication and open educational resources and practice. His expertise is in digital content, archives and visual literacy. Theo also has specialist knowledge of copyright in education, including the use of Creative Commons licenses. He has given presentations and workshops around the world and has participated in major national and international digital projects.

In addition, Theo has developed a number of courses in digital media at the University of Hull and for NAACE. He was invited to advise Qatar education ministers on a strategy for educational digital content and was a principal author of the MeshGuide on visual literacy. He has also developed a toolkit designed to help schools, colleges and higher education institutions harness the affordances of open and public domain content for learning.



Author



Dr Christina Preston

Dr Christina Preston has been at the forefront of education, technology and innovation for over 25 years. The MirandaNet Fellowship, which she founded in 1992, has become a global thought leader in edtech, with over 1,200 members in 80 countries. Christina has won five international awards for education innovation and for building communities of practice.

A senior researcher at the Institute of Education, University College London (UCL), from 1992 and now an associate professor at De Montfort University, Christina has led several high-profile research projects and evaluations for UK government agencies and a range of organisations in Argentina, Chile, China, the Czech Republic, India, Mexico and South Africa as well as edtech companies.

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Beyond the school trip: Designing immersive 360° learning environments for equitable religious education in Wales

Gemma Zeeman, Emma Richards, Lauren Riella and Mathew R. Jones

Abstract

Schools in Wales are required by the Curriculum for Wales to offer learners authentic encounters with diverse religious worldviews, yet financial, logistical and increasingly political barriers prevent many from doing so. This report describes the design and early-stage evaluation of immersive 360° learning environments funded by Adnodd, the Welsh Government's national education resources service, and published on Hwb, Wales's national digital learning platform. Drawing on practitioner reflection and pupil feedback, it argues that 360° technology offers qualitatively different learning from other digital resources, and that its value extends across a whole sequence: preparing teachers and pupils before a visit, reinforcing learning after it and providing access for those who cannot attend. The resource also offers schools a politically neutral route to curriculum compliance at a time of growing sensitivity around visits to religious sites.

Keywords: 360° learning environments, immersive technology, religion, values and ethics, Curriculum for Wales, educational equity, bilingual education, virtual field trips, primary education, practitioner research

Introduction

In Wales, the Curriculum for Wales places Religion, Values and Ethics (RVE) at the heart of the Humanities Area of Learning and Experience, asking schools to provide authentic encounters with diverse worldviews. In practice, this frequently means the school trip – usually limited to a single destination so that a school affording one visit must choose just one faith tradition.

But access is not only about whether a visit happens. Some pupils cannot attend at all, some teachers feel uncertain leading visits to unfamiliar traditions, and follow-up learning often happens days later when vivid detail has faded. In a polarised political climate, schools increasingly face hesitancy from parents or governors about visits to religious sites altogether, leaving curriculum intentions quietly unmet.

This report reflects on what a small practitioner team learned from designing and evaluating immersive 360° learning environments produced with support from Adnodd and published on Hwb. It considers what immersive technology offers that other digital resources do not, and how this kind of resource might support schools – before a visit, after one or in its place.

Why immersive? The case for presence

What distinguishes 360° environments from other digital resources is the quality of presence – the sense, however partial, of being inside a space rather than looking at a representation of it. Learners can look up at a cathedral ceiling, turn to face a temple shrine or stand inside a synagogue. This is qualitatively different from a photograph or video clip, and the distinction matters pedagogically.

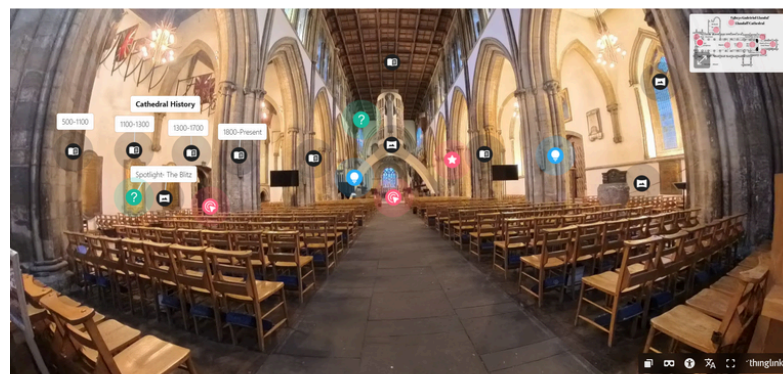


Figure 1. Inside Llandaff Cathedral with tagged information pupils can explore

A recent systematic review by Rosendahl and Wagner (2024) identified 44 studies exploring 360° video in educational contexts, yet none were situated in primary school settings or focused on pupil-led exploratory 360° photography – a gap this project is positioned to address. It is a practitioner-led design project, grounded in classroom realities and intended to generate transferable insights alongside a reusable teaching resource.

The resource was built using Thinglink and encompasses four religious sites in Cardiff: the Shree Swaminarayan Temple (Hinduism), Llandaff Cathedral (Christianity), the South Wales Islamic Centre Mosque (Islam) and Cardiff United Synagogue (Judaism), alongside spaces exploring a non-religion, humanism.



Figure 2. Image of the immersive space central screen with access to each area

Each environment features bilingual (Welsh/English) interactive hotspots, containing text, video and embedded escape rooms as curriculum-linked knowledge challenges.

A complement to school trips, not a replacement

A 360° environment cannot replicate the full experience of visiting a living place of worship: the sensory richness, the encounter with community members, the embodied experience of being a guest in another tradition's sacred space. These things have genuine educational value, and nothing in this project is intended to diminish them.

What the resource does is fill the gap when those experiences are unavailable. For pupils who cannot attend even a single trip – because of cost, parental withdrawal or cancellation – the gap is absolute. As one collaborating teacher observed: “These children are left at school during the trip and struggle to make sense of what has been learnt.”

The resource's value is best understood as a thread running through a sequence of learning. Before a visit, it builds teacher confidence and gives pupils context so the physical experience lands with more meaning. After the visit – perhaps its most valuable function – it gives every pupil something to return to. A writing task set a week later asks pupils to recall specifics they may only half-remember, and an immersive environment they can revisit gives that work a foundation it would not otherwise have. When pupils navigate the environment together, it creates a shared reference point that re-engages those who missed the experience and deepens understanding for those who were there.

The political neutrality dimension

As development progressed, practitioners discovered a dimension of the resource's value that had not been part of the original brief. One collaborating teacher noted that parental objections to religious content have increased in her experience, observing that the resource “offers a very balanced interpretation of different beliefs and views... presented from a very neutral perspective, allowing it to be purely educational.” A second, working in early years, noted that a virtual environment offers “a wonderful opportunity to expose children to things they might not otherwise have access to in their lives” – in a format that carries none of the perceived endorsement of a physical visit.

Matthew R. Jones, Curriculum Tutor on the Postgraduate Certificate in Education (PGCE) Wales programme at the Open University and former headteacher, framed this clearly:

An immersive resource for places of worship, accessed within the classroom, provides a safe and accessible way for children to learn about different faiths, particularly in light of growing sensitivities around visiting religious sites in person. It also offers a cost-effective alternative for schools, enabling inclusive and meaningful religious education without the financial and logistical challenges of educational visits.

That this hesitancy is being discussed in initial teacher education in Wales suggests it is not a marginal concern.

A virtual visit is epistemically neutral in a way a physical visit arguably is not. The child navigates an educational environment 'about' a space at their own pace, with bilingual scaffolding and curriculum-aligned prompts. For schools navigating parental concern, that distinction may make the difference between a lesson happening and not happening at all.

Design reflections: What we learnt

Several design decisions proved more significant than anticipated. The escape rooms – knowledge challenges requiring learners to unlock the next step by demonstrating understanding – emerged as a more powerful engagement mechanism than predicted. One collaborating teacher noted that “the element of being locked really encouraged children to continue to explore the different rooms and learn new information.” The gamification layer appears to transform exploration from passive browsing into purposeful investigation.

The degree of learner independence the resource supports also exceeded expectations. The same teacher observed that “children would gain a lot from the resource just from a chance to freely explore” – distinct from the structured, teacher-directed uses primarily envisaged. This suggests the resource has both guided and independent learning applications, a flexibility that increases its practical value in time-pressured classrooms.

A further application that emerged was the resource’s potential to support teacher confidence and planning. Exploring a religious site digitally in preparation allows teachers to familiarise themselves with the space, identify what they want pupils to notice and plan a lesson sequence accordingly, shifting the resource from classroom tool to professional resource.

Navigation presented the most consistent challenge. Pupils using laptops found movement less intuitive than those on tablets, noting the absence of joystick controls as a limitation. The bilingual toggle, by contrast, was noted by teachers as a particular strength for mixed-language classrooms.

What learners told us

Pupil responses following a Year 6 session were strongly positive. The majority of ratings fell at four or five out of five, with descriptors including ‘fun’, ‘fascinating’, ‘immersive’ and ‘informative’. Qualitative comments such as “it makes me feel like I am there” or “like I was actually there in real life” frequently described the quality of presence. One pupil noted it was “hard to put down the iPad.”

Suggestions for improvement – more religions, joystick controls, different topics – are themselves a pedagogical signal: learners invested enough to want more. The most direct expression of the equity argument came from a pupil comparing the resource to a school trip: “It is fun going on school trips, but this is better because it’s free and faster.”

Implications for practice

This project suggests several transferable principles. First, presence matters: 360° environments create a qualitatively different experience from photographs or videos. Second, gamification embedded ‘within’ the environment deepens engagement and extends time on task. Third, the resource’s value spans a learning sequence: preparing teachers and pupils before a visit, reinforcing and re-engaging after it and providing genuine access for those who cannot attend. Fourth, immersive virtual environments may offer schools a pedagogically robust and politically neutral route to the authentic encounter with diverse worldviews that curriculum frameworks require.

The resource is available on Hwb via direct link or QR code and is compatible with virtual reality (VR) headsets where available. It is offered not as a substitute for a physical visit but as the resource that makes breadth, equity and access possible when that visit cannot happen – or cannot happen for everyone.

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Authors



Gemma Zeeman

Gemma Zeeman is the founder of Immersive Discoveries, a company specialising in interactive 360° learning environments. A qualified primary teacher with a background in large-scale digital project management, she works as a research assistant on the Welsh Government-funded Wales Curriculum Learning Design (WCLD) project, supporting schools across Wales to integrate immersive technology into classroom practice. She is a certified Thinglink Trainer and has designed immersive resources for the Open University, Adnodd and a range of school and cultural partners.

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Emma Richards

Emma Richards is a primary school teacher based in Wales, with professional experience across both denominational and non-denominational educational settings. She has over a decade of experience as a music educator and performer, having held roles with the Royal Welsh College of Music and Drama Junior Department, Making Music Changing Lives, RNCM Young Strings and Jessie's Fund. Emma has extensive experience delivering inclusive music projects in a range of contexts, including additional learning needs (ALN)/special educational needs (SEN) settings, hospitals and custodial environments.

This work has informed her sustained interest in inclusive pedagogical practices within mainstream primary education. Her recent research has focused on the impact of sound environments on learning, with particular attention to the design of inclusive learning spaces for learners with ALN in mainstream settings. She contributed to the content development and curriculum alignment of the RVE immersive environments discussed in this report. This is her first published digital resource.



Lauren Riella

Lauren Riella is a primary school teacher in Wales. She contributed to the content development and curriculum alignment of the RVE immersive environments described in this report, ensuring materials were progression-step appropriate and aligned to the Curriculum for Wales. This is her first published digital resource.



Mathew R. Jones

Following a successful career as both a primary school teacher and headteacher for over a decade, Mathew R. Jones moved to the Initial Teacher Training sector in 2010. Working in various roles as a senior lecturer, the Programme Director and the Assistant Director of Teacher Training at UWTSD in that time and in 2020, he moved to the Open University as a primary PGCE tutor for Wales. During this time he has delivered and supported Welsh and English medium students with their careers.

As a member of the Association for the Study of Primary Education (ASPE), Wales Collaborative for Learning Design (WCLD) and, most recently, the Centre for International Research on Interactive Technologies in Teaching and Learning (CIRITTTL), Mathew has an extensive knowledge of the use of technologies used in primary and secondary education. He sat on the National Digital Learning Council for Wales, worked on the Curriculum for Wales with the Welsh Government as well as with Estyn, EWC and the Education Consortia in Wales. As the Faculty Digital Champion Lead for ECYS, he has also worked and produced a number of educational resources.

Currently working on his EdD, the development of creative pedagogy through an interdisciplinarity approach is a key focus of Mathew's current work. His MA research focussed on problem-based learning with initial teacher training students and using it within the classroom context. Further research interests of his include digital pedagogy, creativity and creative pedagogy, PBL. Welsh language, sustainability, polymathy and educational environments. Within his research, he aims to help teachers to develop their creativity in pedagogy to be able to innovate and connect and deliver in an interdisciplinary approach. He also holds a BSc in Psychology, Primary PGCE and NPQH and an MA in Education.

A kaleidoscope of connections: Shaping Europe's classrooms in the heart of Bruges

Frederik De Laere

The autumn semester of 2025 brought a unique energy to the teacher education departments of five European institutions as they launched a collaborative journey titled *A cultural kaleidoscope: Unity within diversity*. This project was far more than a standard academic requirement; it was a deliberate effort to prepare the next generation of educators for the complexities of teaching in an increasingly diverse Europe. Hosted by Howest University of Applied Sciences in the historic city of Bruges, this Erasmus+ Blended Intensive Programme (BIP) sought to weave together the perspectives of student teachers from Belgium, Germany, Austria, France and Ukraine. By focusing on interculturality and international cooperation, the programme aimed to show that education can build bridges that extend well beyond national borders.

The partnership was a vibrant tapestry of institutions, including Howest University of Applied Sciences; Friedrich-Alexander-Universität; Private Pädagogische Hochschule (PPH) Augustinum; Institut National Supérieur du Professorat et de l'Éducation (INSPÉ), Université de Picardie Jules Verne (UPJV); and Kamianets-Podilskyi Ivan Ohiienko National University. Together, these participants formed intercultural groups tasked with investigating critical themes such as inclusive education, technology in the classroom and culturally responsive teaching. This collaborative research was not just about academic output but about fostering a mindset of openness and civic awareness. The student teachers worked to create digital presentations and infographics that reflected their findings, ensuring their insights could be shared with a wider online audience or during their time together in Belgium.



Figure 1. Building connections

The journey began long before the participants arrived in Bruges, starting with a virtual collaboration phase that utilised the tool Padlet and the platform eTwinning. Beginning as early as October, students engaged in both synchronous and asynchronous online units to begin their research and build initial connections with their international peers. While this virtual start was essential for laying the groundwork, later reflections from the students suggested that a more comprehensive introduction to the eTwinning platform would have been beneficial to help them navigate the digital workspace more effectively. Despite these minor technical hurdles, the online sessions successfully set the stage for the intensive physical week that followed.

The heart of the project beat strongest during the physical mobility week in Bruges from 8 to 12 December, 2025. The week opened with a warm welcome at the Howest Campus, where a meet-and-greet session and icebreaker activities led by the French students helped turn digital avatars into real-life colleagues. For many, this face-to-face interaction was the highlight of the semester, providing the necessary space for deep networking and

the formation of genuine friendships. The initial campus tour and shared informal dinners provided an immediate sense of community, which was vital for the collaborative work ahead.

Throughout the week, the curriculum was designed to challenge the students' perceptions of education and identity. One of the most engaging activities was the European Values Café, where participants rotated between tables to discuss democracy, human rights and multilingualism. These discussions were not merely theoretical; they required students to reflect on how these values are actually taught in schools and how language shapes a person's identity. Similarly, workshops on the concept of 'the European teacher' encouraged students to debate the merits of a standardised teacher education system in the EU. These conversations highlighted the tension between creating a unified educational framework and preserving the unique cultural identities of each member state.

A midweek excursion to Brussels provided a powerful political and historical context for their studies. Visiting the European Parliament and the House of European History was a transformative experience for many, especially during a time of significant global political tension. Anastasiia Polishchuk, a student from Ukraine, noted that the visit to the Parliament helped her realise that true international cooperation is only possible when everyone respects the uniqueness of others. For her and many of her peers, seeing the foundations of European democracy firsthand underscored the teacher's responsibility to foster civic education and tolerance in their own future students.



Figure 2. Visiting the European Parliament

The personal impact on the student participants was a recurring theme in their final reflections. Luiza Dorofei shared how the workshops helped her develop teamwork skills alongside colleagues from different backgrounds, proving that despite their differences, they were united by a shared commitment to passing on European values. Kateryna Hafich observed that diversity should not be seen as an obstacle but as a vital resource for modern education. Meanwhile, Anastasiia Nevenhlovska found that complex linguistic concepts like 'translanguaging' became much clearer when she was actually communicating with peers who spoke different native languages. These testimonials highlight that the project's success was measured not just in academic credits but in the growth of the students' global competence.

Beyond the classroom, the cultural kaleidoscope was enriched by the beauty of Bruges itself. The students explored the city together, taking part in the Winter Glow Light Trail and visiting the Historium to learn about the city's rich past. Social highlights, such as a group dinner at Mister Spaghetti and a photo challenge, allowed the students to bond in a

more relaxed environment. These moments of informal connection were just as important as the formal workshops, as they allowed students to compare their different school systems and personal experiences in a natural, organic way.

As the week drew to a close on 12 December, a final reflection session allowed both students and staff to evaluate the programme's success. The feedback was overwhelmingly positive, with students praising the "cool" topics and the opportunity to meet people from so many different nationalities. However, they also offered constructive ideas for the future, such as including name tags for every participant, providing flags for every country and perhaps visiting a local Belgian school to see the education system in action. Some students also felt that the schedule was quite exhausting and suggested a more flexible approach to timing in future iterations.

Ultimately, the Erasmus+ BIP *A cultural kaleidoscope: Unity within diversity* achieved its goal of broadening the horizons of these future teachers. It encouraged them to view their profession through a wider, European lens and reinforced the idea that teachers matter in the quest for a more unified and understanding society. As the participants returned to their home institutions in Belgium, Germany, Austria, France and Ukraine, they took with them more than just new teaching methods; they carried a renewed confidence in their ability to work within an international environment and a deep-seated belief in the power of education to foster openness and respect.

Author



Frederik De Laere

Frederik De Laere is a teacher educator and an international coordinator in the School of Education at Howest University of Applied Sciences in Bruges, Belgium. He has been involved in many international projects in teacher training and is an eTwinning ambassador for Initial Teacher Education in Europe. He writes poetry and has published several books in Dutch.

