HESWBL
16,5

938

Received 15 July 2025
Revised 24 September 2025
5 November 2025
Accepted 9 November 2025

Using degree apprenticeships to shape the future of traditional undergraduate degrees

Ed Macaulay, Jonathan Jackson, Chris White and Adrian Bevan
Queen Mary University of London, London, UK

Abstract

Purpose – The purpose of this paper is to outline the lessons that can be learned from degree apprenticeship delivery and how these can be applied to the design of a new full-time undergraduate programme.

Design/methodology/approach – Key tactics are identified through authorial reflection based on an insider perspective of delivering various aspects of the Digital and Technology Solutions BSc degree apprenticeship programme at QMUL. These tactics were then grouped under higher level pedagogical principles based on emergent overlapping themes. The application of these tactics to the new Applied AI BSc degree is then outlined.

Findings – Eleven tactics are identified and grouped under four main pedagogical principles: programme coherence, authentic assessment, integrated employability and industry collaboration, and inclusive learning environment. The majority of the tactics are found to be directly applicable to non-apprenticeship degree programme design and delivery, with some requiring adaptations. Three district streams of learning emerged on the new Applied AI degree: foundations, tools and applications.

Practical implications – The four principles, eleven tactics and three learning streams are proposed as scaffolding for use by other degree programme design teams. Future work on the development of a new apprenticeship standard or subject benchmark statement for Applied AI at undergraduate level is proposed.

Originality/value – The new Applied AI BSc degree being launched has a unique curriculum which does not align to any existing apprenticeship standard or subject benchmark statement. The programme, heavily influenced by QMUL's Ofsted Outstanding degree apprenticeship provision, offers a unique testing ground for the development of best practice AI education and AI in education.

Keywords Employability, Authentic assessment, AI, Artificial intelligence, Machine learning, Generative AI, Apprenticeships, Subject benchmarks, Active learning, Project-based learning

Paper type Practitioner paper

Introduction

Since the UK Government introduced Degree and Higher-Level Apprenticeships, many forward-thinking employers and universities have embraced the work-based learning (WBL) model (Boud and Solomon, 2001) and collaborated to deliver transformational educational experiences for a diverse generation of learners (Bravenboer, 2019; Hughes and Saieva, 2019). Within the higher education (HE) sector, we now have a decade's worth of degree apprenticeship delivery experience to draw on which can be used to improve the next decade of practice, but not just within the context of degree apprenticeships.

With its roots in WBL, one significant benefit of the degree apprenticeship model that traditional undergraduate education often lacks is the workplace context in which apprentices can situate their learning throughout their whole programme of study. From the perspective of employability, this workplace context affords a great number of opportunities for theory to intersect with practice, ideal for enabling impactful WBL. Employers understandably want

Approval to publish this paper was granted by the School of Physical and Chemical Sciences at QMUL.

Higher Education, Skills and Work-Based Learning
Vol. 16 No. 5, 2026
pp. 938-949
Emerald Publishing Limited
e-ISSN: 2042-390X
p-ISSN: 2042-3896
DOI 10.1108/HESWBL-07-2025-0290

graduates to apply theoretical knowledge to workplace problems (Bethel, 2017). But are degree apprenticeships the only way to facilitate this?

While it makes sense to encourage growth of degree apprenticeships, the number of places available is fundamentally limited to the number of positions employers can offer, and traditional full-time or part-time degree education remains the dominant paradigm. Despite this limitation, there are many lessons that can be learned from the degree apprenticeship model that can be applied to undergraduate degree programmes.

Embedding employability in traditional degrees is an increasing priority of external regulators. Examples include the office for students, which set targets on employability through its conditions of registration. Employability is also of direct interest to disciplinary accreditors (e.g. the Royal Society of Chemistry and the Institute of Physics), who have adopted an increasingly skills-based rather than knowledge-based approach in recent years. Degree apprenticeships are arguably at the forefront of contemporary employability-led education, as employers contribute so significantly to the learning experience. There is therefore a clear rationale for using best practices from high-quality degree apprenticeship programmes to inform programme and assessment design on traditional degrees.

This paper presents the example of how a new full-time undergraduate Applied Artificial Intelligence BSc programme was designed based on lessons learned from the historical delivery of the Digital and Technology Solutions BSc degree apprenticeship within the same HE institution.

Artificial intelligence (AI) is very much a cross-cutting concern for HE, government and industry in terms of future readiness, particularly with the rise of generative AI (GenAI) and large language model (LLM) chatbot tools like ChatGPT which was released in 2022 with unprecedented speed of adoption (OpenAI, 2022). There are calls for HE to adapt (and even transform) in order to help students be future-ready for a world of work where GenAI may achieve near-ubiquity (Chiu, 2024). The work outlined in this paper endeavours to demonstrate how this call might be answered in a thoughtful manner, confronting hype and ambiguity with grounded pedagogy and clarity of thought. Of course, GenAI is a very specific subset of the entire field of AI. While "AI" is an inherently ambiguous umbrella term, the new Applied AI BSc programme disambiguates clearly within its taught modules and counters the problematic nature of the term itself which can all too easily be used to obfuscate and alienate (Tucker, 2022).

