Imperial College London

Department for Education Consultation on Generative AI in Education – Response from Imperial College London

Contact: Amanda Wolthuizen, Director of Public Affairs, a.wolthuizen@imperial.ac.uk

Summary

1. Imperial College London's mission is to achieve enduring excellence in research and education in science, engineering, medicine and business for the benefit of society. Imperial is one of the world's top universities, with a greater proportion of world-leading research than any other UK university.[1] It is the only major UK university to teach exclusively science, technology, engineering, mathematics, medicine and business (STEMMB) courses. We welcome this timely consultation and would be delighted to further engage with the Department as this new and exciting technology develops in educational settings.

2. Imperial has long-standing excellence in artificial intelligence (AI) research. Our new major cross-disciplinary AI initiative, I-X, will further increase this by bringing together multidisciplinary academic teams from across Imperial with companies and non-profit labs to progress AI science and technology – for example developing new tools for improving image-based detection and diagnosis of disease, using AI to design new biological systems, and building AI systems and networks for monitoring, control, and security of critical infrastructure.[2] Imperial also hosts a cross-faculty AI network that brings together experts from all of Imperial's faculties to look holistically at how AI can solve the planet's major challenges. The AI network encompasses five Centres of Doctoral Training including AI for Healthcare, Smart Medical Imaging and the next generation of Chemical Synthesis.[3] Our Data Science Institute (DSI) advances and connects research in the exciting interdisciplinary field of data science - the integrative fusion of mathematics, statistics and computer science applied to find novel solutions in a range of topics in areas such as Biomedical Informatics, Data Learning, Image Informatics, Data Visualisation, AI System Architectures and the Future of Work.[4]

3. Imperial has a long-standing commitment to translate excellence in research into innovations in teaching, which also applies to the development of our approach to AI in education. The College's initial experience with generative AI has covered a range of education activity, from assessment and feedback to supporting student entrepreneurship and researching student interactions. Generally, we are working towards the following principles in this:

    - developing and using new platforms for delivering our educational offerings
    - engaging learners (and improving engagement) with a richer mix of modalities
    - assessing learning outcomes with new analytics.

4. AI offers the prospect of supporting the student experience and learning through enabling increasingly personalised education, potentially across a wide range of delivery modes and at scale. Developing the responsible use of generative tools, in particular through increasing AI literacy among staff and students, will be critical.

5. Government should consider support for increasing AI literacy and further research into AI in education as well as establishing UK communities of practice. The cost of accessing relevant platforms is a key issue to be aware of as future use will possibly increase. Government may also want to consider the implications for standards around ethics and AI literacy.

Experience with generative AI

6. Imperial's initial experience with generative AI has covered a range of different projects, from assessment and feedback to supporting student entrepreneurship and researching student

[1] REF 2021
[2] I-X, Imperial College London
[3] Artificial Intelligence Network, Imperial College London
[4] Data Science Institute, Imperial College London

interactions. Our approach has been to fuse methods of data science, machine learning, and AI into the discursive and dialogical dynamic of learning.

7. The Imperial College Business School (ICBS) IDEA Lab has introduced a 'Generative AI stress test' for all their taught module assessments. This comprises a four-phase process (Analyse, Review, Collaborate, Adapt) designed not only to evaluate and mitigate potential vulnerabilities in their assessments due to potential use of generative AI tools by students, but also to provide insights for staff into how students use AI tools. The insights are anticipated to help support students and staff to use generative AI tools effectively and appropriately, ensure equal access to AI resources, and foster collaboration among faculty and drive innovative teaching methods and assessment design while upholding academic integrity. The focal point of the stress test comprises a meeting between a faculty member and staff from the IDEA lab in which past indicative assessments are tested against Chat GPT4, Bard and Claude 2 using 6 criteria: accuracy, clarity, relevance, compliance, referencing and ease of use.