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The developing significance of gamification in primary physical education: Advantages, limitations and a way forward

Simon Chapman

Abstract

This article examines the emerging role of gamification in primary physical education (PE) within the context of increasing digitalisation. Drawing on constructivist learning theories and recent research on digital technologies in PE, the article explores how gamification, briefly defined as “the use of game design elements in non-game contexts” (Deterding *et al.*, 2011), can enhance children’s engagement, motivation and formative assessment through mechanisms such as progression systems, narrative tasks and rewards. The article also critically considers limitations associated with gamification, including overreliance on extrinsic rewards, superficial engagement and the potential reinforcement of competitive hierarchies. Given the limited empirical research currently available concerning gamification in primary PE, the article argues that gamification should be implemented cautiously and in alignment with pedagogical aims. It concludes that greater professional development and stronger integration within initial teacher training is needed to support teachers in designing theoretically informed, pedagogically coherent gamified learning experiences.

Keywords: gamification, primary PE, digital technologies, pedagogy, motivation, rewards, teacher education

Introduction

Historically, pedagogical practices within primary physical education (PE) have been shaped by instructional traditions grounded in militaristic drills, demonstration, repetition and performance refinement (Kirk, 2010). Yet from the late 20th century, constructivist perspectives continued to reshape educational thinking: Piaget (1952) argued that children construct knowledge through processes of assimilation and accommodation, while Vygotsky (1978) emphasised socially mediated learning through collaboration and discussion.

More recently, in a post-COVID world, the rapid expansion of digital technologies has introduced new possibilities for enhancing learning alongside these theoretical approaches, particularly through gamification, which can be used to increase engagement, provide immediate feedback and support reflective practice (Blain *et al.*, 2022; Deterding *et al.*, 2011; Hamari *et al.*, 2014). Although the introduction of gamification into PE teaching and learning is predominantly seen in secondary education, it is rapidly filtering into primary settings globally, as primary PE sees itself pressured from secondary education in terms of content and teaching approaches (Griggs, 2007; Penney and Dinan Thompson, 2017).

‘Gamification’ can be defined as the “integration of game-design elements and mechanics into non-game contexts” (Deterding *et al.*, 2011). In PE specifically, gamification seeks to create more dynamic, interactive and engaging learning environments, encouraging children to partake in PE activities and contributing to the unplugged/barefoot computing curriculum (Arufe Giráldez *et al.*, 2022; Dicheva *et al.*, 2015; Teixeira *et al.*, 2022). Strategies under the umbrella term of gamification allow for the setting of specific objectives in PE environments, developing pathways for enhanced problem-solving, decision-making and strategic thinking (Quintas *et al.*, 2020) through increasing children’s intrinsic and extrinsic motivation, helping them to process information and potentially achieve goals (Hamari *et al.*, 2014; Kulkarni *et al.*, 2022; Treiblmaier and Putz, 2020).

This includes unplugged strategies such as logical thinking, sequencing, precision and logical thinking. Not only does this create short-term, in-lesson benefits but also longer-term benefits, including lifelong maintenance of physical activity, exercise and sports concepts for children (Kulkarni *et al.*, 2022). Gamification should not be seen as replacing established pedagogical principles within PE but rather as a tool that is applied in integration with existing teaching models to enhance, extend and deepen the learning experience linked with constructivist ideas (Arufe Giráldez *et al.*, 2022; Santos *et al.*, 2023).

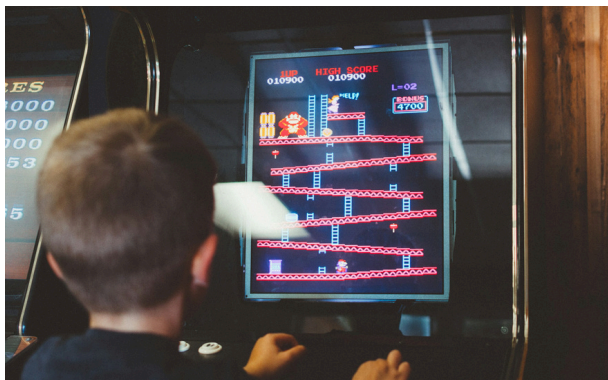


Figure 1. Photo by Kelly Sikkema (Unsplash, 2018)

Although limited, studies within primary PE suggest digital innovation, such as gamification, is becoming increasingly positioned as a means of supporting pedagogical approaches and addressing long-standing concerns around child motivation, differentiation and formative assessment within settings (Armour *et al.*, 2016; Rice *et al.*, 2025). It is therefore essential that teachers and researchers investigate and develop innovative and playful methodologies to motivate children to promote the subject's widespread benefits (Dicheva *et al.*, 2015; Landers, 2014).

This article connects the authors' key research passions: primary PE pedagogy, the development of primary pre-service teacher preparedness and the influence digital concepts can have on teaching and learning within the subject. Through considering the advantages and limitations of the approach, alongside highlighting some specific examples from practice, this article hopes to instigate a wider discussion about gamification generally and within the subject of primary PE.

Advantages of gamification

Literature highlights that gamification has numerous advantages for primary PE practice through using levels and challenges, narrative stories and tangible rewards such as point

point systems (Werbach and Hunter, 2015), which can help to enhance children's motivation, movement competency and social skills (Fernandez-Rio *et al.*, 2020; Rice *et al.*, 2025; Ros-Morente *et al.*, 2018).

Gamification promotes the use of structured level-up systems, which allows children to advance through different levels or stages of a task. As the level increases, they may unlock new challenges, content or privileges, motivating them to continue learning and progress (Kapp, 2012; Ortega-Sánchez, 2022), which also allows teachers to make learning intentions and success criteria explicit in lessons (Çeker and Özdaml, 2017).

When units of work or sequences of lessons are organised around transparent progression pathways, such as coloured levels or those linking to competition medals like bronze, silver and gold movement, children can recognise what constitutes advancement and what technical, tactical or behavioural indicators signal improvement. This strengthens assessment, as children can monitor their own progress and calibrate next steps against shared criteria rather than vague instructions to "do better" (Armour *et al.*, 2017). In heterogeneous primary classes, where developmental differences are marked, such flexible progression is pedagogically valuable because it creates multiple routes to success without defaulting to 'fixed-ability' groupings (Zeybek and Saygi, 2024).

Furthermore, gamification can be used to create narrative-based PE lessons, which allow PE to be taught through meaningful, cross-curricular contexts framed through various English national curriculum topics, such as space exploration, maritime adventures or local histories, and by referring to the types of leisure activities consumed by children, allowing teachers to connect PE with other subject areas (Rice *et al.*, 2025; Toda *et al.*, 2019). Using a narrative framework or using characters and plotlines can make the learning material more relatable and memorable (de la Cruz-Campos *et al.*, 2022; Garone and Nesteriuk, 2019).

In the PE classroom, narrative learning can again be seen through games-based approaches, including teams seeking to protect their territories, for example, a mat or a structure of hoops, whilst the opposition try to destroy the team's territory by throwing softballs; Thieves and Bankers, where children act as thieves trying to steal keys (cones) from houses (hoops), with roles switching upon a successful theft. Within creative narratives, missions can be designed to immerse children in a game-like experience by providing them with different challenges or tasks, which allows them to earn rewards or unlock new content as they progress. This enhances engagement and provides a clear sense of purpose and progression (Kapp, 2012; Krath *et al.*, 2021).

This scaffolded choice enables children to select challenges, co-design tasks and decide upon strategies for reaching agreed outcomes (Arufe Giráldez *et al.*, 2022; Blain *et al.*, 2022). Such autonomy-supportive designs are consistently associated with deeper engagement and more persistent effort, a relationship explained through self-determination theory's account of the basic psychological needs for autonomy, competence and relatedness (Arufe Giráldez *et al.*, 2022; Sailer and Homner, 2020), which are key in understanding the role of motivation (Ryan and Deci, 2020). An example of this is orienteering: using a map and a question sheet, teams of children have a set time to find different locations to answer questions, with each answer being a number or a letter. To do this in the fastest time and find all the answers, children must think tactically and logically, employing ordered, logical reasoning.



Figure 2. Photo by Bulat Khamitov (Pexels, 2017)

Moreover, points-based systems, including the use of badges and leaderboards, are beneficial in creating a more game-like environment (Ferraz *et al.*, 2024; Silva *et al.*, 2021) and can provide a sense of achievement and healthy competition among children, with points awarded for completing tasks or achieving specific learning objectives, badges recognising milestones or specific accomplishments and leaderboards displaying the progress and rankings of children, fostering a sense of achievement and motivation (Plass *et al.*, 2020). With this strategy, teachers can align point awarding with lesson intentions, success criteria and social norms, thereby reinforcing climates in which effort, improvement and responsible participation matter. This means points are being used as a praise of outcome rather than as a controlling, classroom management mechanism (Sailer and Homner, 2020).

However, the pedagogical value of these approaches requires some consideration. Children with different athletic abilities may have varied levels of participation and success in gamified activities, limiting their opportunity to gain rewards (Van Roy and Zaman, 2019). However, this can be mitigated depending on what a teacher awards points for, because when this is for wider outcomes including communication, cooperation, inclusion

and creativity and problem-solving, they broaden the criteria for success and redistribute recognition across a class (Arufe Giráldez *et al.*, 2022; Hamari *et al.*, 2014; Van Roy and Zaman, 2019). Early studies on gamification suggest the removal of points once earned could also have a detrimental impact on motivation (Hamari *et al.*, 2014; Thom *et al.*, 2012).

Across these areas, it can be argued that gamification in primary PE has a positive impact on learning. It normalises iteration, as games-based approaches encourage trying again, strategic refinements and finding alternative solutions, where mistakes are reframed as diagnostic information rather than deficits. Evidence suggests that immediate, constructive feedback strengthens persistence, resilience and competence, particularly when learners perceive challenge as surmountable and feedback as useful (Hamari *et al.*, 2014; Ryan and Deci, 2020; Sailer and Homner, 2020).

Further to this, gamification can nurture self-regulated learning over time, as children can set goals, monitor progress with visible indicators and reflect on outcomes in ways that exercise planning, evaluation and adaptive decision-making. These metacognitive routines extend beyond physical competence into broader educational development across subjects (Armour *et al.*, 2017). When aligned with sound theory and enacted through teacher expertise, gamification can clarify goals, enhance progression, build resilience, foster collaboration, make learning visible, enhance autonomy, promote inclusion and develop self-regulation.

What are the limitations?

However, the limitations of gamification must also be considered. Studies suggest that gamification over-relies on extrinsic rather than intrinsic motivation, creates superficial learning environments and generates learning hierarchies, with some studies reporting that, so far, there is no real evidence to suggest that the approach has a significant change in children's achievement in environments (Ferriz-Valero *et al.*, 2020).

The most significant caution in gamification literature is how it can create an overreliance on extrinsic motivation, with the accrual of points, badges and being top of a leaderboard

becoming the sole focus of a child (Hamari *et al.*, 2014; Treiblmaier and Putz, 2020). The awarding of these, specifically through competition, can lead to inequality if not managed properly, as some children can feel discouraged if they perceive they cannot compete (Quintas *et al.*, 2020). Self-determination theory notes that rewards experienced as a form of control undermine intrinsic motivation, whereas the opposite is more likely to sustain interest and depth (Sailer and Homner, 2020).

Critiques likewise report that gamified lessons which pivot on superficial rewards can produce declines in motivation over time, as novelty fades or as learners perceive systems as unfair or trivial (Hamari *et al.*, 2014; Hanus and Fox, 2015). In PE, where long-term engagement with physical activity is a central aim, designs must therefore ensure that any reward mechanics highlight learning, meaning and self-improvement rather than mere accumulation.



Figure 3. Photo by Mat Brown (Pexels, 2015)

Additionally, gamification creates a risk of surface learning, with participation occurring without any conceptual, tactical or reflective depth. Without careful design, gamification can become superficial, with children focusing only on rewards rather than genuine learning (Arufe-Giráldez *et al.*, 2022). Therefore, when game elements dominate pedagogical approaches and lesson time, movement tasks can be reduced to scoring rituals, with children becoming adept at collecting, striving purely for extrinsic reward without developing understanding of broader areas of learning (Hamari *et al.*, 2014). This could be problematic when thinking about Deterling's (2011) definition of gamification that provision should make use of game design elements and not the wholesale transformation of education into entertainment.

In primary PE, this is problematic if it impacts the time children are on task and trying to develop fundamental movement skills. Therefore, the design of gamification in lessons must ensure it promotes the epistemic aims of the lesson: making principles, skills, strategies and embodied knowledge visible (Armour *et al.*, 2017).

As well as this, whilst there is evidence that the competition and social comparison that gamification creates can have positive implications on progress (Arufe Giráldez *et al.*, 2022; Dicheva *et al.*, 2015), research also suggests this can inadvertently entrench hierarchies (Hamari *et al.*, 2014). Leaderboards and 'public rankings' between peers within PE lessons, especially in classes with pronounced developmental variation, may demotivate lower performing children and amplify social comparison if it is not thoughtfully structured toward co-operative goals and shared learning criteria (Casey and Goodyear, 2015). While competitive play is important, teachers must ensure they consider the psychological safety of the children they teach and ensure multiple outcomes are valued to demonstrate success (Arufe Giráldez *et al.*, 2022).

A way forward?

At this stage, research on the impact of gamification, specifically within primary PE, is sparse. The evidence that is available promotes advantages and limitations, but very little still confirms its overall effectiveness, meaning there are calls for more studies to be

conducted (Arufe Giráldez *et al.*, 2022; Blain *et al.*, 2022; Rice *et al.*, 2025; Zeybek and Saygi, 2024), particularly as this is a developing pedagogical approach.

Literature notes that teachers may resist the introduction of gamification, especially if they are not familiar with the concept or have a more traditional view of physical education (Arden *et al.*, 2022). But this could be because they do not have the specific design skills to do so (Ferraz *et al.*, 2024). This is important because, when implemented effectively, gamification can enhance children's motivation, promote active learning and create an enjoyable and immersive educational experience (Kulkarni *et al.*, 2022).

For this to happen, stakeholders within primary PE, qualified teachers and trainees require more training to develop their confidence in embedding the approach and measuring its impact, as often uneven confidence in both subject content and digital tools can limit depth and sustainability. Gamification is a knowledge intensive approach, requiring alignment between curriculum intentions, game mechanics, computing concepts and assessment criteria, as well as the technical fluency to manage any digital tools. Without adequate professional development, teachers may focus on visible features such as badges, points and leaderboards rather than on pedagogical coherence and assessment for learning (Armour *et al.*, 2017).

In initial teacher education, courses must begin to provide structured opportunities for trainees to explore the use of gamification through co-designing, trialling and critically evaluating technology-enhanced sequences of PE lessons, with explicit attention to aligning constructivist pedagogy and digital tools (Armour *et al.*, 2017; Goodyear and Dudley, 2015). In turn, this could yield more evidence to assess gamification's impact on primary PE teaching and learning. This is applicable to the pedagogical approaches outlined in this article but also to other digital technologies such as augmented reality and virtual reality, which support the implementation of gamification by creating immersive PE experiences and allowing children to engage in virtual simulations that require physical movements, practice skills in virtual environments or participate in interactive games (Orji *et al.*, 2018; Silva *et al.*, 2021; Wang *et al.*, 2022).



Figure 4. Photo by Алексей Вечерин (Pexels, 2021)

Conclusion

Gamification presents a promising pedagogical development for primary PE, particularly when understood not as a replacement for established teaching approaches but as a complementary tool that can extend constructivist learning practices. Gamified elements including levels, narrative tasks and rewards can help clarify learning intentions, support inclusive practice and increase children's motivation while fostering collaboration, resilience and self-regulated learning (Armour *et al.*, 2017; Deterding *et al.*, 2011; Hamari *et al.*, 2014).

When aligned with broader theories of learning that emphasise active engagement and social interaction (Piaget, 1952; Vygotsky, 1978), these approaches have the potential to make learning more visible and meaningful within the context of primary PE. However, the benefits of gamification depend heavily on thoughtful pedagogical design. Overreliance on points, rewards or competitive structures may prioritise extrinsic motivation, encourage superficial engagement or reinforce performance hierarchies if not carefully structured (Hamari *et al.*, 2014; Hanus and Fox, 2015; Treiblmaier and Putz, 2020).

Given the limited research currently available concerning gamification in primary PE, further empirical work is needed to explore its long-term impact on learning and participation. Alongside this, teacher education and professional development will be critical in ensuring that gamification is implemented in ways that remain pedagogically coherent, inclusive and aligned with the core aims of primary PE (Armour *et al.*, 2017; Goodyear and Dudley, 2015).

It leads to the question as to how gamified approaches are being used across different primary educational disciplines, and what similarities or differences exist in their perceived advantages and limitations for teaching and learning. As studies outline, more discussion in this area is required.

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Breaking silos through gameplay: A cross-institutional collaborative approach to gamified learning

Laura Hutchings, Glyn Jenkins and Robyn Griffiths

Introduction

Recently, at the University of Wales Trinity Saint David, conversations about teaching and learning have increasingly focused on collaboration, digital confidence and student belonging. Gamified learning did not begin as a formal solution to these priorities. Instead, it developed gradually through experimentation with more interactive and shared forms of learning. The focus was not on introducing a specific tool but on designing experiences that required students to work together in purposeful ways. This has evolved into a cross-institutional approach that includes a university-wide gaming day, immersive scenario-based activities and a collaborative Minecraft project with several local schools delivered in partnership with a community interest company.

This report reflects on what has emerged, particularly in relation to cross-institutional collaboration, skills development and the practical realities of implementing gamified approaches in higher education.

Collaborative gamified learning framework

As activity expanded, it became useful to clarify what was happening. A simple framework was developed that places gamified learning at the centre of three intersecting areas: creativity and innovation, learning and pedagogy and people and performance (see Figure 1).

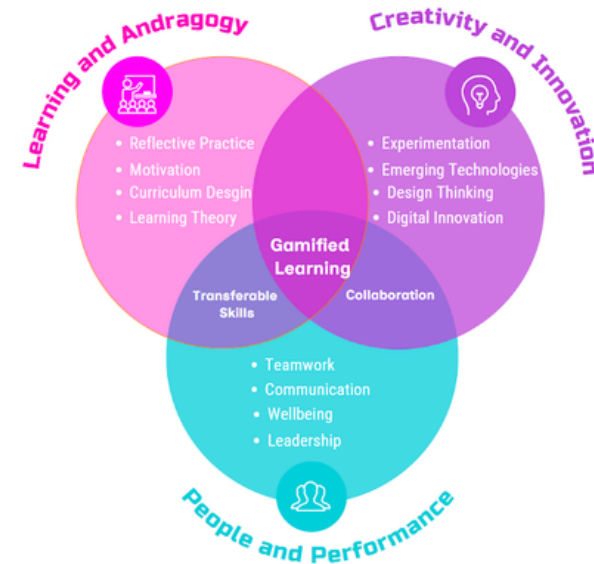


Figure 1. Gamified learning framework (University of Wales Trinity Saint David)

Each area connects to existing strengths within the university. Faculty names were deliberately excluded from the model to avoid positioning the work as belonging to one discipline. Instead, gamified learning operates as shared space. Within this, the Digital Experience and Engagement (DE&E) team sits centrally, acting as a connector across these areas and supporting the design and delivery of activity.