Industry demands people who know how to *use* various forms of AI, not just how to create it. The 2024 Nobel Prizes awarded for AI breakthroughs were in Physics and Chemistry ("AI pioneers win 2024 Nobel prizes", 2024), so the School of Physical and Chemical Sciences (SPCS) at Queen Mary University or London (QMUL) is a natural home to study the applications of AI. The aim of this new programme is to help students learn the relevant theory, apply that to problems in a controlled way and unleash their potential through projects with real-world relevance and benefit. They won't only develop technical skills, but they will also engage with important topics such as commercialisation and the ethical implications of using AI.

Table 1 summarises the pedagogical principles and tactics which had been successfully applied to the Digital and Technology Solutions (DTS) degree apprenticeship programme and that subsequently helped to inform the design of the new Applied AI BSc programme. The list of tactics was collated and refined by means of retrospective authorial reflection on the programme design process based on an insider perspective. The four pedagogical principles were identified based on the overlapping themes that emerged from the final list of tactics.

The third column in Table 1 highlights how some tactics were directly applicable without much difficulty, whereas others required adaptation based on the non-apprenticeship context of the programme. For example, T1.2 required adaptation because a level 6 apprenticeship standard, and therefore a set of predefined knowledge, skills and behaviours (KSBs), did not exist for Applied AI.

Coherent apprenticeship programme design

The design of the new Applied AI BSc programme has been informed by the experience gained through degree apprenticeship delivery, which includes level 6 qualifications in Data

Table 1. Summary of programme design principles drawn from degree apprenticeship delivery experience

Principles	Tactics	Application to non-apprenticeship programme design
P1. Programme coherence	T1.1 Programme-level design	Directly applicable
	T1.2 KSB mapping	Indirect application – Programme Learning Outcomes Mapping instead of KSBs
	T1.3 Modules owned by programme	Directly applicable
	T1.4 Co-teaching of modules	Directly applicable
P2. Authentic assessment	T2.1 Portfolio assessments	Directly applicable
	T2.2 Work-based project assessments	Indirect application – live briefs can be provided by collaborating employers in lieu of an employer context
	T2.3 Minimising exams	Directly applicable
P3. Integrated employability and industry collaboration	T3.1 Industry consultation	Indirect application – non-apprenticeship employer relationships are required
	T3.2 Embedding of industry tools	Directly applicable – while this is discipline-specific, the same approach can be taken for apprenticeships and non-apprenticeship programmes
	T3.3 Professional skills development	Directly applicable – while this is discipline-specific, the same approach can be taken for apprenticeships and non-apprenticeship programmes
P4. Inclusive learning environment	T4.1 Self-managed laptops	Indirect application – while apprentices often had their own personal or work-issued laptops, undergraduate students on the new Applied AI BSc are to be issued with their own self-managed laptops by the university

Analysis, Software Engineering and Business Analysis based on the digital and technology solutions professional degree apprenticeship standard (Skills England, 2023). In 2024 the degree apprenticeship provision at QMUL was rated as "Outstanding" by Ofsted across all areas of Quality of Education, Behaviour and Attitudes, Personal Development, Leadership and Management, and Apprenticeships (Ofsted, 2024). With no areas for improvement identified by Ofsted, it was one of the highest rated Degree Apprenticeship provisions in the country. Of course, an Ofsted inspection does not evaluate every detail of the programmes under review, and so there are still many things to be improved and an abundance of lessons continually being learnt.

One of the most impactful lessons learned from the degree apprenticeship provision by certain academic staff members was the programme-level design and mapping (Harden, 2001) (T1.1) which strengthens programme coherence (P1). With degree apprenticeships, the KSBs specified in the apprenticeship standard are mapped not just across individual taught modules but across the programme as a whole (T1.2). Moreover, assessments are mapped across each semester to avoid assessment bunching and reduce the risk of disadvantaging students who benefit from a more evenly spread workload.

The overarching goal of this approach to programme design is to ensure that the individual modules contribute to a highly integrated programme curriculum. This is facilitated by the concept of modules being owned by the programme (T1.3) and not solely by the individual module leads. This approach is advocated by Wieman (2017) and aims to avoid individual modules becoming siloed and isolated from the broader programme. While this may not be seen as particularly innovative within contemporary HE as a whole, difficulties can still persist in university departments or schools which may still be grappling with resistance to change or lack of experience with skills-based education (Romero-González, 2021). The approach of mapping KSBs across a programme can offer a new perspective for academics who have historically delivered more isolated, theoretically focused modules.