8. In 2022/23, one of the Beng Computing Final Year Projects, suggested and supervised by Dr Konstantinos Gkoutzis, involved adding one extra feature to a Personalised Learning Platform (PleaP), enabling the use of the ChatGPT Application Programming Interface (API) to generate subject-specific multiple choice questions or Fill-In-The-Blank questions for pop-quizzes. The user acting as a teacher would type in the learning objective, for example "*Introduction to Python Programming*", as well as the number of options (e.g. *4*), and the system would then use the ChatGPT query: "*Generate a multiple-choice question with exactly 4 options based on the learning objective: 'Introduction to Python Programming'. Output in CSV format of the following structure: question, correct option (one of the four options), option1, option2, option3, option4. For example: Which of the following is a Python data type?, string, float, integer, string, boolean*. This query would be executed as many times as needed (e.g., *30*), gradually coming up with numerous potential questions. The teacher who requested these would then sift through the results and select the ones that were useful (ie. *were relevant, meaningful, and made sense*), thus creating a pool for PleaP to pull questions from while randomly generating pop-quizzes for students.

9. In a collaboration between the ICBS and Imperial's Department of Computing led by ICBS Professor of Practice David Shrier, an entrepreneurship module entitled 'AI Ventures' was created to help students launch new enterprises using or building AI. Students are placed into diverse teams and workshop a business strategy and product idea during the module. This curriculum was adapted in January 2023 to explicitly incorporate generative AI as a 'thought partner' in creating the components of their business plans. Student prompts were restructured to encourage them to apply critical thinking and analysis to the outputs produced by the Large Language Models (LLMs).[5]

10. In the future, ICBS plan to experiment in AI Ventures with an LLM-based 'generative AI teaching assistant' which takes over 600,000 words of Professor Shrier's writing about AI and tech and loads it into GPT4. This can serve to answer student questions on basic concepts such as 'what is generative AI?'[6]

11. ICBS is also planning a formal study on how our students interact with generative AI systems.

12. ICBS will be using videos of student exercises to analyse features of conversational interactions that explain how some teams manage to engage in sustained robust debates that often lead to breakdowns in communication. Particularly in conflictual work, this engagement is essential to solving complex problems, making the best decisions, and completing difficult tasks. This work leverages advances in machine learning applied to recognition of speech (including both linguistic and prosodic features of speech), emotions conveyed in facial and hand gestures, and sequences of behaviours on conversational turn-taking (including interruptions). It is being integrated into

[5] MSc Computing Programme Specification, Imperial College London
[6] ChatDave.AI

instructional exercises for both in-person and online courses, and we are building it to scale for larger audiences to support an agenda for encouraging a healthy mix of honest engagement and civility.

13. Imperial has held an internal 1-day conference on 'Transforming Education: Adapting Teaching and Assessment with Artificial Intelligence' in August open to all staff and students with around 190 participants (in person and online). The day covered work exploring how Professor Shrier has adapted his teaching and assessments to integrate ChatGPT and other generative artificial intelligence. This was followed by a Q&A session and then a panel-led open discussion and included several sector experts. The afternoon comprised a hands-on workshop looking at stress testing assessments facilitated by the College's Educational Development Unit.

14. Imperial has developed a new web platform to deliver automated feedback on student homework. Led by Dr Peter Johnson, the platform – called Lambda Feedback – is currently in its 'alpha version'. It has hosted nine modules across eight departments and over 1,000 students using the platform. Lambda Feedback works by automating feedback on mathematical problems and solutions that students are set. Though currently utilising deterministic algorithms without using generative AI, Lambda Feedback has great opportunities to utilise generative AI in offering feedback on tasks and providing feedback on what to do next. In the early phase of using this platform, teachers receive the spread of answers that students have given and suggest feedback for the platform, meaning the Lamba Feedback tool can learn the ways in which to address correct and a spread of incorrect answers.