In practice, this has shifted conversations. Rather than asking where an activity sits organisationally, staff consider how it can be designed collaboratively. The framework provides a neutral reference point and encourages joint planning rather than parallel innovation.

Gaming days as collaborative learning spaces

Gaming days were organised to encourage collaboration across institutes and to raise awareness of gamified learning within the university (see Figure 2). The event was delivered in collaboration with the Students' Union and Esports Wales, giving students insight into esports as a developing area within the university and the potential for establishing a future societies.

Students contributed through their disciplinary strengths. Business students organised and managed the event, drawing on planning, logistics and coordination skills. Education students tested the games and examined how they could be linked to learning and curricular frameworks. Computing students supported the technical running of the games and provided troubleshooting where required.



Figure 2. Gaming day (University of Wales Trinity Saint David)

Opportunities for this type of structured cross-institute collaboration are relatively uncommon within standard programme delivery. The use of gameplay and esports formats created a shared focus, requiring coordination across roles and making each group's contribution visible and necessary.

For staff, the day provided insight into how gamified and esports-informed activity can support learning beyond participation, particularly in areas such as communication, planning and adaptability. For students, the experience connected subject knowledge to a live context while introducing the idea of esports as a potential area for future involvement. Engagement with the Students' Union and Esports Wales contributed to a sense of shared experience and highlighted opportunities for students to shape future activity within the university.

Immersive gamified experiences

Immersive activities are another aspect of the approach. Using the university's immersive rooms and virtual reality (VR) environments, scenario-based challenges are used to encourage collective decision making. Instead of discussing situations hypothetically, students work through them directly. They take on roles, manage time constraints and adjust their approach as things change. This tends to shift the focus from explanation to action, with communication becoming more immediate and purposeful.

An immersive room escape-room activity, although not developed specifically for this initiative, is used across a range of programmes (see Figure 3). Students work in teams to solve linked challenges within the space, drawing on different types of knowledge while working under time pressure. The format is flexible and has been used in different subject areas but consistently requires coordination and shared problem-solving.



Figure 3. Immersive escape room (University of Wales Trinity Saint David)

Alongside this, an in-house VR dodgeball game has been developed and is now used to support soft skills development. While competitive in format, the emphasis is on communication, teamwork and decision-making rather than performance. The activity has also been used during school visit days, where it provides a practical introduction to immersive learning while modelling collaborative behaviours.

The DE&E team supports the design and delivery of these activities, helping to ensure they remain aligned with learning aims and can be integrated into teaching rather than treated as standalone sessions. Across programmes, these immersive experiences create situations where teamwork and communication are not optional but required, making them easier to observe and reflect on.

Community collaboration: Minecraft showcase project

The initiative also extends beyond campus through a collaborative Minecraft project delivered with several secondary schools in partnership with a community interest company, Bantani Education (see Figure 4).



Figure 4. Minecraft, immersive room (University of Wales Trinity Saint David)

University students were involved in supporting the final showcase event, where school pupils presented their Minecraft-based work to a wider audience beyond their classroom. The showcase gave pupils a clear purpose for their work and an opportunity to explain their ideas. Enterprise elements were built into the pupil activity, with a focus on how ideas could be developed and communicated. Minecraft provided a space for this, allowing pupils to present their thinking through what they had created.

During the showcase, university students supported the running of the event. This included helping with organisation on the day, supporting pupils as they presented and assisting with the overall flow of the session. Working in this setting required clear communication and the ability to respond to what was happening in real time.

Bantani Education coordinated the project and worked with both the university and the schools to ensure everything ran smoothly. The showcase brought together work from across the schools and provided a shared point of focus.

Staff perspectives

From a staff perspective, one outcome has been a shift in how innovation is approached. There is greater willingness to design collaboratively across institutes rather than within isolated modules and more openness to trying approaches that would previously have sat outside standard delivery.

Working in this way has made it easier to test ideas in practice. Responsibility is shared, which reduces some of the hesitation around trying something new. It has also created more opportunities for informal collaboration, where ideas develop through activity rather than through formal planning alone.

There has also been a shift in the focus of conversations. Rather than centring on content or delivery, discussion more often turns to what students are doing within these activities, how they are interacting, where they are struggling and how they respond to different forms of challenge. This encourages a more practice-focused view of teaching.

For some staff, this has prompted reflection on how aspects of learning that are usually less visible, such as communication, teamwork and adaptability, might be better supported or recognised within their own modules. It has also highlighted the value of creating space within teaching for these elements to develop more naturally.

Student perspectives and skills development

Skills become visible through participation. Students negotiate roles, manage disagreement and adapt when plans change. Communication becomes clearer when tasks are shared and time bound. Digital tools are used with purpose rather than as isolated exercises.

Confidence develops gradually. These changes are incremental but observable, particularly as students become more comfortable contributing within group settings. Working towards shared outcomes strengthens connections across disciplines and encourages a sense of shared responsibility. This supports belonging while developing communication, teamwork and adaptability in context, without these needing to be taught separately.

Breaking down silos through gameplay

The absence of faculty labels signals that gamified learning is shared space. Collaboration becomes more routine. Staff plan across areas more readily and students encounter peers from different disciplines in structured contexts. External partners are integrated into activity rather than positioned separately.

This approach creates opportunities for interaction that would not normally occur within standard programme structures. Students begin to see how different areas of expertise connect in practice, while staff gain insight into how their teaching relates to others. Institutional silos remain, but they become less rigid when collaboration is built into learning experiences rather than added afterwards.

Conclusion

This initiative continues to develop, but several themes are consistent. Positioning gamified learning within a collaborative framework has supported cross-institutional working while strengthening student engagement and skills development. The most significant impact may be cultural rather than technological. When structured gameplay becomes part of academic practice, it influences how students and staff work together. In this context, gamified learning functions as a practical way of organising collaboration.

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Beyond motivation: Using Times Tables Rock Stars critically in the primary mathematics classroom

Aidan O'Brien

Abstract

Times Tables Rock Stars (TTRS) is widely used in UK primary schools to build times table fluency, but its value extends beyond pupil motivation. Drawing on a small-scale case study in one primary classroom, this article explores how TTRS shaped pupil engagement, emotional responses, and fluency and understanding. Using classroom observation, pupil voice and a teacher interview, the study found that TTRS could increase motivation and support fluency through repetition, immediate feedback and visible progress. However, competitive features produced mixed emotional responses, with some pupils thriving on comparison while others experienced pressure or frustration. The findings also suggest that gains in speed and recall did not automatically lead to deeper mathematical understanding. TTRS appears most effective when used critically, as one part of a broader approach to teaching rather than as a stand-alone solution.

Keywords: Times Tables Rock Stars, primary mathematics, gamification, mathematical fluency, pupil motivation, educational technology

Introduction

Most primary teachers will recognise the appeal of Times Tables Rock Stars (TTRS). Anything that gets pupils practising multiplication facts more willingly is likely to earn a place in the classroom, especially when times table fluency remains such a visible priority in Key Stage 2 and within the wider context of the Multiplication tables check (Standards & Testing Agency, 2022). TTRS offers a persuasive mix of timed practice, quick feedback, competition and reward. For many schools, it seems to solve a practical problem: how do we get pupils to practise more readily?

Yet the use of tools such as TTRS raises a wider question for primary mathematics teaching. If pupils appear more engaged, what exactly are they becoming better at? Increased motivation may be valuable in itself, but it does not automatically mean deeper mathematical understanding. Competition may energise some pupils while creating pressure for others. The educational value of TTRS, therefore, cannot be judged only by whether pupils enjoy it or use it regularly.

This article explores those questions through a small-scale case study in one mixed Year 4 and 5 classroom, where TTRS was already embedded in practice. Using classroom observation, a pupil focus group and a teacher interview, it asks a more useful question than whether TTRS simply 'works': what kind of learning does it appear to support, under what conditions and with what trade-offs?

The argument is not that TTRS should be rejected, nor that gamification is inherently problematic. Rather, tools like TTRS are most useful when they are used critically. Motivation matters, but so do pupils' emotional responses, classroom culture and the distinction between becoming faster and becoming more mathematically secure.

Why TTRS deserves a critical look

Digital platforms now occupy a familiar place in primary education, often promoted as ways to increase engagement and make practice more appealing. In mathematics, this is especially visible in tools designed to develop fluency through repetition, feedback and tightly structured tasks. TTRS sits squarely within that landscape. Its design combines timed recall, visual rewards, avatar customisation and competitive features such as battles and leaderboards, making it a clear example of gamification in everyday classroom practice.

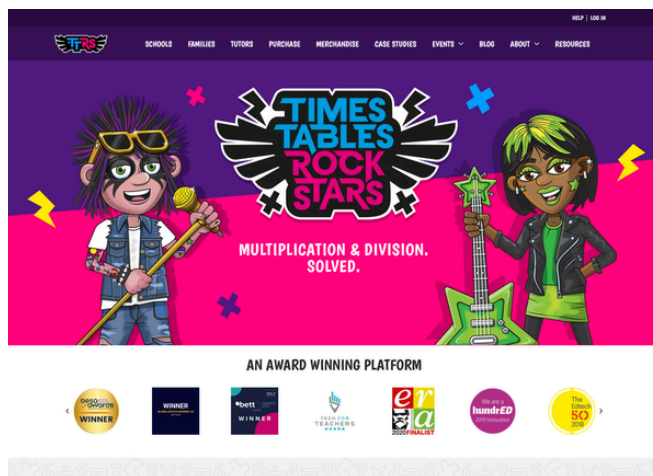


Figure 1. TTRS (Times Tables Rock Stars, n. d.)

Part of the appeal is understandable. Research on gamification has often reported positive effects on motivation and participation, especially when learners experience progress, challenge and recognition (Deterding *et al.*, 2011; Dichev and Dicheva, 2017; Sailer and Homner, 2020). In primary mathematics, this is attractive because fluency with number facts is often seen as a foundation for later success, and digital tools can provide frequent, immediate practice.

However, there are good reasons to approach such tools critically rather than assuming that popularity is evidence of educational value. Educational technology research has long warned that high engagement does not necessarily lead to deeper learning, and that digital appeal can sometimes reflect novelty or surface performance rather than secure understanding (OECD, 2015; Selwyn, 2014). Similar concerns appear in work on gamification, where rewards, rankings and public recognition may motivate some pupils while discouraging others, particularly when comparison becomes too visible (Hanus and Fox, 2015; Ratinho and Martins, 2023).

This matters particularly in mathematics. A pupil may become quicker at recalling multiplication facts without developing a fuller understanding of number relationships or knowing how that knowledge transfers into wider mathematical reasoning. Skemp's (1976) distinction between instrumental and relational understanding remains useful here: producing answers rapidly is not the same as understanding why those answers make sense. TTRS is worth examining because it captures a wider tension in primary mathematics teaching between speed, motivation and understanding.

What I explored in one primary classroom

This article is based on a small-scale case study in one mixed Year 4 and 5 primary classroom, where TTRS was already part of everyday practice. The class was chosen because multiplication fluency was a clear priority at this stage, particularly in relation to preparation for the multiplication tables check, and because pupils were already familiar with the platform. This made it possible to focus on their experience of using TTRS rather than on the novelty of the app itself.

The study drew on three sources of evidence. I carried out classroom observations, including one during regular use of TTRS and another during a whole-school assembly, where achievement on the platform was publicly celebrated. I then conducted a pupil focus group with six children from the class, selected to reflect a mix of year groups, gender and mathematical attainment. Finally, I interviewed the class teacher to gather a practitioner perspective on motivation, competition and learning. The data was analysed thematically to identify recurring patterns across pupil and teacher responses.

As a single-class case study, the aim was not to make broad claims about all uses of TTRS. Instead, it was to gain a closer understanding of how one established use of the platform was experienced by pupils and interpreted by a teacher in context.

Motivation matters, but it is not the whole story

One of the clearest findings was that TTRS did motivate pupils to practise. Pupils spoke positively about using it, and much of that enthusiasm seemed to come from a simple combination: they could see themselves improving, they could revisit tables they found difficult, and the platform made repetition feel more like play than routine. In that sense, TTRS appeared to do something many teachers want: it increased pupils' willingness to practise multiplication facts regularly.



Figure 2. TTRS Mobile App (Times Tables Rock Stars, n. d.)

Part of that pull came from the design of the platform itself. Timed games, instant feedback and visible progress gave pupils a sense of momentum, while rewards and leaderboard movement added excitement. For some, this seemed to strengthen confidence as well as participation. The platform did not just provide practice; it made practice feel purposeful and measurable.

Motivation, however, should not be mistaken for a straightforward sign of educational success. Pupils were often motivated by different things. Some seemed driven by self-improvement and challenge, while others were more influenced by competition, recognition or in-game rewards. Those differences matter because they point to different kinds of engagement. A pupil who is motivated to improve fluency may be experiencing something quite different from a pupil who is mainly motivated by status or reward.

There were also limits to that motivation. Several pupils described frustration or fatigue when sessions went on too long, and the teacher suggested that enthusiasm could tip into overuse. The more useful conclusion, then, is not simply that TTRS motivates pupils, but that it motivates them in different ways, and that this motivation still needs to be shaped by teacher judgement and clear classroom purpose.

When competition helps and when it harms

Competition was one of the most emotionally complex parts of TTRS in this study. For some pupils, it clearly added energy and purpose. Leaderboards, public recognition and the possibility of moving up through the ranks gave achievement a visible social value. One pupil described seeing another child reach *Rock Legend* and wanting to “work so hard” to achieve the same. Another responded to moving down the rankings by saying they could simply “work my way back up”. In moments like these, competition seemed to reinforce pride, aspiration and persistence.



Figure 3. Status badges (Times Tables Rock Stars, n. d.)

However, that was only part of the picture. The same competitive structures that motivated some pupils created frustration, sadness and anxiety for others. Several pupils described feeling upset when they moved down the leaderboard, and one admitted avoiding *Rock Slams* because they did not want to lose. The teacher added that some children “beat themselves up” and that there had been “tears in the past”. Competition was therefore not experienced as a neutral classroom feature. For some pupils, it introduced a genuine emotional risk, especially when performance was visible to others.

What seemed to matter most was not competition in the abstract, but the way it was felt socially. Pupils were highly aware of how they appeared in relation to their peers. One pupil commented that “people get shocked” when certain children are at the top, hinting at the status attached to success within the class. Another said, “I don’t want to get a bad score in front of my friends,” suggesting that even before play began, the possibility of

public failure could shape behaviour. Observation notes from assembly pointed to a similar tension, with at least two pupils appearing reluctant or embarrassed when asked to stand at the front.

Competition in this classroom therefore appeared to motivate unevenly. Some pupils thrived on visible challenge and recognition, while others experienced the same conditions as pressure or exposure. That does not mean competitive features should be removed entirely, but it does suggest that they need careful handling.

Fluency is not the same as understanding

One of the clearest strengths of TTRS in this study was its support for fluency. Pupils spoke about becoming quicker and more confident with multiplication facts, and their comments suggested that repeated, timed practice helped answers become increasingly automatic. One pupil explained, “I get used to how fast I’m going, so it helps me get faster and faster,” while another said, “I don’t have to think about the answers; they just pop into my head now.” The teacher supported this too, describing TTRS as something that “helps with speed and accuracy”.

This is important in primary mathematics. When pupils are still counting on fingers or working out basic facts from scratch each time, much of their mental effort is spent on retrieval itself. Greater fluency can reduce that burden and make it easier to focus on the wider demands of a task. In that sense, TTRS appeared to function well as a rehearsal tool.

Its limits were equally important. Becoming faster with multiplication facts did not automatically mean that pupils had developed deeper mathematical understanding. Several pupils drew that distinction themselves. One reflected, “I know all the answers really fast, but sometimes I forget what it means when we do problems with words or money,” while another commented, “It’s not the same as when we do hard maths with the teacher.” The teacher made a similar point, describing TTRS as something that “gives them the tools, but it doesn’t teach them how to use them in real-life problems”.

This distinction sits at the heart of the wider argument in the article. A child may answer quickly within a timed game and still struggle to apply that knowledge in a less structured context. TTRS seemed most effective as a tool for strengthening recall, not as a route to deeper conceptual learning on its own.

There was also some evidence that the speeded nature of the platform could create its own difficulties. One pupil noted, "Sometimes I rush too much on TTRS and get things wrong that I know really well." TTRS can strengthen automatic recall, but it can also encourage pupils to associate mathematical success too closely with speed. Used critically, it can support fluency. Used less carefully, it risks narrowing pupils' sense of what it means to be good at mathematics.

What this means for classroom practice

For primary teachers, the findings do not point towards abandoning TTRS but towards using it more precisely. The platform appeared most useful when it was treated as one part of mathematics teaching rather than as a complete approach in itself. Its strongest contribution was in helping pupils rehearse multiplication facts until recall became quicker and more secure. That is valuable, particularly for pupils who still rely on counting strategies or who need frequent, structured practice. However, fluency practice should not be confused with the teaching of understanding. If TTRS is used regularly, it needs to sit alongside discussion, reasoning and problem-solving so that pupils can connect rapid recall to wider mathematical meaning.

The findings also suggest that teachers need to pay close attention to how competition operates in the classroom. For some pupils, rankings, battles and public celebration increased motivation and built a sense of achievement. For others, the same features created pressure, frustration or embarrassment. Competitive elements should therefore not be assumed to suit everyone equally. Teachers may need to think carefully about how visible comparison is made, how achievement is recognised, and whether quieter pupils are being drawn in or pushed to the margins.

A final implication concerns teacher judgement. TTRS did not remove the need for professional interpretation; if anything, it made that judgement more important. Pupils' enthusiasm could easily be mistaken for secure learning, and quick answers could give the impression of deeper understanding than was actually present. Teachers therefore need to look beyond scores and speed alone, noticing how pupils explain their thinking, how they apply number facts in other contexts, and how they respond emotionally to the platform.

Used well, TTRS can make practice more engaging and strengthen fluency. Used less carefully, it risks overvaluing speed, overlooking emotional differences and narrowing what counts as mathematical success. The question for teachers is not simply whether to use TTRS, but how to use it in ways that keep motivation, wellbeing and understanding in balance.