Building further on this approach to module ownership, all taught modules on the degree apprenticeship programme are led by two or more module organisers working in cooperation (T1.4), as opposed to the more conventional approach of one module organiser.

Table 2 shows the programme structure of the three-year Digital and Technology Solutions BSc degree apprenticeship programme as of 2025. A similar structure was adopted for the new Applied AI BSc (see Table 3) which is outlined in more depth in the next section.

Programme design of the Applied AI BSc

The BSc in Applied AI is a new degree programme in QMUL's School of Physical and Chemical Sciences and takes its first cohort of students in September 2025. The aim of the degree is to prepare the graduates with the necessary skills to succeed as practitioners of applications of AI across a wide range of sectors and industries. Following the QMUL principles of programme design (Queen Mary University of London, 2024), the curriculum was designed from the ground up around three, year-long, 30-credit taught modules each year, combined with extensive and closely integrated group and individual project work as part of a fourth 30-credit module each year.

While the DTS degree apprenticeship programme was based on an approved apprenticeship standard (Skills England, 2023), there was no level 6 apprenticeship standard for Applied AI. Neither was there a subject benchmark statement available in the same way that there is for subjects like computing (QAA, 2022) or an external accrediting body. This proved to be both a challenge and an opportunity for innovation within the curriculum design process and suggests

Table 2. Digital and Technology Solutions BSc Programme Overview (all 30 credit modules)

Year 1 modules	Year 2 modules	Year 3 modules
Fundamentals of Programming	Next Generation Technology Design: Network, Security and Green Computing	Digital Innovation and Sustainable Product Development
Quality Driven Development	Business Organisation and Decision Making	Pathway-Specific Module
Reflective Practice for Technology Professionals	Reflective Leadership and Project Management	Final Project
Pathway-Specific Module	Pathway-Specific Module	End Point Assessment

Table 3. Applied AI BSc Programme Overview (all 30 credit modules)

Stream	Year 1 modules	Year 2 modules	Year 3 modules
Foundations	Mathematical Principles for AI	Machine Learning	Analysing Language
Tools	Coding Practices in AI Development	Tools and Applications of Generative AI	Analysis of Social Media
Applications	Exploring AI: Understanding and Applications	AI in the Real World	Entrepreneurship and Consultancy
Projects	Applied AI Collaborative Project	Disciplinary AI project	Applied AI in Industry Project

the potential need for future work on a relevant apprenticeship standard or subject benchmark statement to which the authors of this paper would be keen to contribute.

An overview of the curriculum of the Applied AI degree is shown in Table 3. When presenting the curriculum to potential students at applicant days for the programme, it became clear that the taught modules each year comprise three distinct streams, which cover the foundations, tools and applications of AI. Although the Applied AI curriculum was not originally planned with these three distinct streams in mind, the fact that they naturally emerged reflects the programme-level approach to the design of the individual modules and their place in the programme as a whole. These three streams – foundations, tools and applications – not only provide a useful lens which emphasises the coherence of the Applied AI programme but may also serve as a useful framework that could generalise to the design of future degrees.

The learning outcomes for the taught modules have all been designed to provide a closely aligned programme-level curriculum across the taught elements of the degree. For example, where a new concept is introduced in the first-year "Mathematical Principles for AI" module, students will also see how the concept is implemented in the "Coding Practices in AI Development" module and how it is relevant to the applications of AI in the "Exploring AI" module.

The taught elements of the programme are also reinforced in each year by a closely integrated project module. In the first year of the programme, the project module begins with a highly scaffolded introduction to collaborative project work, academic research and referencing, and guidance on constructive use of generative AI. Embedding projects from the beginning of the programme gives students the opportunity to engage with authentic, real-world assessments throughout their programme, which increase in complexity as they progress into year 2 and year 3. This progressive, pedagogical scaffolding helps build their skills, confidence and overall employability by the time they graduate (Morley and Jamil, 2021).

Alongside traditional subject matters, such as maths and AI, the programme includes real-world elements including practical application of technologies, configuring laptops, product commercialisation, patent application development, venture capital and grant pitching, and project-based problem solving.

The culmination of the programme is the final-year group project, which is a "Dragons' Den" style challenge to build an AI-based application with the potential to spin out into a standalone business. The students completing the most successful project each year are to be supported to take a step into the entrepreneurial world through financial investment and business support provided by QMUL. The aspirations of the programme to have real-world impact and directly support graduate innovation through this Dragons' Den challenge aligns closely with the concept of transformative education as described by Wink (2005) in the context of critical pedagogy which focuses on shifting power into the hands of students through collaborative endeavour instead of passive knowledge transmission. Academic staff and students are positioned as partners in learning, combining theory and practice, transforming knowledge into new innovations and enabling students to develop a deeper understanding of themselves, others and the world along the way. This also links strongly with authentic assessment which is discussed in more detail in the next section.