15. The research behind Lambda Feedback centres on the understanding of the capabilities of computers to undertake the tasks of teachers in university settings. The work has identified things such as finding errors in answers, writing feedback and recording progress, which could all be undertaken on a platform such as Lambda Feedback, giving time back to teachers. This means that in-person teaching time can be of the highest quality, with time only being used to discuss work and problems in a way that can only be undertaken by humans. The long-term goal of Lambda Feedback is to develop high-quality and highly personalised feedback at the time when homework is submitted, allowing students to receive constructive feedback instantly.[7]

Challenges of using generative AI

16. Based on the findings from PleaP, generative AI indeed saved teachers some time – especially when the provided learning objective was very specific, but manual moderation was essential, meaning this mechanism could not be used unattended. This was because many of the results were either repeated or irrelevant/meaningless, since GPT does not "understand" what is requested *per se* and is simply trying to "guess" based on its probabilistic model.

17. In the AI Ventures module outlined above, students were able to discover that LLMs create superficial and repetitive responses. Some students learned that if they iterate their prompts within the memory buffer of the LLM, they can get better results. We accordingly plan to add a 'prompt engineering' unit to the module to better prepare students to leverage the capabilities of LLMs.

Opportunities and benefits

18. Incorporating the use of generative AI tools into teaching methods and assessments has the potential to enhance the student learning experience, improve critical reasoning skills and prepare students for the real-world applications of the generative AI technologies they will encounter beyond university. Blending of Imperial's research and innovation in education present the opportunity to make education more inclusive, thereby making the most of the talents of the whole population.

[7] Computers make us human, Dr Peter Johnson [accessed 30/07/23]

19. The Russell Group has recently outlined a position paper on the use of generative AI tools in education.[8] It contains five key principles for universities to adhere to in the responsible uptake and use of generative AI tools:

    - Universities will support students and staff to become AI-literate.
    - Staff should be equipped to support students to use generative AI tools effectively and appropriately in their learning experience.
    - Universities will adapt teaching and assessment to incorporate the ethical use of generative AI and support equal access.
    - Universities will ensure academic rigour and integrity is upheld.
    - Universities will work collaboratively to share best practice as the technology and its application in education evolves.

20. Imperial played a significant role in the development of these principles and endorses them. The Russell Group paper recognises the importance of giving staff and students the ability to utilise generative AI tools, ensuring that the use of such tools adds to the student experience and does not give way to unethical use. The paper also recognises that universities need to continually update and enhance their pedagogies and assessment methods in any case, and that to adapt to the use of generative AI is therefore no different.

21. As generative AI tools such as ChatGPT look to become commonplace in the lives of our staff and students, Imperial is taking the approach to ensure that all at Imperial can gain an understanding of how these tools work so that they can be used responsibly and effectively. Imperial is recommending that all staff members explore these tools to begin to understand how they work and recognise how these tools can be used to the benefit of their students during teaching and assessment.[9] This also includes asking teaching staff to think about the types of assessments generative AI can solve, and assessments that might consequently be susceptible to plagiarism.

22. In the near term, students will need to become adept at prompt engineering as a basic skill such as using Microsoft PowerPoint or Excel (see para 17). Over time, AI systems may become better thought partners for humans and might not require special handling. However, given that basic search functions (ie. Google or Bing) still require syntax and structure expertise to produce the best outcomes, it may be that prompt engineering remains a needed skill for many years.

23. There are the potential benefits in the future for generative AI tools to enable students to access research literature, particularly relating to identifying and summarising relevant papers. These functions can also be of benefit in extended writing projects, such as dissertations, to enable a focus on the logical arguments and critical analysis. Without taking ideas straight from the output or analysis produced by tools such as ChatGPT, generative AI tools can also be of benefit in idea generation for projects.

Concerns and risks

24. There are several concerns that we outline below, however, these concerns only heighten the importance of increasing the AI literacy of our staff and students, as outlined above. The initial concerns with generative AI tools centred around assessment and academic integrity.[10] Generative AI presents new challenges when it comes to assessment and the integrity of qualifications. The challenge before us is to be clear about separating skills and abilities learners will need on their own — without the assistance of generative AI — and skills that will allow them to make the most of the augmentations to their abilities that generative AI already offers.