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The ‘forbidden fruit’ effect: Psychological reactance and the regulation of generative AI use in higher education assessment

Andra-Mihaela Abu Ghuwaleh

Abstract

The rapid rise of generative artificial intelligence (AI) has prompted regulatory responses across higher education institutions. Concerns about authorship, academic integrity and the development of key academic skills have led many universities to introduce policies that limit the use of AI tools in assessment. However, comparatively limited attention has been given to the behavioural implications of AI governance for student engagement with generative technologies. This paper offers a conceptual perspective on how students may respond to such institutional constraints. Drawing on psychological reactance theory, it proposes a ‘forbidden fruit’ dynamic, in which perceived limitations on behavioural freedom increase the salience of regulated technologies. From this perspective, policies governing AI use may influence not only whether students engage with such tools but also how that engagement occurs and how it is represented within assessment. The article highlights the need for further research on how students interpret institutional AI policies and how regulatory environments shape patterns of technology use.

Introduction

The rapid diffusion of generative artificial intelligence (AI) writing tools such as ChatGPT has intensified debates in higher education regarding their pedagogical value, risks and long-term consequences for academic writing (Shabir, 2025). Earlier AI-assisted writing tools, such as Grammarly and similar applications, primarily supported tasks (e.g., grammar correction, paraphrasing, stylistic refinement), serving mainly as feedback and editing aids within the writing process (Deep and Chen, 2025; Raitskaya and Tikhonova, 2024). However, the emergence of generative AI systems following the release of ChatGPT has significantly expanded these capabilities, enabling the production of extended and coherent text, as well as idea generation and structural support for academic writing (Raitskaya and Tikhonova, 2024; Deep and Chen, 2025).

This rapid development has contributed to growing concerns in higher education regarding academic integrity, authorship and the impact of AI on student learning, prompting institutions to reconsider existing policies and frameworks governing academic writing (Deep and Chen, 2025; Raitskaya and Tikhonova, 2024). Academic discourse has increasingly framed generative AI as both a challenge to established principles of academic integrity and a potential opportunity for pedagogical innovation. Because many forms of assessment rely on assumptions of individual authorship and independent knowledge production, the capacity of generative AI systems to produce sophisticated written responses raises questions about the extent to which submitted work reflects students’ own reasoning and learning processes (Cotton *et al.*, 2024).

On the other hand, some literature highlights the potential of these tools to support learning through enhanced feedback, accessibility and the development of AI literacy, particularly when integrated within guided instructional frameworks (Peterson, 2025). In both instances, higher education institutions have increasingly responded to the rise of generative AI by introducing policies and guidelines to regulate its use in assessment (Bittle and El-Gayar, 2025). However, while existing research has largely focused on technological, pedagogical and regulatory responses, comparatively limited attention has been paid to the behavioural implications of these frameworks, particularly in relation to how students engage with and respond to AI tools in academic contexts (Bittle and El-Gayar, 2025).

This article advances a conceptual account of the potential behavioural consequences of restrictive or tightly regulated AI policies in assessment contexts. Drawing on psychological reactance theory, which posits that perceived threats to behavioural freedom can elicit resistance and increase the attractiveness of restricted options (Brehm and Brehm, 1981; Steindl *et al.*, 2015), it suggests that prohibitive approaches may unintentionally heighten the salience of restricted technologies when students interpret such policies as limiting their autonomy. From this perspective, regulatory responses may influence not only whether generative AI is used but also how it is used and how visible it becomes within assessment practices. This paper aims to contribute to emerging debates on generative AI governance in higher education by applying psychological reactance theory to examine how restrictive AI policies may shape student engagement with generative technologies.



Figure 1. Generative AI (Photo by Markus Winkler on Unsplash, 2020)

Institutional responses to technological disruption

Institutional responses to disruptive technologies are rarely neutral. Universities operate within broader regulatory and societal contexts in which educational qualifications serve as signals of graduate competence, and assessment plays a key role in defining and validating learning outcomes (Holmes *et al.*, 2019). In this sense, when technological developments appear to introduce uncertainty into established evaluation practices, institutions may respond by seeking to stabilise the system through clarification, regulation and monitoring.

Such responses might be described as a policy reflex designed to contain perceived risks associated with new technologies. Similar dynamics have been observed in earlier debates surrounding plagiarism and contract cheating, where the boundaries between legitimate academic support and misconduct are often complex and context-dependent, requiring careful interpretation within institutional frameworks (Bretag, 2013; Dawson and Sutherland-Smith, 2017). The emergence of generative AI has triggered similar patterns of institutional response. Universities have introduced a range of governance measures, including formal policies regulating AI use, guidance documents outlining acceptable

practices and technological monitoring tools intended to detect AI-generated content (Peterson, 2025). While such policies are often framed as necessary safeguards for academic integrity, they also reshape the normative environment in which students interpret assessment expectations.

Notably, regulatory frameworks do not simply constrain behaviour but also influence how individuals perceive legitimacy, risk and autonomy within institutional contexts. Therefore, rules governing the use of generative AI form part of the behavioural environment in which students make decisions about how to approach academic work. Understanding how students respond to these regulatory conditions represents an important but underexplored dimension of the broader debate surrounding generative AI governance in higher education. The following section introduces a theoretical perspective that may help explain some possible behavioural responses.

Psychological reactance and perceived loss of autonomy

To explore the potential behavioural implications of restrictive technological policies, it is useful to draw on psychological reactance theory. Originally proposed by Brehm (1966), reactance theory suggests that individuals are motivated to preserve their perceived behavioural freedom (Brehm and Brehm, 1981; Steindl *et al.*, 2015). Thus, when institutional rules or directives are interpreted as constraining a valued freedom, individuals might experience a motivational state oriented towards restoring autonomy, commonly referred to as psychological reactance. A key implication of this perspective is that restrictions can alter how individuals perceive the value of the option being restricted. Behaviours framed as prohibited or tightly controlled may become more salient, attracting increased attention precisely because they are positioned as limited or unavailable (Steindl *et al.*, 2015).

This dynamic could be described as a 'forbidden fruit' effect, whereby a threatened sense of freedom may lead to student resistance (Mirick, 2016). From this perspective, institutional policies not only regulate behaviour but might also shape how individuals interpret the boundaries of acceptable action. When applied to generative AI, restrictive

restrictive policies may influence student engagement with these technologies beyond mere compliance, potentially increasing their perceived significance in assessment contexts. *Figure 2* illustrates a conceptual relationship between restrictive AI policies, perceived autonomy threats, psychological reactance and potential behavioural adaptations, and is discussed in the following section.

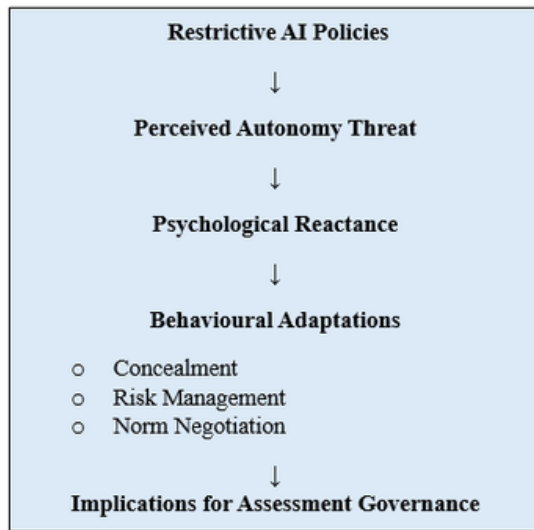


Figure 2. Conceptual model of behavioural responses to restrictive AI policies

Behavioural adaptation and the reconfiguration of AI engagement

Studies examining contract cheating and related forms of academic misconduct suggest that student behaviour often shifts across a spectrum of practices rather than being eliminated entirely, with engagement shaped by perceived opportunities and contextual factors within the learning environment (Bretag *et al.*, 2018; Dawson, 2020). From a behavioural perspective, regulation does not merely suppress undesirable practices but might also reshape their form and visibility within institutional settings. In the context of generative AI, this suggests the potential emergence of several forms of behavioural

adaptation, which could include the strategic concealment of technological assistance, shifts in the allocation of cognitive effort and the negotiation of normative boundaries surrounding acceptable technology use.

One possible adaptation involves strategic concealment. If institutional policies frame generative AI primarily as a source of academic risk, students may attempt to retain the perceived advantages of these tools while minimising the visibility of their use within assessment processes. This may involve integrating AI systems during earlier stages of the writing process, substantially modifying generated text or blending AI outputs with independently produced material in ways that obscure the extent of technological assistance. However, this dynamic might also reduce institutional visibility into how generative technologies are actually used within assessment contexts. As AI engagement becomes increasingly concealed or indirect, the gap between formal policy expectations and everyday academic practice may widen, complicating efforts to evaluate whether governance strategies are effectively shaping learning behaviour.

A second form of adaptation might concern the reallocation of cognitive effort within AI-mediated learning environments. If engagement with generative technologies is perceived as risky or illegitimate, part of the effort associated with academic work may shift towards managing that risk. In this sense, students could devote time to editing AI-generated outputs to avoid detection, adjusting stylistic features to align with their own writing patterns or ensuring that generated material appears indistinguishable from human-authored work. While these activities would still involve forms of revision and judgment, they may redirect attention away from conceptual engagement with course material towards the management of technological legitimacy. From an educational perspective, this raises the possibility that restrictive governance frameworks could inadvertently encourage students to allocate cognitive resources towards navigating institutional scrutiny rather than developing deeper disciplinary understanding.

A third adaptation involves interpreting and negotiating normative boundaries surrounding acceptable AI use. Institutional policies governing generative technologies are still evolving,

communicated unevenly and interpreted differently across courses and instructors. Under such conditions, students might develop their own working understandings of what constitutes legitimate technological assistance. Rather than interpreting AI engagement in strictly binary terms of compliance or violation, students may perceive institutional rules as defining flexible boundaries within which certain forms of technological support remain acceptable. This interpretive negotiation could also contribute to an increased ambiguity around academic norms. If expectations are perceived as unclear or inconsistently applied, students could rely more heavily on informal interpretations of acceptable practice, potentially weakening the normative clarity that academic integrity frameworks are intended to maintain.

Therefore, applying psychological reactance theory, these patterns suggest that restrictive AI policies might influence not only whether generative technologies are used but also how they are integrated into academic work. Rather than eliminating technological engagement, regulatory strategies may displace it into less visible, more strategic or more ambiguously interpreted forms. From this perspective, the behavioural effects of AI governance could be understood less as the suppression of technological practices and more as their reconfiguration within institutional constraints. Thus, recognising these dynamics may be important for institutions seeking to design governance approaches that protect academic integrity while also supporting meaningful learning processes in increasingly AI-mediated educational environments.

Aligning assessment, policy and technology in AI-mediated learning

As discussed in the preceding sections, restrictive regulatory approaches might reshape how students engage with generative AI rather than eliminating its use altogether. These behavioural dynamics suggest that institutional responses to AI may not be addressed through policy mechanisms alone. Instead, questions of AI governance are inseparable from broader considerations of assessment design and pedagogical strategy. If generative technologies are likely to remain embedded within students' learning environments, institutions should consider how assessment practices, policy frameworks and technological realities interact.

One implication concerns the relationship between assessment outputs and learning processes. Traditional assessment practices rely on submitted work as evidence of student learning, which can create vulnerabilities in contexts where authorship is difficult to verify (Dawson, 2020). However, when generative systems can assist with drafting, summarising and structuring text, the connection between the final product and the intellectual processes it is intended to represent becomes less transparent. Pedagogical approaches that emphasise the visibility of reasoning, such as staged drafting, process documentation or reflective explanations of methodological choices, may help realign assessment practices with the underlying cognitive work they aim to evaluate. This proposition is informed by broader concerns that conventional assessment formats might not reliably capture students' actual reasoning processes, particularly in contexts where authorship is uncertain (Cotton *et al.*, 2024), and where assessment plays a key role in signalling competence (Holmes *et al.*, 2019).

By shifting evaluative attention towards how ideas are developed rather than solely the finished written work, such approaches could also reduce incentives for the strategic concealment of technological assistance. However, this remains a theoretical proposition rather than an empirically established outcome. At the same time, process-oriented assessment may introduce practical challenges. Documented reasoning would not necessarily guarantee genuine intellectual engagement, and increased emphasis on process might generate additional administrative and evaluative workload for instructors. As a result, while greater process visibility may strengthen the interpretability of assessment outcomes, it may also complicate the scalability and efficiency of assessment practices.

A second implication concerns the role of transparency in AI governance. As earlier sections suggest, regulatory environments that frame AI use primarily in terms of prohibition may encourage forms of strategic or concealed engagement. Transparency-based approaches, such as requiring students to declare their use of generative AI tools in assessed work, have emerged as a potential alternative to more restrictive responses (Gonsalves, 2025). In principle, these models shift the evaluative focus from detecting technological assistance to examining the student's intellectual engagement with that

assistance. However, the effectiveness of transparency frameworks depends heavily on institutional implementation. In some contexts, students may be encouraged to acknowledge their use of AI while simultaneously facing penalties if that use exceeds narrowly defined allowances. Under such conditions, transparency might become conditional rather than supported, creating a paradox in which disclosure could increase rather than reduce perceived risk. Instead of fostering openness, such arrangements might reinforce incentives for concealment and further complicate the relationship between policy expectations and actual student behaviour.

A third consideration involves the development of AI literacy as a pedagogical objective. As generative technologies become increasingly embedded within professional and knowledge work, graduates are likely to encounter them beyond formal education (Dwivedi *et al.*, 2023). Therefore, higher education may face the challenge of preparing students not only to use such systems but also to critically evaluate their outputs. Developing competencies in recognising bias, identifying hallucinated information and assessing epistemic uncertainty could support more reflective and responsible engagement with AI tools. At the same time, integrating AI literacy into existing curricula might present its own challenges.

These considerations suggest that effective governance of generative AI may depend less on the strictness of institutional restrictions and more on how well policy frameworks align with pedagogical design. Where assessment practices, institutional expectations and technological realities operate in isolation, regulatory approaches may possibly struggle to meaningfully shape behaviour. Conversely, when governance strategies are integrated with assessment design and educational objectives, institutions might be better positioned to maintain academic standards while adapting to the evolving technological landscape.

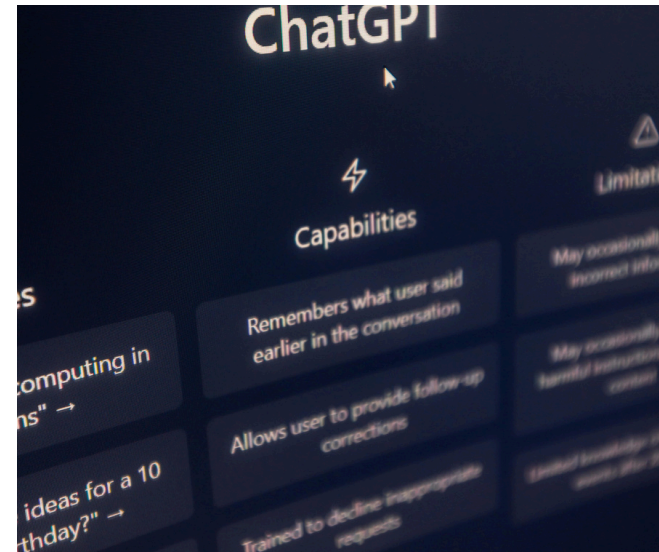


Figure 2. ChatGPT (Photo by Matheus Bertelli on Pexels, 2023)

Limitations and future directions

The argument advanced in this article is conceptual and, consequently, introduces several limitations. The analysis draws on psychological reactance theory to propose a potential behavioural dynamic associated with restrictive AI policies in assessment contexts. However, the article does not present empirical evidence demonstrating that such responses occur systematically among students. Therefore, the framework should be understood as a theoretical lens intended to guide future research rather than as a claim about observed behavioural patterns. Student engagement with generative AI is also unlikely to be uniform. Not all students will use AI tools in their academic work, and among those who do, many might operate within institutional guidelines rather than attempting to circumvent them. Consequently, the behavioural dynamics discussed in this article should be interpreted as possible tendencies within particular regulatory environments rather than universal patterns of student behaviour.

A second limitation concerns the scope of behavioural adaptations considered. The discussion highlights several potential responses to restrictive AI governance, including strategic concealment of technological assistance, shifts in cognitive effort toward managing institutional risk, and negotiated interpretations of policy boundaries. These dynamics do not represent an exhaustive account of how students could adapt to regulatory environments. As generative technologies continue to evolve, students may develop additional strategies to circumvent institutional restrictions, including using alternative digital tools, indirect forms of technological assistance or hybrid workflows that combine human and automated inputs.

A further limitation relates to the diversity and evolving nature of institutional responses to generative AI. Universities are currently experimenting with a range of governance approaches, including prohibition, partial restriction, declaration-based frameworks and more permissive models of technological integration. Because the analysis in this article focuses primarily on restrictive policy environments, behavioural responses might vary across institutional contexts, disciplinary cultures, assessment formats and stages of technological adoption.

These limitations point towards several avenues for future research. Empirical studies examining how students interpret and respond to AI policies would help clarify the behavioural assumptions underlying current governance approaches. Additionally, comparative research across institutions employing different regulatory models could help clarify whether policy structures influence patterns of AI engagement. Qualitative approaches, including interviews, focus groups and ethnographic studies, may be particularly useful for exploring how students perceive policy legitimacy, evaluate risks associated with AI use and navigate ambiguous institutional guidelines. Experimental and survey-based research could also examine whether restrictive policy framing influences perceived autonomy, intentions to use AI tools and willingness to disclose AI assistance in academic work, thereby testing whether the behavioural dynamics proposed in this article align with predictions derived from psychological reactance theory.

Conclusion

The rapid emergence of generative AI has raised new challenges for established assumptions about authorship, assessment and academic integrity in higher education. Institutional responses have largely focused on developing regulatory frameworks that define acceptable uses of AI within academic work. While such measures aim to preserve the credibility of assessment practices, the behavioural consequences of these approaches have received comparatively limited attention.

This article has argued that psychological reactance theory provides a useful lens for examining how students might interpret and respond to restrictions on generative AI. If institutional rules are perceived as constraining behavioural autonomy, students may seek ways to restore that autonomy. In the context of AI governance, restrictive policies could shape not only whether students engage with generative technologies but also how that engagement occurs and how visible it becomes within academic work. From this perspective, institutional regulation may possibly produce what this article terms a 'forbidden fruit' dynamic, in which technologies framed as restricted acquire heightened behavioural salience. Rather than eliminating technological engagement, regulatory pressure may redirect it into more strategic, concealed or negotiated forms. The behavioural adaptations discussed in this article, including concealment of technological assistance, shifts in cognitive effort toward managing institutional risk and negotiated interpretations of policy boundaries, show how governance strategies might reshape technological engagement without necessarily reducing its prevalence.