Approach to authentic assessment

One of the key principles from our experience with the degree apprenticeships that informed our new Applied AI degree was our approach to authentic assessment (P2). In the degree apprenticeships, all assessments are closely aligned to assess the KSBs expected of the students. For example, in the level 5 data analyst specialism module "Professional Software and Career Practices", coding skills are assessed with an interview style coding challenge, where they develop a solution to a coding challenge under interview conditions. In addition to directly assessing the code written by the students, their approach to code planning is assessed with a pseudocode plan of the coding challenge, and after completing their code, the students write a brief reflection on their code, where they highlight what they feel are the strengths of their approach and also consider how their code could be developed further.

In addition to the interview style coding challenge, the "Professional Software and Career Practices" module also takes a portfolio-based approach to authentic assessment (T2.1). At the start of the semester, students create their own code repository for the module on GitHub, which they then develop during the module. The code repository comprises part of the final assessment for the module and aims to ensure that students develop good professional software development practices, such as frequent commits to their repositories for the duration of the project. In addition to building professional software development habits, this approach to authentic assessment naturally leads the students to build an independent portfolio of their work, which they can use to demonstrate the skills they have developed on the programme.

This experience with authentic assessment has directly influenced our approach to assessment on the Applied AI degree. For example, in the level 4 module "Exploring AI: Understanding and Applications", students use generative AI to generate a solution to a coding challenge, which they then critique and reflect on as part of the assessment.

In the entire Applied AI degree, the only traditional in-person exam is in the level 4 module "Mathematical Principles for Artificial Intelligence", and only because, in the case of this module, a traditional exam does represent an authentic form of assessment (T2.3). Students will be prepared for this examination by completing a skills-based "maths portfolio", in which they have multiple chances to perform a series of basic mathematical tasks, in order to demonstrate competency to a staff member. This itself mimics the development of skills in the workplace, through appraisals and informal conversations. The ability to learn through failure and receive ongoing feedback is in stark contrast to the traditional degrees that heavily rely on multiple problem sheets to test mathematical acumen, with numerical marks and written solutions as the only feedback to students. We thus aim to both increase the value of, and ameliorate student anxiety around, the assessment process.

We have also built on our experience with the degree apprenticeship programme to develop portfolio-based assessment in other areas. Throughout the degree, students will be curating their code repositories on GitHub and also demonstrating their skills via the IBM SkillsBuild programme and QMUL's MySkills platform.

The final-year "Dragons' Den" style group project mentioned in the previous section is a strong example of active learning (Barnes, 1989; Bonwell and Eison, 1991) and also lends itself to a deeper meaning of authenticity being closely linked to how students find their place in society, as articulated by McArthur (2023). Live briefs or "live case studies" are another type of highly effective learning which can facilitate authentic assessments (Schonell and Macklin, 2019), mirroring the kind of work-based projects that apprentices would have access to through their employer (T2.2), leveraging the benefits of WBL (Lester and Costley, 2010) and affording social and emotional learning opportunities when the live briefs have a social or civic focus which can lead to students becoming emotionally invested and feeling a deeper sense of commitment (Jackson *et al.*, 2024).

Underlining the whole approach to authentic assessment is the principle of quality over quantity which helps avoid an "assessment arms race" by focussing on "fewer but more integrated inquiry-type assessments" (Harland *et al.*, 2015). Assessments should act as a means for effective learning, not the end in themselves.

Industry involvement and employability

During the DTS degree apprenticeship, apprentices are enrolled as students at QMUL while also being employees of their respective employers. QMUL has been privileged to work with apprentices from world-leading companies with strong digital technology capability including Amazon, Goldman Sachs, KPMG, Morgan Stanley and PwC. Working closely with partner organisations from industry provides authentic opportunities to apply the KSBs developed during the programme and has informed the development of the curriculum for the Applied AI BSc degree (T3.1).

As an example, on the Applied AI degree, IBM is already a collaborating partner through their SkillsBuild offering (IBM, 2025), which has been embedded in the Applied AI curriculum as part of a portfolio-based approach to skills development (T2.1 and T3.2). As the Applied AI programme grows, further industry involvement is planned, including seminars from industry professionals, collaborations on student projects and authentic industry “live” briefs which would support true student–staff–stakeholder partnerships (Jackson *et al.*, 2024) where all participants benefit from the process of learning and working together (Harrington *et al.*, 2014).

But the definition of employability does not need to be constrained to solely preparing students for how to qualify for a job. Oliver (2015) states that employability is “about empowering learners as critical reflective citizens”, while Clarke (2018) identifies various dimensions to employability including human, social and behavioural factors. Knight and Yorke (2006) highlight that metacognition is also a key element of employability.

On both the DTS degree apprenticeship and the Applied AI programme, the close alignment with industry and the outward-facing nature of the curriculum underscores the authentic nature of the programme, ensuring that students will have the skills they will need to succeed beyond graduation.