[8] Russell Group principles on the use of generative AI tools in education, 2023
[9] Generative AI Tools Guidance, Imperial College London [accessed 11/07/2023]
[10] A Generative AI primer, Jisc [accessed 11/07/2023]

25. The pace of development of generative AI and an increasing perception that these tools can be used to undertake work on behalf of a student has prompted concern around the implications for academic integrity, should students submit AI-generated work as their own. The focus on problem-solving in science, technology, engineering, mathematics, medicine and business (STEMMB) subjects and the range of Imperial's assessment types limit the capability of current AI models being able to produce highly refined answers to our assessments, but the impact it might have on quality assurance is still a concern. Imperial's Faculty of Medicine has convened a working group to consider the impact on postgraduate taught assessments.

26. As noted in Imperial's guidance for students,[11] submitting work generated by something or someone else, including AI-generated content, as if it was the student's own is considered plagiarism, creating an unfair advantage and is a form of cheating.

27. AI detection software that can reliably counter any plagiarised content has yet to be demonstrated. AI detection software can only move after advances in generative AI models are made. Large detection tools including Turnitin have outlined issues with detection software reporting false positives that could lead to false accusations of cheating for students,[12] which would cause significant issues for universities and their students. The primary digital provider for universities, Jisc, has also warned of the issues of AI detection software creating false positives or that AI detection tools are unable to conclusively prove that text has been written by AI.[13]

28. Due to the learning nature of natural language processing models predicting text based on what typically follows any previous text, it can produce false references or academic paper results to embed throughout any produced content. Although the creation of such 'hallucinatory' references may be suppressed as the technology evolves, vigilance is required to ensure the fabrication of false references to pieces of evidence is captured.

29. There are also concerns over individual's use of generative AI tools in inputting sensitive or personal data without understanding the full consequences of doing so. This is emphasised in the DfE's guidance. Tools like ChatGPT will, by default, record everything that is submitted to them; this data can then be reshared with other users. Individuals typing in data or uploading documents with sensitive personal information can then be accessed by other users. This is why Imperial, in supporting the development of the Russell Group principles outlined above, will work to ensure students and staff are aware of this issue.

30. Students run the risk of accepting AI outputs 'on autopilot'. Not knowing the fundamental steps involved in creating a certain output (that might be created by an AI) could make it more difficult for a student to determine if the AI output is faulty. Accordingly, we will need to teach new critical analysis skills so that students better understand the limits of generative AI, and how to detect issues such as 'hallucinations', knowledge gaps, superficiality, or other issues associated with machine-generated output. We also need to help students better understand the data pipelines that train generative AI systems, and the implications of these.

Impact of these concerns and risks

31. As outlined above, Imperial and the wider higher education sector understand the importance of developing AI literacy to counteract the concerns raised by the use of generative AI. We are explicitly incorporating AI literacy (including prompt engineering) into our AI Ventures curriculum (see para 10). ICBS has added an 'AI day' to the MBA induction process, delivered by multiple ICBS faculty members, to sensitize students to the risks, opportunities and issues surrounding AI.

[11] Generative AI Tools Guidance, Imperial College London [accessed 11/07/2023]
[12] AI writing detection update from Turnitin's Chief Product Officer, Turnitin [accessed 11/07/2023]
[13] A Generative AI primer, Jisc [accessed 11/07/2023]

Ethical and legal considerations

32. Individual students need to develop a better understanding of the data privacy and security implications of AI, and Imperial's guidance outlined above seeks to inform the student knowledge of generative AI.

33. In addition, with the promulgation of AI regulations or policy interventions differing across the world,[14] a better understanding of the compliance context will be necessary to mitigate risk when those students go on to take jobs in the private and public sectors.