Recognising these dynamics has important implications for institutional responses to generative AI. Regulatory frameworks developed without attention to behavioural incentives might unintentionally shape patterns of technological engagement in ways that differ from institutional intentions. Addressing this challenge may require closer alignment between policy frameworks, assessment design and pedagogical objectives. Approaches that increase the visibility of reasoning, promote meaningful transparency and develop students' critical engagement with AI technologies could help mitigate some of the

behavioural dynamics identified in this article.

Ultimately, the governance of generative AI in higher education is unlikely to be resolved through regulation alone. As AI systems become increasingly integrated into learning environments, institutional responses will need to balance the protection of academic integrity with the realities of technologically mediated knowledge production. Therefore, understanding how students respond to technological restrictions may be as important as determining how such technologies should be regulated.

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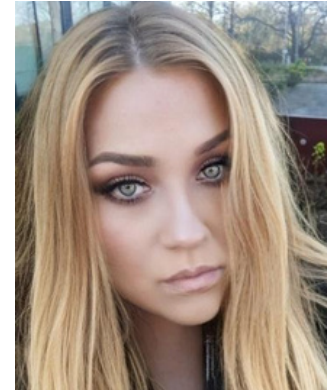
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Using AI to create coaching training materials for teachers

Martin Richards

“AI is not just my production tool, it is my thinking partner.”

Guiding teachers to coach their students requires a steady supply of clear, practical examples. Coaching is not the same as direct instruction – it emphasises curiosity, questioning and student-led problem-solving. To make this concrete for teachers, I need dozens of realistic dialogues and visual illustrations.

Creating the dialogues and visuals manually was unsustainable. Artificial intelligence (AI) now allows me to produce the volume and variety of material needed while refining how I explain coaching itself. This article showcases the production process for creating AI-generated coaching resources.

Why AI?

Teachers learn best from scenarios that mirror their own classrooms. A science teacher wants examples about lab reports, a language teacher about vocabulary practice. I also prefer to present these dialogues both in text and as cartoons. The visual form helps teachers quickly absorb the flow of a coaching exchange.

The challenge is scale. New training contexts often demand fresh material, and I could not draft or draw fast enough. Training an AI model on coaching structures and cartoon prompts solved this problem. I can now generate new examples in minutes.

Equally important, creating instructions for AI forced me to clarify what effective coaching looks like. In refining prompts, I refined my own definitions, which has made my training sessions more coherent.

Why train teachers to coach?

Coaching is not an ‘extra’ skill for teachers; it is an extension of what they already do. Whenever a teacher asks, “How might you approach this differently?”, instead of giving the answer, they are coaching. By naming and strengthening this practice, we help teachers use it more deliberately. The benefits are clear:

- Coaching fits seamlessly into the school day.
- It improves instruction by fostering dialogue.
- It deepens student learning through greater ownership.
- It reduces pressure on teachers to provide every solution.

Framing coaching as part of the everyday toolkit helps teachers embrace it with confidence.

The approach

I introduce coaching in three stages:

1. Mindset – Teachers explore beliefs that underpin coaching: valuing growth, listening deeply and seeing learning as collaborative.
2. Structure – Teachers practice simple frameworks for dialogue, such as: “What’s on your mind?” → “What’s challenging here?” → “What options do you see?” → “What will you try first?”
3. Application – Teachers test these frameworks in everyday situations, comparing their instincts with how a coach-trained teacher might respond.

This cycle – mindset, structure, application – makes coaching practical and transferable.

Example prompts

The training material is intended to show how a teacher can coach a range of students asking the same key questions, interspersed with follow-up questions based on what the student says.

Coaching questions

These all came from earlier work, [10 Coaching Models](#), and were based on the familiar GROW Model.

The students

Five student characters were defined and labelled as:

- Philosopher teen – reflective, searches for meaning, uses metaphors, questions expectations
- Comedian teen – witty, humorous, sarcastic, often hides seriousness behind jokes
- Pragmatist teen – practical, straightforward, focuses on realistic solutions
- Romantic teen – emotional; expressive; poetic; cares about beauty, feelings and belief
- Skeptic teen – doubtful, questioning, sometimes cynical, values honesty and authenticity

Coaching dialogues

This is how their respective dialogues were created. The teacher's key questions were fixed. What I needed was student responses in line with their personality.

“Good morning. We'll be writing coaching dialogues using this quick reference list of the five teen character archetypes we developed. In the dialogue, label the teacher as T and the student as S. Use these questions for T:

Are there any topics or areas that you don't want to discuss?
What thoughts have you been having about this lately?
What's the best possible outcome you can imagine?
What do you need to say yes or no to?
What did you learn about yourself in the process?

T asks questions as before, and also asks follow-up questions using the words that S has spoken.

T does not answer any questions from S.

S is sometimes less sure of themselves and has some trouble formulating their response.

T helps them formulate their response by summarising and suggesting what they might mean.

At the end of the conversation, include a summary. T invites S to reflect on the conversation. Then summarise their takeaways, learnings and plans for the future.

If there's anything that's unclear, ask me first.”

Those prompts produced the dialogues I needed for the training material.

Scene: Maths classroom, on Monday morning after a football match.

Several students are restless, whispering, and giving sharp looks across the room. The teacher notices and pauses before starting the lesson.

👉 Here the teacher doesn't resolve the football dispute or declare a "right side." Instead, they acknowledge the conflict, invite students to notice its impact, and guide them to choose a way forward together.

Teacher: I can see there's a lot of energy in the room right now. Looks like something's on your minds. Who wants to share what's happening?

Student 1: (crosses arms) They were totally cheating in yesterday's match. Everyone saw it.

Student 2: (snaps back) That's not true! We won fair and square.

Student 3: (to Student 2) You just don't want to admit it.

Teacher: Okay, so I'm hearing strong feelings about the football game. Sounds like some of you are still carrying that into class. Did I get that right?

Students: (murmur in agreement, nodding, some still scowling)

Teacher: Given that the match is over, and we've got Maths work in front of us, what do you think would help you handle those feelings so you can focus here?

Student 1: (after a pause) Maybe just agree to disagree?

Student 2: Yeah... arguing isn't gonna change it.

Student 3: We could talk about it later, not now.

Teacher: Those are good ideas. So, for now, what's your shared choice, how do you want to show up in maths class?

Students: (a few nods) Try to let it go.

Teacher: Great. Let's test that. We'll dive into the first question, and at the end of ten minutes, I'll check in: you tell me if you managed to focus better. Deal?

Students: Deal.

Figure 1. Training material 1

Scene: A classroom. Some students are whispering and fidgeting while the teacher writes a problem on the board.

👉 The teacher doesn't scold or direct but instead invites the students to notice what's happening, voice their needs, and make choices—helping them refocus in the moment and practice self-awareness.

Teacher: I notice some of us are finding it hard to focus right now. Before we continue, can I ask, what's on your minds?

Student 1: (shrugs) I dunno... this just looks boring.

Teacher: Thanks for being honest. What about you?

Student 2: I was trying to remember what we're supposed to start with. I got lost a few steps back.

Teacher: Okay, so one of you feels bored, and another feels confused. Does that sound about right?

Students: (nodding) Yeah.

Teacher: Now we know that, what do you think might help you pay better attention for the next ten minutes?

Student 3: Maybe if you showed us a quicker way to understand what to do?

Student 1: Or if we got to try the exercise ourselves instead of just watching you?

Teacher: Those are good ideas. Which one would you like to try first?

Student 2: Let's try the exercise ourselves.

Teacher: Great choice. I'll set up the exercise, and each of you can give the first step a shot. Then, let's check in again: you'll tell me if you feel more engaged, and we'll decide together how to move on.

Figure 2. Training material 2

Pictures speak a thousand words

Then I wanted to have pictures. So I opened a conversation with ChatGPT.

I would like you to create cartoon images for each dialogue, landscape format.

Thanks for the clear request. Before I start generating, let me check a couple of details so I can make sure the cartoon images are exactly what you're looking for:

1. Do you want **one image per archetype** (so five images total), each showing the Teacher and the Student in a coaching moment that reflects their dialogue?
2. Should the Teacher's appearance stay **consistent across all five images** (same clothes, style, etc.) so the focus is on the different teens?
3. For the Student, do you want me to reflect the **archetype + cultural/ethnic diversity** we discussed earlier (e.g., Philosopher Teen, Comedian Teen, Pragmatist Teen, Romantic Teen, Skeptic Teen all looking distinct)?
4. Do you want the images to include **speech bubbles with sample dialogue lines**, or just show the characters visually in conversation?

Would you like me to generate them **all at once as five separate images**, or begin with the **first (Philosopher Teen)** so you can review the style before I create the rest?

Yes, five images. Keep the teacher the same for all of these images. The students are as before. Include speech bubbles. Begin with the first Philosopher Teen.

The conversation had eight to ten steps, so the prompts got longer!

I noticed that ChatGPT added text at the top and/or bottom of the image as well as the text in the speech bubbles. So I had to be clear. In the end, after a few attempts that produced partial results, I wrote a panel-by-panel description of what I wanted.

The main change is the teacher's questions are at the top of the panel, not in speech bubbles.

Panel 1 (T+S): Top text: Teacher's Question: Are there any topics or areas that you don't want to discuss?

Speech bubble: S: "I don't wanna just talk about grades. Feels small."

Panel 2 (S only): Top text: Teacher's Question: What thoughts have you been having about this lately?

Speech bubble: S: "I wonder if my goals are mine... or just what others expect."

Panel 3 (S only): Top text: Teacher's Question: What's the best possible outcome you can imagine?

Speech bubble: S: "Best outcome? A path that's mine. Even if it's messy."

Panel 4 (S only): Top text: Teacher's Question: What do you need to say yes or no to?

Speech bubble: S: "I need to say no to copying others. Yes to trusting myself."

Panel 5 (S only): Top text: Teacher's Question: What did you learn about yourself in the process?

Speech bubble: S: "I care a lot about being true to myself. More than I thought."

Panel 6 (T+S): Top text: Teacher's Question: Looking back, what stands out to you?

Speech bubble: S: "That I don't just want grades. I want my own path."

If there is anything that's unclear, please ask before you draw.

It would be great if the student showed slightly different facial expressions for each of the panels, in line with what he is saying.

Perfect — thanks for the note about facial expressions, that's a great touch. I'll make sure the Philosopher Teen's expressions change panel by panel to match his words:

- Panel 1: Slight hesitation / unsure.
- Panel 2: Thoughtful, a little conflicted.
- Panel 3: Brighter, imagining possibilities.
- Panel 4: Firm but nervous (serious look).
- Panel 5: Reflective, slightly surprised at himself.
- Panel 6: Clearer, more confident expression.

Teacher remains consistent across Panels 1 and 6 (attentive, encouraging).

Tweaking the faces

I wanted the student to have authentic facial expressions but was not sure if it would work, so I asked:

Oh, wow. The student changed their clothes as well as their facial expression. Please redraw. I have attached the previous image as a guide. Hmm. You did not follow the instructions. Why not?

You're right—sorry about that. Two things went wrong:

1. **The image model “helped” too much.** When prompts mention headers or layout, it sometimes invents extra captions or splits text across areas. That's why it kept putting part of the line at the bottom or making two sections.
2. **Style drift.** If wardrobe and pose aren't locked in every prompt, the model may subtly change clothing (hoodie → polo) while keeping the face similar.

Here's how I'll prevent it next time (and what I'll explicitly tell the model):

- **Wardrobe lock:** Student wears the same navy hoodie as Panels 1–3; no collar, no logos; same hairstyle and colors.
- **Text placement:** One header line at the top **only** (the teacher's question). One **single** student speech bubble containing the **entire** exact line: “I need to say no to copying others. Yes to trusting myself.” No bottom captions, no second bubbles, no extra text anywhere.
- **Composition:** Single portrait panel; warm orange background; student only; 3/4 view facing left; expression determined but slightly nervous; consistent line weight/ colors with prior panels.

If you're happy with that, I'll regenerate Panel 4 now using those hard constraints.



Figure 3. AI-generated material

Finally

Despite being very clear, I was not wholly happy with the results, simply because they did not fit onto one page. There were too many. So I chose the individual images I had generated and pasted them into a table, adding the teacher's words in the top text as needed.

Recent applications

AI-generated materials have already supported varied contexts:

- International school: examples tailored to bilingual classrooms
- Webinar in Hungary: live AI translation enabled participants to see dialogues in Hungarian
- Workshop in Sweden: introductory sessions delivered in Swedish, supported by translated text and cartoons

In each case, AI made it possible to adapt materials rapidly without weeks of preparation.

Conclusion

AI has become essential to my work training teachers in coaching. It enables me to produce materials at scale, sharpen my explanations and adapt resources to different contexts and languages. Teachers gain confidence by seeing clear, relatable examples; students gain independence and resilience through more deliberate coaching in the classroom. AI may generate the dialogues and cartoons, but the real transformation happens when teachers use them to guide students towards deeper learning.

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Martin Richards, a retired teacher and certified coach, is the founder of Teachers Who Coach—a newsletter, book series and collaborative platform created for and by teachers who coach. With a rich educational background spanning fifty years, Martin has taught mathematics, computer science and drama, worked with special needs students and conducted evening English as a foreign language classes for adults. Additionally, he has run an English training consultancy and led coaching training programs for teachers. Martin, originally from the UK, has authored 30 books published online. He now resides in Sweden with his wife and three grown children.

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Professional judgement in the age of generative AI

Simon Lea and Sarah Gleave

The emergence of generative AI (GAI) in education has moved rapidly from a speculative 'if' to now becoming almost ubiquitous. Data indicates that the percentage of teachers using these tools has surged within just two years. Adoption has climbed from 58 per cent in 2025 (National Literacy Trust, 2025) to around 80 percent in 2026, as recent data from National Education Union ([NEU], 2026) members suggests.

Typically, such profound shifts in educational approaches are built around a grounding of evidence. For example, the adoption of the mastery approach influenced by East Asian mathematical methods was prompted by PISA data, indicating that a group of countries within that region were regularly outperforming countries such as England. Therefore, the adoption within English schools had a clear degree of evidence behind it (Jerrim and Vignoles, 2016).

With GAI, the situation is different. While the Department for Education ([DfE], 2025a, 2025b) endorses GAI use, it simultaneously acknowledges a lack of evidence regarding its impact on teacher development. This suggests a 'cart before the horse' approach to innovation. This is translated into the classroom, as – despite almost four in five teachers using GAI – data reveals that 49 per cent of schools lack any formal AI policy, and 57 per cent of state schools do not have a member of staff responsible for monitoring how GAI is used within the school (Latham and Montecute, 2025; NEU, 2026). This means many teachers are using GAI within their practice without the guardrails or policies required for safe and effective use.

This rapid increase in usage indicates that GAI is becoming a permanent fixture in the classroom. As these tools become more sophisticated, they raise important questions about the metacognitive thought processes of the teaching profession. This trend shines a particularly bright light on less experienced staff who may not yet have the 'backpack' of tacit knowledge to fall back on when GAI outputs require scrutiny.

The focus must now shift to questions of maintaining, and in some cases rebuilding, professional judgement. In this article, we explore how the convenience of GAI could erode the 'hard thinking' essential to meaningful learning and look at how educators can reclaim their professional agency through three approaches: policy, subject discipline and teacher professionalism.

Policy approach

At Liverpool John Moores University (LJMU), the rapid emergence of GAI presented both opportunities and dilemmas. While the potential for efficiency and innovation was clear, there was also a pressing need to ensure that trainee teachers developed the critical thinking and professional judgement necessary to use GAI responsibly. Within the Primary Education Team at LJMU, we have sought to achieve this by creating a modelled framework for our student teachers to apply, which can help ensure fidelity and consistency along with effective and accurate use of GAI. This is known as the CARE framework.

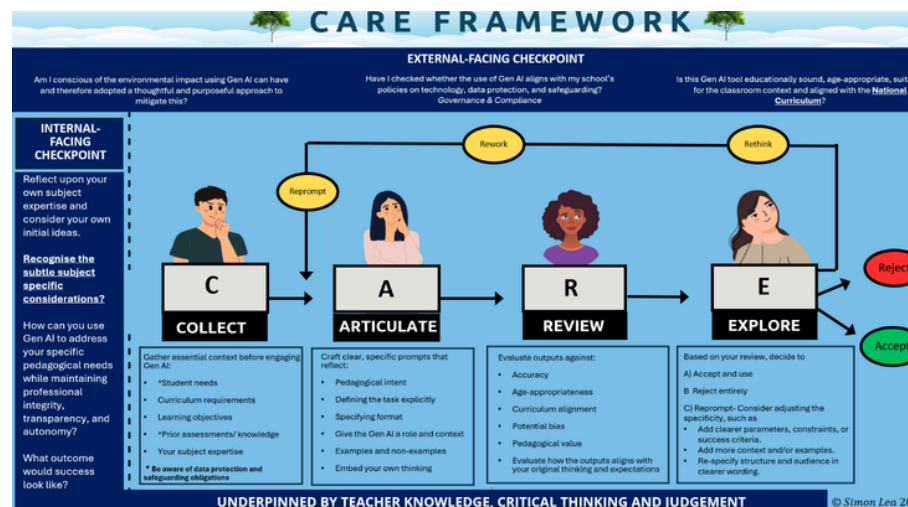


Figure 1. CARE framework

The CARE framework was developed to scaffold trainee teachers' engagement with GAI in a way that prioritises rigour, reflection and pedagogical integrity. These principles are grounded as both preventative and proactive actions. Without this, concerns grow that the use of GAI could present "new challenges, such as cognitive laziness, cognitive overconfidence, and unconditional reliance on algorithmic guidance" (Tezer, 2025, p. 3).

To avoid this, the framework is fundamentally underpinned by developing two key steps before using GAI, which demands robust metacognition. The students are guided to consider external-facing (the institution) and internal-facing (themselves) checkpoints. These steps ensure students align GAI with the guardrails set out within school policies and the national curriculum while maintaining ethical accountability. Crucially, this process continues to encourage teachers to lead with their own expertise so that GAI augments rather than dictates their thinking. The sequence of engagement is vital: if, for example, a student teacher asks GAI to generate a lesson from scratch, they could fall into 'passive acceptance', lacking the confidence to challenge the output. Conversely, when GAI is used to build upon a teacher's initial ideas, it functions as a tool for enhancement. By remaining the active agent, the teacher retains pedagogical ownership and ensures the final resource is contextually appropriate.