Inclusive learning resources

Another unique aspect of the Applied AI BSc programme that has been informed by experience on the DTS degree apprenticeship is the provision of new, self-managed laptops for students to use throughout their studies (T4.1). This decision was based on several observations from the degree apprenticeship programme and aims to encourage an authentic culture of living and breathing their subject without having to rely on university machines only available on campus.

A great deal of the teaching sessions on the DTS degree apprenticeship naturally involves computing and coding work. Historically, this was typically facilitated through centrally managed desktop computers in designated teaching spaces. However, experience on the degree apprenticeship programme highlighted some of the limitations with this traditional approach and brought to light the preferred approaches of apprentices on the programme.

Firstly, a reliance on desktop computers in designated teaching spaces can cause difficulties with timetabling teaching sessions, particularly for large cohorts of students. For example, in a data analysis pathway-specific module (Artificial Intelligence and Statistical Data Analysis), it was necessary to divide the ∼80 students enrolled on the module between two separate computing labs, which necessitated double teaching some of the material of the module and dividing teaching staff between the two locations.

Moreover, a reliance on centrally managed desktop computers complicated the process of installing the software and packages which were necessary for code development, and technical issues with centrally managed fileservers often restricted students’ access to necessary computing resources.

Perhaps the most curious insight from computing provision on the degree apprenticeship modules was simply that students overwhelmingly preferred to use their own devices, with almost every student on the programme using either their own personal computer or a machine provided by their employer. However, students using their own devices itself brought about a range of issues. For example, students using machines provided by their employer were often unable to install new software or packages themselves, and for students using their own devices, the range of different devices and operating systems often required significant time during teaching sessions to assist with installing and managing the necessary software.

To mitigate these issues on the Applied AI programme, all students are to be provided with their own, self-managed laptop. At the time of writing, the procured laptops are all Dell Pro 14 Plus models running Windows 11 Pro and will be provided to the students on a self-managed basis. One of the goals of providing uniform machines to all students is to streamline the process of managing the devices, since the process of installing and maintaining the devices will be identical for all students. This process of maintaining their own laptops as professional devices for applications of AI is one of the specific learning outcomes of the programme, and dedicated teaching time for this is scheduled as part of the support on project modules in an effort to mitigate and even remove any digital divide (Buzzetto-Hollywood *et al.*, 2018).

Providing uniform devices to all the students in the cohort also helps to promote an inherently inclusive learning environment in the programme (P4), by ensuring that students from the wide range of backgrounds on the degree all have access to the same high-performance resources and are equipped with the skills to fully make use of them. This strongly aligns with several of the UN's Sustainable Development Goals (SDGs) such as an inclusive and equitable quality education (Goal 4) and reducing inequalities (Goal 10) (United Nations, n.d.).

Beyond the benefits of facilitating more flexible scheduling of teaching sessions and streamlining device management, the broader goal of the laptop provision is to nurture an authentic culture of autonomous code development and ownership over their own professional development, while being able to live and breathe various applications of AI through experimentation on their own devices at any time. Real-world code development is often not confined to typical offices hours or corporate environments and often emerges from ad-hoc opportunistic experimentation, such as working collaboratively in non-traditional working environments such as coffee shops (Fang *et al.*, 2024). Just as many Silicon Valley startups were born in garages and coffee shops, it is hoped that providing all students with their own laptops will encourage them to embrace a similar mindset of innovation and experimentation, working on their projects with their peers in heterogeneous locations throughout campus and beyond.

AI education and AI in education

As noted in the introduction to this paper, AI is a cross-cutting concern for education, government and industry. The UK government has called for wider AI adoption "to boost economic growth, provide jobs for the future and improve people's everyday lives" (Department for Science, Innovation and Technology, 2025), and education's envisaged role has been articulated through public policy (Department for Education, 2025).

The symbiotic relationship between the DTS degree apprenticeship programme and the new Applied AI BSc programme at QMUL provides a unique opportunity to accelerate the development and dissemination of best practice around AI education and AI in education.

Through the degree apprenticeship model, employers and apprentices can provide real-time feedback to education providers on what type of work is being done and what tools are being used in the workplace. Of course, it is the responsibility of the HE institution to request this information in the first place and then decide how, or indeed if, to act on it in order to achieve alignment with workplace requirements (Helyer, 2011). Apprentices themselves are in the rare position of being able to engage with HE while simultaneously being embedded in a workplace which has direct relevance to the subject they are studying. It is vital that their perspective is heard.

An example of how this kind of collaborative information sharing is driving change relates to the university's stance on GenAI usage in assessed project work. Historically, any assessments involving the production of code have understandably required that the code submitted is the student's own work. The proliferation of GenAI tools available publicly and within the workplace has meant that more knowledge work such as coding is being carried out with the support of GenAI (e.g. using tools such as GitHub Copilot), so prohibiting the use of GenAI as part of assessed work-based projects has become problematic. In this context, maintaining a stance of prohibition would seem to directly oppose the principles of authenticity, employability and inclusivity.