Future predictions and enabling use

34. While AI is currently in the limelight due to the latest advancements of its "generative" type, its potential extends far beyond this. Particularly in the realm of education, AI holds the promise of effectively educating large groups of individuals while still maintaining a personalised approach.[15]

35. In the face of modern technological advancements, the purpose and future of university education warrant thoughtful consideration. The role of education extends beyond merely preparing students for their careers; it should also cultivate creativity, critical thinking, and a passion for lifelong learning. Emerging technologies, particularly Artificial Intelligence and Digital Learning platforms, hold significant potential to revolutionise the educational landscape.

36. One of the pressing concerns with current teaching methodologies is their lack of personalisation. Typically, all students within a cohort receive identical information in the same manner, which can fail to accommodate individual learning styles and paces. AI offers a promising solution to this issue, potentially enabling a more personalised, tailored, approach to teaching that aligns with each student's unique requirements.

37. As we continue traversing the age of AI, universities are poised to play a pivotal role, much like their instrumental role in the advent of the internet in the 1970s. Universities will have a central role to play in serving as incubators for new technologies, preparing students for a future where AI is increasingly integral and prevalent.

38. Ideally, AI systems can be trained that support robust hybrid Human+AI implementations, where we teach students how to benefit from AI assistants and we incorporate 'collective intelligence' functions into curricula, teaching techniques and systems. Therefore, the combination of human and AI is able to perform tasks that neither one can do as well by itself.

Support for staff and students

39. Increasing AI literacy amongst staff and students will be vital in developing the responsible use of generative tools and avoid some of the issues such as plagiarism, sharing sensitive information and incorrect generation of information as outlined above. Imperial has recently hosted a Generative AI and Knowledge Economy symposium to provide an overview of generative AI and large language models and their implications for the knowledge economy.[16] By increasing AI-literacy, universities can equip students with the skills needed to use these tools appropriately throughout their studies and future careers, and ensure staff have the necessary skills and knowledge to deploy these tools to support student learning and adapt teaching pedagogies.

[14] Rules to keep AI in check, Nature, 2023
[15] Konstantinos Gkoutzis - The Role of Universities in the Age of AI
[16] Generative AI and the Knowledge Economy Symposium co-hosted by Imperial College London and The London School of Economics and Political Science, May 24-25 2023

40. As outlined in the Russell Group paper, fostering relationships between higher education institutions, schools, employers, professional bodies who accredit degrees, AI experts, leading academics and researchers, as well as ensuring an inter-disciplinary approach to addressing emerging challenges and promoting the ethical use of generative AI, will be crucial.[17]

Options for support from the Department for Education

41. The UK must strive to ensure that AI tools are both accessible and inclusive, catering to all students. This necessitates both a strong emphasis on promoting digital literacy among both students and teachers, as well as careful deliberation on the high subscription costs to the paid User Interface and/or APIs of the GenAI providers. To achieve the former, a robust array of training and professional development opportunities for educators should be provided, ranging from workshops and online courses to forums where best practices for using AI in education are shared and discussed. Institutions with a strong AI focus, such as Imperial, can play a crucial role in developing and disseminating these resources, leveraging their extensive and high-end knowledge and experience in the field. To achieve the latter, funding could be reserved and provided in each academic year for a specific number of GenAI-related projects.

42. Alongside these efforts, further research into the application of AI in education must also be championed and supported. Such research should aim to deepen our understanding of AI's impact and effectiveness, encompassing areas such as student outcomes, pedagogical experiences, as well as the wider implications of AI on the education system as a whole.

43. Extending these concepts further, government support of communities of practice around the integration of AI into education would help with ecosystem development. Institutions like Imperial with excellence both in AI and in pedagogy, can serve as critical conveners and supporters of such communities.

44. Adding standards about ethics and AI literacy, particularly in alignment with pending regulations but also in addition to those, would be beneficial to encourage wider-spread adoption.

[17] Russell Group principles on the use of generative AI tools in education, 2023