A more specific example could be student teachers becoming seduced by the ease and neat curation GAI can produce. Images are often clean and sharp while also beautified to the viewer. A student who may be teaching a history lesson and looking at steam engines may well be tempted by the gravitas of generating an image using GAI, but any decision should be grounded in its accuracy and effectiveness. Therefore, the framework encourages the trainee teachers to justify its superior efficacy over traditional or readily available resources by posing the question if generating an image of an early steam train via GAI (Figure 2) is preferable to utilising real photographs (Figure 3) that could be found in school archives or through a simple web search. This approach prevents GAI from becoming an uncritical default tool when more authentic or efficient alternatives exist.



Figure 2 and 3. A GAI image of early steam engines in England (created by Microsoft Copilot, 2025) compared to a photograph of early steam engines (National Railway Museum, n. d.)

Once the student teachers have carefully deduced that using GAI will be beneficial, the framework begins with:

Collect is where trainees gather essential contextual information: curriculum objectives, prior learning, available resources and knowledge of pupils. This is vital to the ultimate contextual output, as without important context, there is likely to be a more ambiguous nature to the GAI's output (Sakamoto *et al.*, 2024). This would all be done with careful consideration of the General Data Protection Regulation (GDPR).

Articulate encourages the crafting of purposeful prompts, including using role-based instructions and multi-shot prompts (examples) to maximise the quality of GAI responses. The word 'articulate' is important, as it sets out the emphasis on communicating our own thoughts and ideas as opposed to merely asking for a response.

Review is a critical step where trainees apply their teacher knowledge, spanning subject, pedagogy and curriculum, to evaluate the GAI's output.

Explore invites them to accept, reject or engage in iteration (rethink, reword, reprompt), thus reinforcing the idea that GAI is a thinking partner, not a replacement for professional judgement. This structured approach ensures that GAI use is not passive or automatic but intentional.

We would encourage staff and institutions to carefully consider developing a formal policy and framework. Such a move provides the necessary guardrails and protections for staff, while an agreed manifesto ensures a sense of consistency across the profession. By establishing these boundaries, schools can protect the integrity of their teaching while still creating the space to explore the genuine opportunities that GAI offers.

Looking through a subject-specific lens

At LJMU, we believe that while there are certain commonalities across primary subjects, our trainee teachers must understand that each discipline requires a distinct pedagogical approach. Without this focus, we risk losing sight of the unique disciplinary value that each subject provides. To address this, we have evolved the CARE framework to help our trainees navigate these unique landscapes and recognise that GAI is not a one-size-fits-all solution. For instance, our students are encouraged to apply a critical lens to GAI output based on the specific demands of the curriculum. These could include:

- **Mathematics:** Trainees might check for alignment with school calculation policies and specific methods. They should consider the importance of GAI recognising conceptual and conditional understanding rather than just offering a procedural 'shortcut' to an answer.
- **Humanities:** This requires a focus on cultural sensitivity. Trainees should recognise Western-centric biases in training data and actively identify the marginalised voices or local perspectives that GAI may have omitted.
- **English:** Here, the focus might focus on the 'soul' and subtext of a genuine author. We ask our students to consider if the GAI is pushing a generic style that reduces creativity or misses a text's specific sense of place.

A more specific example of this could be within the teaching of history. We encourage our trainee teachers to be particularly alert to bias, hallucinations and anachronisms. This is necessary because AI-driven educational platforms are often built on algorithms that reflect dominant Western perspectives. Such a bias can lead to local or global histories being marginalised or presented in reductive, simplified ways (UNESCO, 2025).

While GAI can collate vast amounts of data at speed, this efficiency does not guarantee the accuracy or relevance of its responses, with significant concerns regarding the presentation of entirely fabricated material. Often described as 'hallucinations', these inaccuracies can be particularly persuasive, making it difficult for an uncritical user to distinguish between historical fact and plausible-sounding fiction (Nah *et al.*, 2023).

The limitations of these tools become particularly evident when looking at GAI imagery. In *Figure 4 and 5*, we can see issues that undermine historical integrity:

- **Persistent demographic bias:** there is a common representation of historians as white, middle-aged men. This often relies on outdated stereotypes, such as the universal inclusion of glasses, beards and tweed clothing, which subtly suggests who is 'allowed' to be an expert in the field.
- **Spelling and graphic errors:** basic literacy errors in generated text and graphic distortions, such as figures on fire and with anatomical anomalies, remain common.
- **Jarring historical anachronisms:** GAI often struggles with chronological accuracy. For example, a depiction of the 1666 Great Fire of London might incorrectly feature the version of St Paul's Cathedral built in 1675 or include modern roadside signage.



Figure 4. Four separate prompts requesting an image of a historian (created by Google Gemini, 2025)



Figure 5. Prompting for images of the night of the Great Fire of London (generated by Microsoft Copilot, 2025)

Compare this with art and design, the lens would focus on avoiding mere technical execution to a deep ethical and subjective consciousness. Maximising GAI's potential in this field requires the student to act as a 'moral curator' who respects the sanctity of the creative process. This means recognising that while GAI can mimic aesthetics, it lacks the lived experience of the 'artist's journey.' To use GAI responsibly is to recognise the tension between innovation and intellectual property, ensuring that the GAI is used to explore new horizons rather than to bypass the hard-earned skills of human creators or infringe upon their copyright. Below are examples of key considerations for our student teachers to consider:

- Be aware of cultural bias, discriminatory outputs and copyright concerns in GAI-generated artwork, ensuring respectful and ethical use of artistic references and styles.
- Use GAI purposefully and critically. Avoid replacing the development of personal art skills, modelling or demonstration, and ensure GAI-generated images support rather than confuse artistic understanding.
- Use GAI to encourage diverse interpretation and inclusive participation while promoting sustainable use through carefully considered prompts and avoiding overly rigid teaching approaches.

These examples highlight why a subject-specific approach is essential. A teacher without deep subject knowledge might overlook these errors, but by using the CARE framework, they are equipped to be alert to these disciplinary specific cornerstones and use them as a point of critical discussion.

Teacher approach

The current technological shift is distinct from previous digital milestones. During the rise of search engines, finding information still required a certain mental resistance; users had to sift through disparate sources, evaluate credibility and reconstitute information into a preferred manner. This 'friction' ensured that the user remained an active participant in the process.

However, research by Sparrow, Liu and Wegner (2011) suggests that even early forms of digital interaction began to change our cognitive habits. Their study on the Google effect found that when people believe information will be available for later retrieval, they are less likely to remember the facts themselves, instead prioritising memory for where information can be found. With GAI, this process may become more complex. By delivering polished, ready-to-use responses, it could encourage a shift from using tools to support thinking towards relying on them to carry out aspects of thinking on our behalf. Reduced cognitive engagement may contribute to more superficial understanding and retention (Kosmyrna et al., 2025). At the same time, emerging research suggests digital technologies do not simply replace human cognition but reshape how remembering, synthesis and judgement are distributed across people and tools (Fawns, 2025). Rather than replacing thinking entirely, GAI may increasingly reorganise how professional expertise, reflection and decision-making are developed and exercised.

Using GAI to address workload demands is recommended by the UK Government (DfE, 2025) to 'free up teachers' time, allowing them to focus on delivering excellent teaching'. Saving time is one of the main celebrated attractions, with examples around reducing lesson planning time (EEF, 2024; DfE, 2025). However, it is important to note that it is too early to know if this translates into improved teaching and learning over a consistent and sustained period.

The DfE's Planning and Resources Review Group (2016) drew an important distinction between producing detailed lesson plans and the cognitive process of planning itself, arguing that "planning is essential for good teaching" and should be understood as a core element of professional thinking rather than a bureaucratic exercise. Effective planning requires teachers to sequence learning, anticipate misconceptions and align pedagogy with curriculum intent – a process that strengthens both subject knowledge and pedagogical fluency. Crucially, there is a difference between lesson planning and the production of written lesson plans: the former is central to pupil progress and involves conceptual iteration, while the latter can too easily become little more than evidence for accountability processes.

While GAI may reduce workload, overreliance on it risks reducing that conceptual iteration and deliberate professional decision-making with curated performance delivery (Jose *et al.*, 2025). In doing so, teachers may lose valuable opportunities for reflection, adaptation and intellectual struggle that underpins professional growth. The danger is not simply poorer lesson plans but the gradual erosion of the internalised expertise developed through the often-messy process of planning, teaching and refining practice and, ultimately, the impact this might have within the lesson themselves.

An example could be found in the teaching of English when using a modelled write. The temptation to request GAI to create a modelled write is obvious: it will save time and likely produce something coherent. But while GAI excels at delivering a polished final product, its efficiency can undermine the pedagogical power of the struggle. Effective modelled writing is not meant to be a fluid, seamless performance; rather, it is an important dance between inspiration, impasse and resolution.

When a teacher relies on AI-generated text, they risk playing a passive role, bypassing the conscious decisions regarding sentence structure, vocabulary and punctuation that students need to see. Authentic modelling requires the teacher to externalise their internal deliberation, showing that writing is often a messy process of confusion and correction. This is not to say that GAI cannot be used effectively, but doing so requires a confident and knowledgeable teacher to actively scrutinise and unpick the curated GAI version. We believe this brings us back full circle to developing an effective framework, as a teacher could use GAI to develop the modelled writing, but the cognitive engagement came from the teacher who has *deliberately and consciously* led the process and can therefore model it to the children with honesty and integrity.

Conclusion

GAI must remain a tool that works on our terms. We cannot risk outsourcing the essential human elements of thinking, learning and emotion. Rather than exhausting ourselves trying to adapt to a constantly shifting technological landscape, we must recognise that education's truest value is intrinsic. Now more than ever, our focus must remain

steadfastly human: cultivating the critical minds, purposeful lives and deep connections that no machine can replicate. As GAI becomes ubiquitous, institutions and policies must equip teachers with the critical reflection needed to command these tools effectively. While many schools have yet to formalise GAI policies, the priority is clear: GAI must support teacher expertise, not replace it. We must ensure that commercial interests do not overshadow the 'human craft' of education, the honesty, vulnerability and deep student knowledge that defines great teaching (Selwyn, 2025). As GAI becomes increasingly embedded within education, we must remember who should be playing the tune – and who should be doing the dancing.

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From watching to making: How self-produced videos and peer feedback build teacher confidence

Muhammed Özgür Yaşar

Many pre-service teachers finish their training feeling unprepared for real classrooms. This article shares a simple, low-cost intervention called 'Video-based Pedagogical Framework (VIDPEF)': pre-service teachers make short teaching videos, share them on YouTube and give each other structured feedback – all *before* the live class. Forty pre-service English language teachers tried this approach, while a control group watched ordinary videos. Results from a standard self-efficacy scale showed a large, meaningful gain for the VIDPEF group (effect size $d = 0.91$). Interviews and focus groups revealed that video making and peer feedback helped them plan better, manage lesson time, engage students and reflect on their own teaching – skills they then used in real school placements. This article offers practical steps for teacher educators who want to move beyond passive video watching and build genuine teaching confidence.

Keywords: pre-service teacher confidence, video creation, peer observation, flipped classroom, teaching rehearsal

Introduction

Teacher self-efficacy – the belief that 'I can teach this well' – is one of the strongest predictors of teaching quality and student success. Yet many pre-service teachers graduate with fragile confidence. The gap between theory and practice remains stubbornly wide (Tschannen-Moran & Hoy, 2001).

In recent years, flipped learning has become popular: students watch videos *before* class, then discuss in class. But most of these videos are made by instructors. Students remain passive viewers (Weng *et al.*, 2023). What happens if they make the videos themselves? What if they also give each other feedback on YouTube?

This article describes exactly that. I tested my own model, the Video-based Pedagogical Framework ([VIDPEF]; Yaşar, 2025), with 40 pre-service English language teachers. Their task was not just to watch but to *create* – and to comment on each other's work. The results were striking.

The VIDPEF cycle: A visual overview

The VIDPEF intervention follows a structured, iterative cycle. *Figure 1* shows the complete seven-step process, from studying course content to responding to peer feedback. This cycle repeats weekly, with students alternating roles between content presenter and reflective viewer.

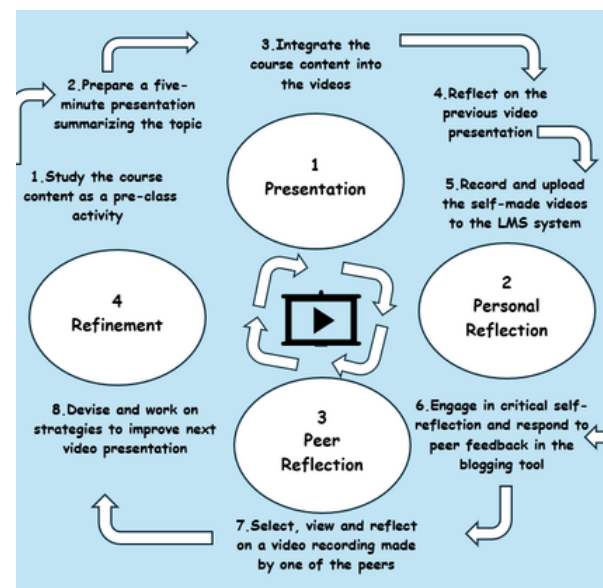


Figure 1. The VIDPEF seven-step cycle for self-produced teaching videos

A simpler version of the core weekly routine is shown in *Figure 2*, which highlights the four key actions each participant completes every week.

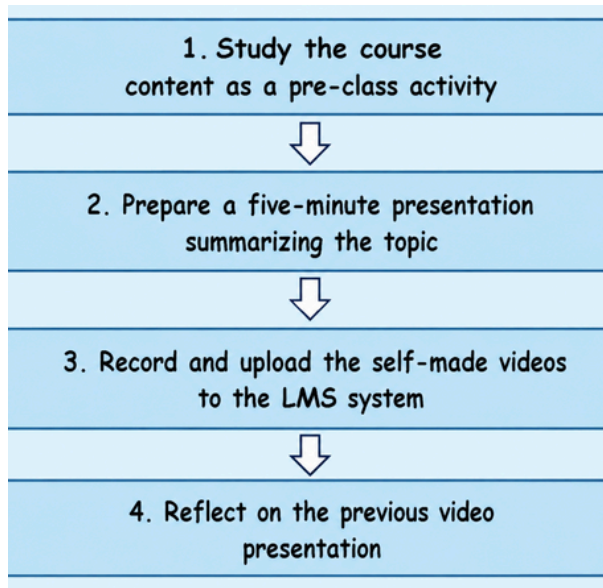


Figure 2. VIDPEF routine (simplified)

Both figures illustrate the same underlying principle: creation before consumption and reflection before instruction.

What I did: The intervention in brief

The experimental group ($n = 40$) followed the VIDPEF cycle (*Figure 1 and 2*) for eight weeks:

1. Study – Read a chapter on language assessment.
2. Create – Produce a 5- to 10-minute teaching video explaining key ideas.
3. Share – Upload the video to YouTube (unlisted, shared only with classmates).
4. Give feedback – Watch peers’ videos and post rubric-guided comments.
5. Discuss – Bring reflections to the face-to-face class.

A control group ($n = 42$) studied the same chapters and watched instructor-made videos but did **not** make their own videos or give peer feedback. Both groups were also doing teaching practice in real K-12 schools during the same semester, so I could see whether skills learned through videos transferred into real classrooms.

What I measured

- Quantitative: the Teachers’ Sense of Efficacy Scale (TSES) before and after the eight weeks
- Qualitative: semi-structured interviews and focus groups with nine volunteers from the experimental group

What I found: Confidence grew significantly

Before the intervention, both groups had similar self-efficacy scores. After eight weeks, the VIDPEF group scored much higher. The difference was both statistically significant and practically meaningful (see *Table 1*).

Table 1. Changes in teaching self-efficacy (TSES, 1–9 scale)

Groups	Pre-test mean	Post-test mean	Gain	Effect size (Cohen’s d)
VIDPEF ($n = 40$)	6.30	7.48	+1.18	1.24 (within-group)
Control ($n = 42$)	6.12	6.83	+0.71	0.35 (within-group)

Between-group effect at post-test: $d = 0.91$ (large)

The VIDPEF group improved most in 'instructional strategies' ($p = .006$), followed by 'student engagement' ($p = .012$) and 'classroom management' ($p = .019$).

What teachers said about video making

"When I prepared my presentation on test types, I used classroom examples. Later, I used the same ones during my school teaching. I felt more confident because I had rehearsed it in the video."

– Focus group participant 6 (Figure 3)

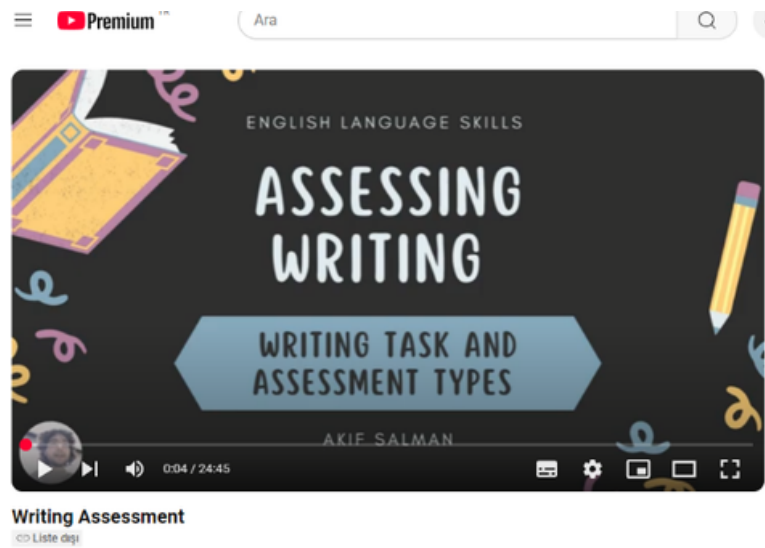


Figure 3. A pre-service teacher's self-produced micro-teaching video: recording at home before class gave them time to rehearse explanations and check clarity.

Teachers told us that making a video forced them to plan carefully, find clear examples and think about pacing.

One said: "Because I had practised the structure in the video, I was able to stay on time during my 40-minute lesson at the school." This rehearsal effect mattered. Even though the video was not a real class, the act of explaining out loud, sequencing content and timing the presentation built a sense of readiness.

What teachers said about peer feedback

Posting videos on YouTube – not just submitting to an instructor – created a sense of accountability. Participants took the task more seriously because their peers would see and comment (Figure 4): "When you know others will watch, you try harder. And reading their comments showed me things I hadn't noticed about my own teaching."