Engagement with employers and apprentices on the DTS degree apprenticeship has forced the academic team at QMUL to address this internal policy vacuum and spearhead work on innovative assessment design along with clearer guidance and support for both academics and students on appropriate applications of GenAI within summative assessments.

Of course, using GenAI to write code is just one use case, and the wider discourse of GenAI's applicability to education is complex and often polarising (Kasneci *et al.*, 2023; Bastani *et al.*, 2024). LLMs, for example, have been deftly described as "stochastic parrots" (Bender *et al.*, 2021) and their potential for social, political, educational and environmental harm is well documented (Weidinger *et al.*, 2021; Kurian, 2024; de Vries, 2023). But education can help combat these harms. Misuse abounds when there is a lack of education and criticality.

Education can help maximise the potential benefits of GenAI by teaching students the fundamentals of prompt engineering contextualised within their subject of study (Cain, 2024). Techniques such as "flipped interaction" prompting (White *et al.*, 2023) can help transform LLMs into tools which aid discovery, criticality and reflection. Moving beyond the passive consumption of statistically likely text outputs and shifting to a mindset of what might be called higher order prompting can help cultivate higher order thinking (Jackson, 2025).

While there are some potentially useful starting points for thinking about GenAI and assessment (e.g. traffic light systems), applying labels or categories to existing elements of assessment is not the kind of structural change often needed to deliver truly authentic means of assessment (Corbin *et al.*, 2025). The hard work lies in the detail of designing authentic assessments which map back to appropriate learning outcomes, which in turn map back to the overall intent of a coherently designed programme. Robust assessment design will set the boundaries of appropriate GenAI usage either implicitly or explicitly and facilitate the development of AI literacy in line with employability demands but not at the expense of criticality and higher order thinking.

Helping students develop and maintain their criticality and creativity is an essential part of contemporary education, particularly in the context of AI and its various flavours. Like several other institutions, QMUL has taken the positive step of setting up a Centre for Excellence in Artificial Intelligence in Education (Queen Mary Academy, n.d.), but it is up to the academic teams on the front lines of teaching to engage with the ongoing discourse and make sense of it within the context of their discipline for the benefit of their students.

Conclusions

This paper has presented a set of practical programme design and delivery tactics aligned to four pedagogical principles: programme coherence, authentic assessment, integrated employability and industry collaboration, and inclusive learning environment (see Table 1). These tactics were collated based on the learnings from running a successful degree apprenticeship programme. It has been demonstrated that the majority of these tactics can also be applied to the design and delivery of a new non-apprenticeship degree programme in a different, but related, discipline.

It is clear that the principles are closely interrelated and that neglecting one would negatively impact the others. For example, the lack of a coherent programme structure would undermine the effectiveness of authentic assessments to progressively build in complexity year on year. This also highlights the potential difficulty of trying to redesign assessments at a module level within an already existing programme that may lack coherence, but this should not be used as a reason to neglect extant assessments that may need reviewing.

The authors are cognisant of the fact that the degree apprenticeship provision would likely not have existed within QMUL if its institutional values had not focussed so strongly on social mobility and inclusivity within HE. This paper highlights the positive knock-on effects of an institution engaging with alternative types of HE provision (i.e. degree apprenticeships) which can raise the bar in terms of employability for other more traditional programmes within the same institution.

Looking to the future, there is a case to be made for the development of a skills framework, apprenticeship standard or subject benchmark statement for Applied AI at undergraduate level. The authors hope that the work presented in this paper can help catalyse this process and that the new Applied AI BSc programme will be a valuable testing ground for the development of best practice AI Education and AI *in* education, benefitting students, employers and the HE sector as a whole.

References

"AI pioneers win 2024 Nobel prizes" (2024), "Nature machine intelligence", *Nature*, Vol. 6 No. 11, p. 1271, doi: 10.1038/s42256-024-00945-0.

Barnes, D.R. (1989), *Active Learning*, Leeds University TVEI Support Project, Leeds.

Bastani, H., Bastani, O., Sungu, A., Ge, H., Kabakcı, Ö. and Mariman, R. (2024), "Generative AI can harm learning", SSRN Scholarly Paper, Rochester, NY, 15 July.

Bender, E.M., Gebru, T., McMillan-Major, A. and Shmitchell, S. (2021), "On the dangers of stochastic parrots: can language models Be too big?", *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency, Association for Computing Machinery*, New York, NY, USA, pp. 610-623, doi: 10.1145/3442188.3445922.

Bethel, C.L. (2017), "Improving student engagement and learning outcomes through the use of industry-sponsored projects in human-computer interaction curriculum", *2017 15th International Conference on Emerging eLearning Technologies and Applications (ICETA), Presented at the 2017 15th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, pp. 1-6, doi: 10.1109/ICETA.2017.8102468.

Bonwell, C.C. and Eison, J.A. (1991), "Active learning: creating excitement in the classroom", 1991 ASHE-ERIC Higher Education Reports, ERIC Clearinghouse on Higher Education, The George Washington University, One Dupont Circle, Suite 630, Washington, DC 20036-1183 ($17).

Boud, D. and Solomon, N. (2001), *Work-Based Learning*, McGraw-Hill Education, UK.

Bravenboer, D. (2019), "The creative disruption of degree apprenticeships in the UK", *Global Perspectives on Work-Based Learning Initiatives*, pp. 57-83, doi: 10.4018/978-1-5225-6977-0.ch003.

Buzzetto-Hollywood, N.A., Wang, H.C., Elobeid, M. and Elobaid, M.E. (2018), "Addressing information literacy and the digital divide in higher education", *Interdisciplinary Journal of E-Skills and Lifelong Learning*, Vol. 14, pp. 077-093, doi: 10.28945/4029.

Cain, W. (2024), "Prompting change: exploring prompt engineering in Large Language Model AI and its potential to transform education", *TechTrends*, Vol. 68 No. 1, pp. 47-57, doi: 10.1007/s11528-023-00896-0.

Chiu, T.K.F. (2024), "Future research recommendations for transforming higher education with generative AI", *Computers and Education: Artificial Intelligence*, Vol. 6, 100197, doi: 10.1016/j.caeai.2023.100197.

Clarke, M. (2018), "Rethinking graduate employability: the role of capital, individual attributes and context", *Studies in Higher Education*, Vol. 43 No. 11, pp. 1923-1937, doi: 10.1080/03075079.2017.1294152.

Corbin, T., Dawson, P. and Liu, D. (2025), "Talk is cheap: why structural assessment changes are needed for a time of GenAI", *Assessment and Evaluation in Higher Education*, Vol. 50 No. 7, pp. 1087-1097.

de Vries, A. (2023), "The growing energy footprint of artificial intelligence", *Joule*, Vol. 7 No. 10, pp. 2191-2194, doi: 10.1016/j.joule.2023.09.004.

Department for Education (2025), "Generative artificial intelligence (AI) in education", GOV.UK, 10 June, available at: https://www.gov.uk/government/publications/generative-artificial-intelligence-in-education/generative-artificial-intelligence-ai-in-education (accessed 17 June 2025).

Department for Science, Innovation and Technology (2025), "AI opportunities action plan", 13 January, available at: https://www.gov.uk/government/publications/ai-opportunities-action-plan/ai-opportunities-action-plan (accessed 17 June 2025).

Fang, L., Adelakun, F. and Goetemann, T. (2024), "Brewing entrepreneurship: coffee and startups", *Journal of Planning Education and Research*, Vol. 44 No. 3, pp. 1401-1414, doi: 10.1177/0739456X211067272.

Harden, R.M. (2001), “AMEE Guide No. 21: curriculum mapping: a tool for transparent and authentic teaching and learning”, *Medical Teacher*, Vol. 23 No. 2, pp. 123-137, doi: 10.1080/01421590120036547.

Harland, T., McLean, A., Wass, R., Miller, E. and Sim, K.N. (2015), “An assessment arms race and its fallout: high-stakes grading and the case for slow scholarship”, *Assessment and Evaluation in Higher Education*, Vol. 40 No. 4, pp. 528-541, doi: 10.1080/02602938.2014.931927.

Harrington, K., Flint, A. and Healey, M. (2014), “Engagement through partnership: students as partners in learning and teaching in Higher Education”, *Monograph, Higher Education Academy*, York, UK, available at: https://repository.londonmet.ac.uk/5176/ (accessed 24 February 2024).

Helyer, R. (2011), “Aligning higher education with the world of work”, *Higher Education, Skills and Work-based Learning*, Vol. 1 No. 2, pp. 95-105, doi: 10.1108/20423891111128872.

Hughes, C.J. and Saieva, G. (2019), “Degree apprenticeships – an opportunity for all?”, *Higher Education, Skills and Work-based Learning*, Vol. 9 No. 2, pp. 225-236, doi: 10.1108/HESWBL-10-2018-0113.

IBM (2025), “Free skills-based learning from technology experts”, *IBM SkillsBuild*, 15 July, available at: https://skillsbuild.org/ (accessed 15 July 2025).

Jackson, J. (2025), “Higher order prompting: applying Bloom’s revised taxonomy to the use of large language models in higher education”, *Studies in Technology Enhanced Learning*, Vol. 4 No. 1, doi: 10.21428/8c225f6e.0915c17e.

Jackson, J., Buzasi, Z., Syrett, K. and Trenyik, N. (2024a), “The power of external stakeholders to enhance social and emotional learning in Higher Education”, *The Journal of Educational Innovation, Partnership and Change*, Vol. 10 No. 2.