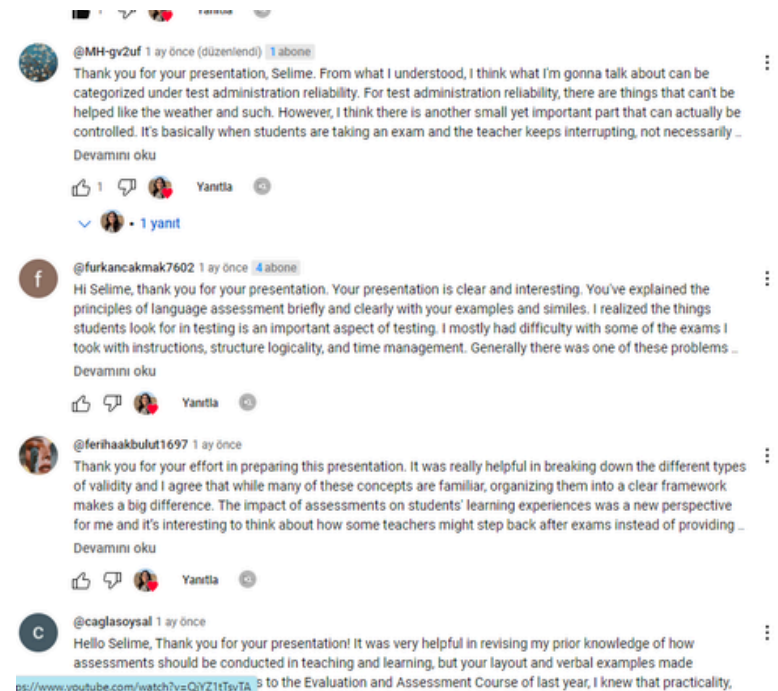


Figure 4. Example of peer feedback posted as a YouTube comment: rubric-guided comments focused on clarity, examples, and pacing.

Some of the most useful feedback was about tone, gesture and whether an explanation was really clear. This is not something you get from watching expert videos alone. Peer feedback made reflection social and concrete.

Transfer to real classrooms

A key finding: strategies practised in videos did not stay in videos. Teachers reused examples, pacing techniques and engagement strategies in their K-12 practicum lessons: “I used some of the jokes and examples I tried in the video during the real class. The students liked it, and I felt more relaxed.” However, participants also noted limitations. Videos cannot simulate unpredictable student behaviour. One said honestly: “In the videos, everything is in your control. In the real classroom, students interrupt, get bored or don’t respond.” So VIDPEF is not a replacement for live teaching. It is a ‘scaffold’ – a safe, low-stakes rehearsal space (Figure 5).



Figure 5. In-class follow-up session: After practising with videos at home, students presented their topics face-to-face and received further feedback from peers and the instructor.

Practical takeaways for teacher educators

Based on this study, here are four actionable recommendations for integrating VIDPEF into your own pre-service programmes.

1. Flip from watching to making

Instead of assigning instructor-made videos, ask trainees to produce short (5- to 10-minute) teaching videos explaining a concept. This turns passive viewing into active rehearsal.

Tip: Start with a low-pressure task, for example, “Explain one key term from this week’s reading as if to a 14-year-old.”

2. Use public (but private) sharing

YouTube unlisted links or closed LMS forums works well. The key is that peers can see and comment. This raises effort and creates a community of practice.

Tip: Provide a simple rubric (e.g., clarity of explanation, use of examples, pacing). Ask each student to comment on at least two peers’ videos.

3. Train feedback literacy

Peer feedback is not automatically useful. Brief training helps. Show examples of helpful vs. unhelpful comments. Ask for one strength and one specific suggestion.

Tip: A 20-minute session on how to give kind, useful feedback pays off across the whole semester.

4. Connect video tasks to practicum

The transfer I observed did not happen by accident. Align video topics with what trainees are about to teach in schools. Ask them to reflect afterwards: “Which strategy from your video did you use in your real lesson?”

Tip: Use a simple reflection form: “One thing I rehearsed in my video that worked well in class. One thing I would change next time.”

Limitations

This was a single-semester study with one group of English language teachers in one university. I do not yet know whether confidence gains last into the first year of teaching. Also, I relied on self-reports, not live observations of teaching. Future work should include classroom video analysis and longer-term follow-up. But within these limits, the VIDPEF model shows consistent, practical promise.

Conclusion

Pre-service teachers do not need more passive video watching. They need structured opportunities to *rehearse* teaching, *receive* peer feedback, and *reflect* before stepping into real classrooms. The VIDPEF model – self-made videos, YouTube sharing, rubric-guided peer feedback and in-class discussion (*Figure 1 and 2*) – is one low-cost way to do this. In this study, it produced large gains in self-efficacy. More importantly, teachers reported using what they practised in real schools. If you are a teacher educator looking for a practical, evidence-informed next step, try flipping the script: from watching to making, from individual to social, from passive to rehearsed.

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Note: This condensed, practitioner-focused report is based on a larger mixed-methods study. The full version of the study is currently under consideration elsewhere. This submission to *Advancing Education* is independent in scope, word count and audience, and no duplicate publication is intended.

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How do institutional contexts shape the TEL experiences of students with SpLDs and their lecturers?

Abass B. Isiaka, Alexia Achtypi, Jeremy Schildt and Fabio Arico

Introduction

The rise in the uptake of technology in UK higher education has generated a number of terms used to describe the complex interaction between technology and learning. We have moved from 'information and communication technology (ICT) for learning' to 'educational technology', from 'computer-based learning' to 'online education' and to 'learning technology', later ceding position for 'technology-enhanced learning (TEL)', which became a dominant term across UK university support units at the turn of the 21st century (Bayne, 2014). The fleeting nature of 'naming' how technology is used in education generally has contributed to an ongoing struggle to define what TEL actually means (Kirkwood and Price, 2014). This ambiguity persists despite a growing body of empirical research highlighting the potential of TEL to improve learning and teaching experiences (McNicholl *et al.*, 2019). Within this evolving landscape, our study challenges the prevailing assumption that TEL inherently benefits all students in higher education.

While TEL is often positioned as beneficial for all learners (Bayne, 2014), its implications for neurodivergent students are less consistently understood, making it difficult to reach firm conclusions (McDowall and Kiseleva, 2024). Emerging studies suggest that technology can both enable and constrain learning depending on how it is designed, implemented and supported, with the experiences of students with Specific Learning Differences (SpLDs), Autism Spectrum Disorder (ASD) and Attention Deficit (Hyperactivity) Disorder [AD(H)D] reinforcing the need for more inclusive and flexible approaches (Coxon *et al.*, 2022).

Taking these points into consideration and drawing on our previous work conducted in a single higher education institution (HEI) (Achtypi *et al.*, 2025), this study extends the

analysis across multiple UK HEIs. It explores how TEL is used by undergraduate students with SpLDs, ASD and AD(H)D, together with their lecturers, to support learning and teaching. With the rising number of students with SpLDs entering UK HEIs (HESA, 2025), this study aims to contribute to our understanding of how TEL impacts the learning experiences of students with dyslexia, dyscalculia, dyspraxia and AD(H)D (Achtypi *et al.*, 2025; Coxon *et al.*, 2022). Echoing critiques of what is often "taken for granted" in literature on TEL (see Bayne, 2014), this study also 'takes context seriously' by examining how institutional contexts mediate the complex relationship between the individual and the technology (Abbott, 2007).

To address these aims, we asked students and staff about the TEL tools and practices they currently use and their perceptions of their effectiveness. We situate their understanding and experiences of these tools within institutional policy and practice contexts to offer evidence-based suggestions for how institutions can develop more inclusive and effective use of TEL for all learners. For clarity, TEL is used in this paper to describe the use of digital technologies that support teaching and learning, including virtual learning environments, interactive applications, online and cloud-based resources and communication platforms.

Methodologically, semi-structured interviews were conducted with 21 students and lecturers across four UK universities of different sizes. In addition, publicly available institutional documents, such as policy documents on TEL, accessibility and disability inclusion, were reviewed to map existing approaches to TEL and support for students with SpLDs. Taking into consideration student and staff experiences, the analysis provides evidence on how institutions of different sizes and contexts can further embed technology to enhance inclusion and participation in learning.

Findings

Policy alignment and institutional commitment

The findings revealed that across the participating universities, there is clear institutional recognition of the importance of accessibility and inclusion in TEL. All institutions have frameworks or guidelines that encourage staff to produce accessible content and embed inclusive practices into teaching and learning. This reflects alignment with the Equality Act (2010) and the Public Sector Bodies Accessibility Regulations (2018), as well as broader commitment to fairness, respect and inclusion.

We know that not everyone who accesses our services thinks of themselves as disabled, but we use the term because it is used in the Equality Act. We support students with a range of conditions, including specific learning differences (SpLDs) such as dyslexia, dyspraxia, autism... (Policy Document, Uni B)

While both staff and students acknowledged the availability of policies for SpLDs and TEL, especially since after the pandemic, their implementation remains uneven across faculties and schools. More specifically, job functions such as disability coordinators, technologists and mentors continue to play a central role in supporting both staff and students. All four universities provide a wide range of services, including assistive technology support, study skills tutoring, mentoring and drop-in sessions. These are complemented by online and in-person workshops focused on neurodiversity, mental health and accessible study strategies.

Notably, the larger institutions seem to have broadened their approach to include students who self-identify as having learning differences but do not hold a formal diagnosis. This anticipatory approach reflects a growing emphasis on inclusive pedagogical design rather than reactive or deficit-based support systems.

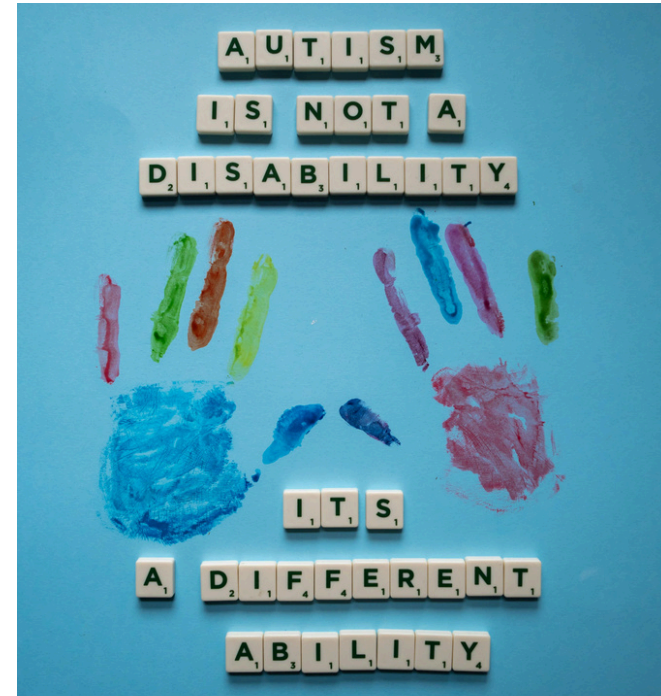


Figure 1. Photo by Polina (Pexels, 2021)

Diagnosis, disclosure and digital access

Despite strong policy frameworks, the findings indicated challenges in accessing support in practice. Across the institutions, most students had formally disclosed their learning differences and were receiving support through university systems. However, the process of disclosure and access to support was described by both staff and students as

nconsistent and, at times, fragmented. While institutional policies clearly outline procedures for registering with disability services and obtaining reasonable adjustments, communication gaps between central services, departments and individual lecturers often limit the effectiveness of this process.

Students described mixed experiences with diagnosis and disclosure. Some were proactive in contacting disability services before starting their studies, viewing disclosure as essential to academic success. Others, however, reported challenges in having existing diagnoses recognised, delays in updates to staff lists and uncertainty over who was responsible for implementing adjustments. As one participant explained, "I had next to no support last year because they made me get retested for dyslexia, even though I already had evidence from college" (SW02).

Students also highlighted the social and emotional barriers to disclosure within the classroom. Approaching lecturers about learning needs was described as uncomfortable or "cringey," with many preferring that staff initiate contact rather than expecting students to self-advocate repeatedly. "If professors knew who was registered, they could just send an email saying, 'I see you're registered, let me know if you'd like PowerPoints in advance.' That takes the pressure off the student to reach out or disclose" (SG02).

To address these barriers, one institution has begun integrating tools such as Jisc's Discovery Tool, which enables students to self-assess their digital capabilities, including proficiency with assistive and generative AI technologies. Such initiatives show potential for bridging gaps between disclosure, diagnosis and digital access by empowering students to understand and communicate their own learning and technological needs more confidently.

Another significant shift observed is the move away from an exclusive reliance on formal diagnosis and Disabled Students' Allowance (DSA). As one staff member explained, traditional systems built around diagnostic verification are being replaced by more flexible, needs-based approaches. For example, institutions now offer non-diagnostic pathways that provide short-term, targeted support and access to assistive technologies based on

functional need rather than formal diagnosis. This shift indicates an evolving understanding of inclusion, one that seeks to embed support within institutional structures rather than treating it as an add-on.

Pedagogical integration of technology and the everyday challenges

Participants broadly agreed that technology, when effectively integrated, enhances teaching clarity, accessibility and engagement. Staff described designing courses with a strong emphasis on structure and coherence to support students with diverse learning needs, noting that clear sequencing and context help reduce anxiety and improve comprehension for students with SpLDs. When asked what the most important factor was when designing a course for students with SpLDs, one lecturer said,

Clarity of information. Start with a big overview before moving into details. Many lecturers jump straight into detail, and students get lost. It's about giving structure and context, it reduces anxiety and helps all students, especially those with autism, ADHD or dyslexia. (LN01)

Some of the universities have adopted platforms that extend beyond traditional *assistive* technologies, offering software such as captioning tools, mind-mapping applications and note-taking programmes to all staff and students. This universal design approach aligns with the principle that inclusive teaching benefits everyone, not only those formally diagnosed with specific learning differences. Staff also emphasised the importance of balancing technological use with human interaction, including clear explanations, formative feedback and opportunities for dialogue, which remain central to effective teaching.

Technology definitely enhances everything... It's useful, but there's a risk in focusing too heavily on technology and overlooking the human element. We can provide all the technology, but if we neglect how to guide students in using it effectively, it's not as impactful. (LG04)

Students particularly appreciated flexible digital formats such as short recorded lectures, captioned videos and online quizzes, which allow for self-paced learning and review. Many highlighted how tools like Glean and Microsoft Word enhanced their ability to take and organise notes efficiently, while others reflected on how digital tools improved accessibility and retention. However, both staff and students cautioned that these benefits depend on reliable systems and consistent institutional support.

Yes. Glean has been the most practical, especially when professors don't share slides in advance. It helps me capture everything I'd otherwise miss... In [the] first year, I handwrote everything, bought a printer, printed out graphs, glued them into a notebook. It took forever and didn't help me retain anything... (SG03)

However, challenges persisted, particularly around the logistics of online delivery, inconsistent access to reliable internet or devices and technical breakdowns on learning platforms. Staff also reported difficulties in gauging student engagement during remote teaching and in managing multiple digital systems simultaneously. Finally, some participants observed that while technology offers efficiency, it can also contribute to stress, workload intensification and occasional system failures that disrupt learning.

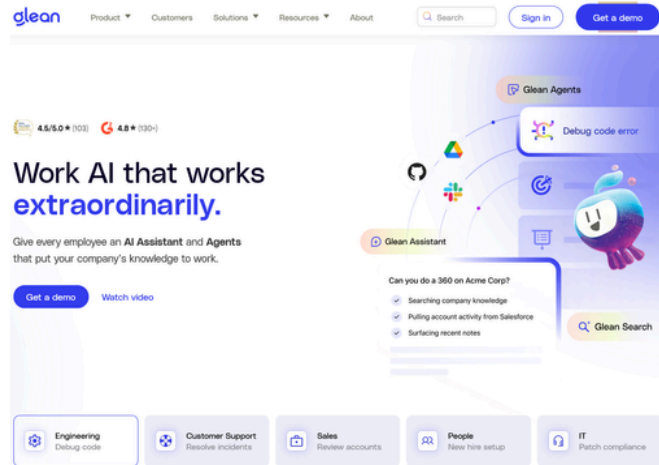


Figure 2. Glean (Glean, 2026)

Recommendations for HEIs

To improve how TEL support is provided in HEIs, staff and students agreed on the need for a more proactive communication model across disability, digital learning and academic support services. Students who disclose learning differences should be directly offered sessions to help them set up assistive technologies and access available resources rather than being left to navigate them independently. Moreover, greater clarity and timely follow-up are needed to ensure that students with SpLDs receive clearer direction and timely follow-up when they request support.

Similarly, when introducing new learning technologies, structured and discipline-specific support should be provided for both staff and students. Generic staff training on technology is considered insufficient. Many staff agreed that tailored training would allow them to experiment with tools confidently and apply them meaningfully in their teaching. Consistent, supported use of technology will prevent disparities between staff who readily adopt new tools and those who avoid them due to uncertainty.

Participants also highlighted the need for institutions to prioritise the pedagogical value of technology over platform choice. Learning environments should offer multiple means of engagement, including text, video and audio options, to accommodate varied learning preferences. A senior leadership role dedicated to accessibility and inclusive digital education should be established to coordinate a holistic approach across departments. Communication about inclusive technologies should be concise and regular, as short, practical 'little and often' tips are more effective than long, generalised guidance. This could be done using video tools such as Panopto or Kaltura to provide short, targeted content that reinforces learning or answers common questions. The development of local departmental champions could support the promotion of inclusive digital practices and encourage everyday engagement among staff.

More broadly, staff commented on the need for institutions (particularly those balancing research and teaching priorities) to rebalance the value placed on research and teaching to foster a culture that rewards meaningful integration of technology into pedagogy. They should ensure that technology is maintained, accessible and purposefully used rather than

treated as an occasional or superficial enhancement. Last but not least, at the sector level, universities should collaborate to share evidence of what works, co-develop effective digital systems and create sustainable, inclusive frameworks for TEL.

Conclusion

This study demonstrates that the pedagogical integration of technology to support students with SpLDs is shaped by both individual practices and broader institutional contexts. While many staff and students value the flexibility and multimodality that technology can bring, its effectiveness often depends on clear communication, targeted training and meaningful coordination between academic and support services. The findings highlight that successful practice depends not only on providing tools but also on ensuring they are reliable, supported and embedded within a clear pedagogical framework that values both technological and human dimensions of teaching and learning. Although the sample size was relatively small (n=21 across four UK higher education institutions), the cross-institutional design provides a rich view of students' and staff's practices and experiences across the four institutions. These findings contribute to ongoing discussions on inclusive digital education by emphasising the importance of aligning technological implementation with pedagogical intent and institutional support structures.