Jackson, J., Day, N. and Maher, K. (2024b), “Bringing the real world into the classroom through team-based live brief projects”, in *Approaches to Work-Based Learning in Higher Education: Improving Graduate Employability*, Taylor & Francis, pp. 81-105.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., Stadler, M., Weller, J., Kuhn, J. and Kasneci, G. (2023), “ChatGPT for good? On opportunities and challenges of large language models for education”, *Learning and Individual Differences*, Vol. 103, 102274, doi: 10.1016/j.lindif.2023.102274.

Knight, P.T. and Yorke, M. (2006), “Employability: judging and communicating achievements”, *Learning and Employability*, Vol. 2.

Kurian, N. (2024), “‘No, Alexa, no!’: designing child-safe AI and protecting children from the risks of the ‘empathy gap’ in large language models”, *Learning, Media and Technology*, Vol. 50 No. 4, pp. 1-14, doi: 10.1080/17439884.2024.2367052.

Lester, S. and Costley, C. (2010), “Work-based learning at higher education level: value, practice and critique”, *Studies in Higher Education*, Vol. 35 No. 5, pp. 561-575, doi: 10.1080/03075070903216635.

McArthur, J. (2023), “Rethinking authentic assessment: work, well-being, and society”, *Higher Education*, Vol. 85 No. 1, pp. 85-101, doi: 10.1007/s10734-022-00822-y.

Morley, D.A. and Jamil, M.G. (2021), *Applied Pedagogies for Higher Education: Real World Learning and Innovation across the Curriculum*, Springer International Publishing, Cham, doi: 10.1007/978-3-030-46951-1.

Ofsted (2024), “Inspection of queen mary university of London”, 15 November, available at: https://reports.ofsted.gov.uk/provider/43/133813 (accessed 14 July 2025).

Oliver, B. (2015), “Redefining graduate employability and work-integrated learning: proposals for effective higher education in disrupted economies”, *Journal of Teaching and Learning for Graduate Employability*, Vol. 6 No. 1, pp. 56-65, Deakin University, doi: 10.3316/informit.174658230609829.

OpenAI (2022), “Introducing ChatGPT”, *Open*, 30 November, available at: https://openai.com/index/chatgpt/ (accessed 9 September 2024).

QAA (2022), "Subject benchmark statement – computing", 30 March, available at: https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/computing (accessed 15 July 2025).

Queen Mary Academy (n.d.), *Centre for Excellence in Artificial Intelligence in Education*, Queen Mary University of London, London, available at: https://www.qmul.ac.uk/queenmaryacademy/educators/innovation-and-scholarship/innovative-pedagogies/centre-for-excellence-in-ai-in-education/(accessed 15 July 2025).

Queen Mary University of London (2024), "QMUL principles of programme design", October, available at: https://www.qmul.ac.uk/governance-and-legal-services/media/dgls-media/policy/2024-25/Principles-of-Programme-Design-(October-2024).pdf (accessed 14 July 2025).

Romero-González, M. (2021), "Mapping skills for curriculum design using a programme level approach in a transnational education context", *Employability: Breaking the Mould*, pp. 111-116.

Schonell, S. and Macklin, R. (2019), "Work integrated learning initiatives: live case studies as a mainstream WIL assessment", *Studies in Higher Education*, Vol. 44 No. 7, pp. 1197-1208, doi: 10.1080/03075079.2018.1425986.

Skills England (2023), "Digital and technology solutions professional", Institute for Apprenticeships and Technical Education, 9 January, available at: https://skillsengland.education.gov.uk/apprenticeship-standards/st0119-v1-2 (accessed 14 July 2025).

Tucker, E. (2022), *Artifice and Intelligence*, Tech Policy Press, Texas, 17 March, available at: https://techpolicy.press/artifice-and-intelligence (accessed 6 June 2024).

United Nations (n.d.), "The 17 goals", *Sustainable Development*, available at: https://sdgs.un.org/goals (accessed 23 September 2025).

Weidinger, L., Mellor, J., Rauh, M., Griffin, C., Uesato, J., Huang, P.-S., Cheng, M., *et al.* (2021), "Ethical and social risks of harm from Language Models", 8 December, doi: 10.48550/arXiv.2112.04359.

White, J., Fu, Q., Hays, S., Sandborn, M., Olea, C., Gilbert, H., Elnashar, A. *et al.* (2023), "A prompt pattern catalog to enhance prompt engineering with ChatGPT", 21 February, doi: 10.48550/arXiv.2302.11382.

Wieman, C. (2017), *Improving How Universities Teach Science: Lessons from the Science Education Initiative*, Harvard University Press, Cambridge, MA.

Wink, J. (2005), *Critical Pedagogy: Notes from the Real World*, 3rd ed., Pearson/Allyn & Bacon, Boston.

Corresponding author
Jonathan Jackson can be contacted at: jonathan.jackson@qmul.ac.uk