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Fabio Aricò is a professor of Higher Education and Economics at the University of East Anglia and the founding Director of the University's Centre for Higher Education Research Practice Policy and Scholarship (CHERPPS). He is a National Teaching Fellow, with an established record of award winning innovative practice in higher education. His research interests include policies to widen access and close attainment gaps for university students, inclusive pedagogies, measuring educational gain, oral assessment and self-assessment.

Recommended reads

Advancing educational innovation through machine learning: A review of *Machine learning in educational sciences*

Benny Widaryanto, Hastangka, Happy Fitra, Aldila Rahma, Iskandar Agung, Heni Waluyo and Adison Adrianus Sihombing

Abstract

The integration of machine learning (ML) into educational research and practice represents a transformative shift in how teaching, learning and assessment are conceptualised and implemented. This review critically examines *Machine learning in educational sciences: Approaches, applications and advances* (Khine, 2024), an edited volume that brings together interdisciplinary perspectives on the role of artificial intelligence (AI) and ML in education. The book offers a comprehensive exploration of foundational concepts, predictive analytics, assessment innovations and emerging research applications. This paper evaluates the book's contributions to educational technology and computing education, highlighting its strengths in bridging theory and practice while identifying areas requiring further development, such as ethical considerations and implementation challenges. The review argues that the volume is a valuable resource for educators, researchers and practitioners seeking to understand and apply ML in diverse educational contexts. It concludes by discussing implications for future research and practice in advancing technology-enhanced education.

Keywords: machine learning, educational technology, artificial intelligence, learning analytics, educational research, predictive modeling, assessment innovation, computing education

Introduction

The rapid advancement of artificial intelligence (AI) and machine learning (ML) has significantly influenced multiple sectors, including education. As educational institutions increasingly rely on data-driven decision-making, ML offers powerful tools for understanding learning processes, predicting student outcomes and enhancing instructional design. The edited volume *Machine learning in educational sciences: Approaches, applications and advances* (Khine, 2024) provides a timely and comprehensive contribution to this evolving field.

Positioned at the intersection of educational research and technological innovation, the book aligns well with the mission of *Advancing Education*, which emphasises the dissemination of research in educational technology and computing education. This review critically examines the book's structure, key contributions and relevance while also reflecting on its limitations and implications for future scholarship. The volume is organised into five thematic sections: (1) introduction and conceptual overview, (2) foundations of ML, (3) prediction of student performance, (4) ML in assessment processes and (5) applications in educational research. This structure provides a logical progression from theoretical grounding to practical applications.

The introductory chapter highlights the growing role of ML in education, emphasising its ability to analyse learning patterns, personalise instruction and predict outcomes with high precision. Importantly, the editor situates ML as a subset of AI that enables systems to learn from data without explicit programming, a distinction that is crucial for educational researchers entering the field. Overall, the book adopts a multidisciplinary approach, drawing contributions from experts in education, psychology, computer science and data analytics. This diversity strengthens its relevance across different educational contexts.

Foundations of ML in education

One of the book's major strengths lies in its accessible introduction to ML concepts for educational researchers. The foundational chapters explain key ideas such as supervised and unsupervised learning, data preparation, feature selection and algorithm choice. For instance, DiStefano *et al.* (2024) provide a clear explanation of ML as a process of deriving knowledge from data to make predictions, distinguishing it from traditional statistical methods. The discussion of big data, data mining and AI helps situate ML within a broader analytical framework, making the content approachable for readers without a technical background. This section is particularly valuable for early-career researchers and practitioners, as it demystifies complex concepts while maintaining an academic atmosphere.

Predictive analytics and student performance

The third section of the book focuses on predictive modeling, a central application of ML in education. Several chapters explore how ML algorithms can identify at-risk students, predict academic performance and analyse learning behaviours. For example, studies on student attrition and achievement prediction demonstrate how ML models can integrate diverse data sources such as learning behaviours and demographic variables to improve accuracy. One study reports prediction accuracy as high as 93.5 per cent when combining traditional datasets with advanced features such as node embeddings. These contributions highlight the potential of ML to support early intervention strategies and personalised learning pathways. However, the emphasis on predictive accuracy also raises questions about interpretability and ethical use, which are not extensively addressed in the volume.

Innovations in assessment and learning design

The book also explores the application of ML in assessment processes, including automated analysis of instructor practices and the design of immersive learning environments. Notably, the use of topic modeling to analyse instructors' responses during the COVID-19 pandemic illustrates how ML can provide insights into pedagogical adaptation in crisis contexts. Similarly, the application of neural networks and clustering techniques in immersive learning environments demonstrates how data generated through digital interactions can inform instructional design. These chapters align strongly with

current trends in educational technology, particularly the move toward data-informed and adaptive learning systems.

Expanding the scope of educational research

The final section broadens the discussion to include innovative research applications, such as analysing the relationship between well-being and academic performance, generating instructional materials using large language models and developing automated question classification systems. The inclusion of generative AI tools, such as ChatGPT, reflects the book's contemporary relevance. These chapters emphasise the potential of ML not only as an analytical tool but also as a creative and generative resource in education. Importantly, the book highlights how ML can support theory building and multidisciplinary research, reinforcing its value for advancing educational sciences.

Critical evaluation and implications for educational technology and practice

The edited volume demonstrates considerable strengths in its scope, accessibility and interdisciplinary orientation, making it a meaningful contribution to the field of educational technology. One of its most notable achievements lies in its comprehensive coverage of ML applications across diverse educational domains. By organising the chapters into thematic sections that move from foundational concepts to applied research, the book offers readers a structured pathway for understanding both the theoretical and practical dimensions of ML in education. This progression is particularly valuable for readers who may be new to the field, as it gradually builds conceptual understanding while introducing increasingly complex applications.

In addition to its breadth, the volume is characterised by a commendable level of accessibility. The contributors make a deliberate effort to explain technical concepts in ways that are understandable to educators and researchers who may not have a background in computer science or data analytics. This inclusive approach aligns closely with the mission of advancing educational research and practice by lowering barriers to entry for emerging scholars and practitioners. Furthermore, the interdisciplinary nature of the contributions enriches the discussion, as perspectives from education, psychology and computing converge to provide a more holistic understanding of how ML can be integrated into educational contexts.

Another strength of the book is its emphasis on practical relevance. Many chapters present real-world applications, case studies and empirical findings that illustrate how ML can be used to address pressing educational challenges, such as predicting student performance, identifying at-risk learners and improving assessment practices. These examples not only demonstrate the potential of ML but also provide a foundation for translating research into practice.

Despite these strengths, the volume also reveals certain limitations that warrant critical reflection. One of the most significant gaps is the relatively limited attention given to ethical considerations. While the book highlights the capabilities of ML, it does not sufficiently engage with issues such as data privacy, algorithmic bias and the potential consequences of automated decision-making in education. Given that ML systems often rely on large datasets that include sensitive student information, the absence of a sustained discussion on ethics represents an important area for further exploration.

In addition, the book tends to emphasise the potential benefits of ML without fully addressing the practical challenges associated with implementation. Educational institutions vary widely in terms of technological infrastructure, expertise and resources, and the adoption of ML solutions may not be equally feasible across contexts. A more detailed consideration of these constraints would enhance the applicability of the research, particularly for practitioners working in underresourced environments.

There is also an observable imbalance between technical and pedagogical perspectives in some chapters. While the technical explanations are often thorough, they are not always accompanied by a clear discussion of how the findings relate to established learning theories or classroom practices. Strengthening this connection would help ensure that ML applications are not only technically sound but also pedagogically meaningful.

Taken together, these strengths and limitations provide important insights into the broader implications of the book for educational technology and practice. The volume underscores the transformative potential of ML in enabling more personalised and adaptive learning experiences. By analysing large and complex datasets, ML systems can identify patterns in student behaviour and performance, allowing educators to tailor instruction to individual

needs. This shift towards personalisation represents a significant advancement in the design of learning environments.

Moreover, the predictive capabilities of ML offer valuable opportunities for early intervention. By identifying students who may be at risk of failure or disengagement, educators and institutions can implement targeted support strategies that improve learning outcomes. This proactive approach has the potential to enhance student retention and success, particularly in higher education settings.

The book also highlights the growing importance of data-driven decision-making in education. As institutions increasingly rely on data to inform policies and practices, ML provides powerful tools for extracting actionable insights. These insights can support a range of decisions, from curriculum design to resource allocation, thereby contributing to more effective and efficient educational systems.

In the area of assessment, the applications discussed in the volume point towards a future in which evaluation is more dynamic, automated and responsive. Machine learning can facilitate the analysis of both structured and unstructured data, enabling more nuanced assessments of student learning. This has important implications for formative assessment practices, as it allows for timely and personalised feedback.

However, the integration of ML into educational practice must be approached with caution. The benefits of these technologies must be balanced with careful consideration of ethical, social and pedagogical factors. Ensuring transparency, fairness and inclusivity in ML applications is essential to maintaining trust and equity in education.

In conclusion, the critical evaluation of the volume reveals both its substantial contributions and its areas for further development. At the same time, it points to the broader potential of ML to reshape educational technology and practice in meaningful ways.

Conclusion

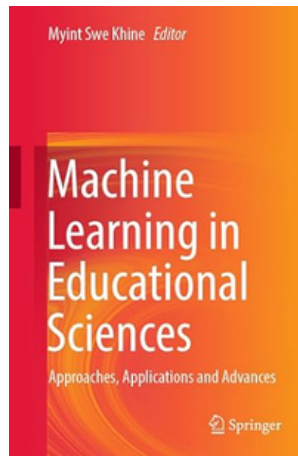
Machine Learning in Educational Sciences is a valuable and timely contribution to the field of educational technology and computing education. The book successfully bridges

theoretical foundations and practical applications, making it suitable for a wide audience, including educators, researchers, and practitioners. While the volume could benefit from a deeper exploration of ethical and implementation challenges, it provides a strong foundation for understanding the role of ML in education. As such, it aligns closely with the goals of *Advancing Education* by supporting knowledge sharing and encouraging innovation in teaching and learning.

Future research should build on this work by addressing ethical concerns, exploring scalable implementation strategies, and strengthening the connection between ML applications and pedagogical theory. Overall, the book serves as both an introduction and a call to action for advancing education through technological innovation.

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Hastangka is a researcher at the Research Center for Education, National Research and Innovation Agency. He completed his undergraduate degree in Philosophy at Universitas Gadjah Mada. He also obtained a master and doctoral degree in Philosophy at Universitas Gadjah Mada in 2014 and 2019.

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Further recommends

The Raspberry Pi Foundation released a position paper titled 'Why kids still need to learn to code in the age of AI'.

Richard Human wrote for the TES Magazine 'Is this the best way to structure pupils' AI learning?'

Frei-Landau, R., Avidov-Ungar, O., Heaysman, O., Ron-Ezra, M., Schor Edelsztejn, H., Schwartz, N. and Abo-Sareya, A. (2026) 'Blending video-based learning and simulations to practice inclusion of children with neurodevelopmental disorders', *Technology, Pedagogy and Education*, pp. 1–26. <https://doi.org/10.1080/1475939X.2026.2639404>

Annika Bautz is Pro Vice Chancellor Education at the University of Surrey. "The University of Surrey will have embedded AI use into all of its degree programmes by September. Annika Bautz explains why doing so in a discipline-specific way was so crucial": 'AI literacy is not enough – universities must teach through disciplinary standards' (Wonkhe, 2026).

A tribute to Lawrence Williams

Dr Christina Preston

We are very sad to hear of the death of Lawrence Williams, who was a Senior MirandaNet Fellow, had an award for Lifetime Achievement from NAACE and was also a member of TPEA. He directed MirandaNet's World Ecitizens Charity as well as being a World Peace Ambassador. He also represented the United Kingdom at international ICT conferences for the Department for Education and Skills (DfES) and Becta.

A graduate in English language and literature as well as in education and in philosophy, he was an experienced classroom practitioner, who had also taught literacy, ICT and computing in initial teacher training and MA courses at Brunel University London, the UCL Institute of Education, King's College London and at a number of other universities in England and abroad. His wide interests included literacy, creative uses of ICT/computing, cross-curricular teaching and learning and international collaborations, on which he has written and published widely. A key collaboration was with Lambeth College in South London to develop teaching materials in computing for further education students with learning difficulties and disabilities, work that was presented at the Association for Information Technology in Teacher Education (ITTE) in London in 2016 and at the IFIP World Conference on Computers in Education (WCCE) in Dublin in 2017.

He has received many national and international awards for his classroom practice, including a 1998 Japan Festival Award for *Kabuki Gift*, a bilingual international drama through video conferencing; a 1999 National Teaching Award in ICT; and Rolls-Royce Science Awards in 2007 and 2008 for *Science Through ARts*, an online collaboration with NASA scientists in Cleveland, Ohio. In his last book, *Introducing computing: A guide for teachers* (2015), he outlined his *Literacy from Scratch* storytelling-with-computing project.

He always kept up his Japanese collaboration with Professor Hiroyuki, who has sent his condolences:

I am still so grateful for Lawrence's great contribution to the huge development of the global friendship between Japan and England through technologies in enhancing global friendship and awareness of school students over the years. Indeed, my own research developed so fruitfully thanks to Lawrence's input, so I thank him for his kind and warm-hearted support. He was an excellent research-based practitioner and contributed hugely to the new cutting-edge uses of technologies in school education.



Final reflection

Spot the difference...?

Alison Hramiak

In this reflective article, Alison Hramiak explores the process of inputting their own poem into an AI system and asking it to rewrite the piece in different poetic styles, prompting a series of questions about authorship.

The world's a contradictory and confusing place to be at the moment. It feels like there's an excess of white noise that plays out in and outside one's head, like a really bad episode of tinnitus that just won't go away. So much so that, when it came to thinking about what to write for this next issue of *Advancing Education*, I was somewhat flummoxed. At a loss for words even. Yes, really, and not something that happens to me that often. I'm more one of those people that it's hard to stop talking, as you all know.

I'd tried reading about various AI issues, looking at what's going on in schools with it and keeping abreast of all things TPEA as far as I could (thank you, WhatsApp groups) but was still struggling to come up with a topical idea for my article. That is, until I read my youngest son's latest copy of [The Society of Authors](#) – a very useful organisation to join if you're a writer – which had some really useful articles on AI from a writer's perspective. I also know from the poetry groups that I'm part of that the issue of AI rears its head frequently, as editors and reviewers strive to ensure authenticity of submissions. But is my definition of authenticity the same as yours?

With that in mind, I thought I'd put this to the test within this piece of writing by asking more questions than I have answers to. Below are two poems. One has been written by me and one by AI. But if you use your own words and then ask the AI to rewrite it, as it were, in the style of a different poet, then whose work is it? For example, if I ask the AI to write a poem based on one that I've written and enter the whole poem (my work entirely) for it to use, is it still my work? Aren't they still my words but just rearranged?

What if you then take the AI version of your poem and adapt your original again, all your own words, and rewrite it to mimic what the AI came up with in terms of structure and formatting, is it still your own work? Is that so very different from writing a poem in the style of the war poets, just because you've read and admired Wilfred Owen's work? Haven't we all been asked to do something along those lines at some point (probably in GCSE English) in our school/college/university lives?

As the AI gets more and more sophisticated, and as we get more sophisticated when using it—and I confess to being a beginner, as it's not something I use—it is likely to get harder and harder to spot the difference between the AI and the original human version of a text, be that prose or poetry. So maybe it's about working with it, not instead of it?

It took me (the AI) seconds to rewrite my words in the style of a different poet, and I tried a few. It was interesting to play with it and to look at the various poetic styles generated, comparing, for example, Shakespeare with Owen, and so on. And, having asked it to try out some styles, I chose one I liked and then found myself editing my original to mimic the AI version. As part of this exercise, honest.

I firmly believe that authors, poets and artists should be given credit for their original authentic work and that we need to be aware of when and how less 'disciplined' others try to pass off the work of AI as their own. It's not a level playing field, really. But you can (usually) tell the difference if you look hard enough. Perhaps we'll have to rely on the professionalism and integrity of authors, poets and artists as we go forwards, at least until we find a way to authenticate work.

Maybe, as we forge ahead with AI, it needs to be more about how we might use AI in different, inventive ways in our classrooms for subjects that involve imagination and creativity. I really liked the ability to enter text, in this case my poem [Half life dream](#), and then ask AI to rewrite it in various forms. To me, this is a very clever, efficient (if unlikely to be original in that I'm sure teachers are doing this everywhere) way to introduce students to very different forms of poetry. It gives them a way to see how the formats, structures, wording, metaphors and so on change in real time – before their eyes – as it were. A very

powerful way to allow students to visualise how the poets they're studying used various poetic tools in diverse ways.

That facility to take the same words and then rearrange them according to poetic style is both engaging and inclusive and uses AI for creativity without 'cheating' – in my mind. For me, this capacity isn't about asking AI to write something for me; rather, it's about asking it to write something with me and to show me how those words might echo through the poetic style of others.

You could give it a try next time you're with students. It doesn't have to be about poetry. How about when you're writing code? And in the meantime, see if you can spot which of the two poems below is all mine...

Half life dream

*Slow. Awakening – half unencumbered by sleep.
Dreams in the pseudo light lay fuzzy in the lilac dawn.
Cooked up in a kitchen of unconsciousness,
They emerge unrecognizable even to the chef.*

*Stretch memories on the rack of your mind
To see if the truth will out. Pieces of a mish-mash dream
Float separately just beyond reach. Meanings remain meaningless.
Did anyone ever get anything real from torture?*

*When you can only remember half the trials of your night,
Then there's not enough evidence to convict you, is there?
Corpus delicti. Leave the half life dream to decay over time.
Greet the day and leave the unfinished in the ether, a radium cur(i)e.*

Half life dream

*Half-life dream – slow surfacing from sleep,
Mind dragging through a dim, lilac-lit haze;
The night's remains lie scattered, blurred and deep,
Like broken thoughts that will not hold their place.*

*What forged them there – what fevered, hidden room?
No maker knows the shapes his dreaming cast;
We stretch their truth, but find no living proof–
Only the echo of a night half-passed.*

*No crime remains when memory falls apart;
Day finds no guilt within the waking mind–
So let it fade, this dream without a heart,
And leave its ghostly fragments far behind.*



Author



Alison Hramiak

Alison Hramiak is a poet, writer and tutor living and working in West Yorkshire, England. She is published in several *Forward Poetry* anthologies, *New Contexts* 4, 6 and 7 and on various poetry websites such as Impspired and The Causley Trust. She edits and reviews poetry anthologies and is a member of several poetry groups, such as Consilience. She blogs for the Sheffield Institute of Education. Her work can be found at [Poetry for Lives](#).

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