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The Future of Academia:

The Convergence of AI and the Modern Classroom

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EXECUTIVE SUMMARY

This research paper presents a comprehensive analysis of the integration of Artificial Intelligence (AI) in the modern educational landscape, with a specific focus on its application in university settings. As AI continues to revolutionise various sectors, its infiltration into academia brings forth unique challenges and opportunities, especially in the realm of formative assessments. This paper aims to provide an in-depth understanding of how AI can be effectively incorporated into these assessments, addressing both the technological and pedagogical aspects.

Key Findings

This research paper addresses the integration of AI in university education, emphasising both challenges and opportunities. It focuses on how AI can be effectively used in formative assessments, acknowledging the complexities and evolving nature of AI technologies. The study also explores the historical development of technology in education and assesses the effectiveness of current AI tools in academic settings. Furthermore, it highlights the ethical and societal implications, including data security and the impact on student learning, providing a nuanced view of AI's role in modern academia.

Recommendations

This paper recommends a balanced approach to integrating AI into university assessments, emphasising the importance of considering both technological capabilities and ethical implications. It advocates for regular evaluation of AI tools to ensure their alignment with educational objectives and adherence to ethical standards. Addressing ethical concerns, data security and personalised learning is highlighted as a priority for safeguarding students' rights and interests. Additionally, the paper calls for a broader dialogue about the societal impacts of AI in academia, including labour rights and the future of education, to foster a holistic understanding and responsible implementation of AI technologies in educational settings. These recommendations aim to guide educators, policymakers, and stakeholders in higher education as they navigate the complexities of integrating AI into academic environments.

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1.0 INTRODUCTION

Artificial intelligence (AI) has infiltrated countless sectors in today's increasingly digitised world, impacting decision-making processes, automating operations, and transforming industries. Its rapid expansion and integration have permeated the sphere of education, particularly in the university context, where the challenges of large student populations and diverse learning needs necessitate innovative solutions. This relationship between AI and education raises a myriad of challenges ranging from technological feasibility to ethical concerns. This study addresses the subject of how universities are incorporating AI in assessments.

In this paper, we attempt to answer a series of questions:

1. *What is AI?*
2. *How has it been successful in the past?*
3. *How can we build upon that success in education?*
4. *What obstacles are there in the way of doing so?*
5. *How do we redesign curricula to incorporate AI?*

Banning AI completely fails in preparing students for life after education. Simultaneously, surrendering fully to AI-produced research and ideas fails to encourage students to think for themselves. To carefully tread the middle path between these two extremes, we propose incorporating AI in *formative* assessments.

Thus, our ultimate question is:

6. *How should we approach incorporating AI in formative assessments?*

To answer these questions, we begin with an examination of AI's growth and linguistic complexities. We then turn to the history of technology in classrooms, particularly the rise of search platforms, such as Google, and mobile devices. Next, we will evaluate real-world examples of AI in universities, identifying significant tools and their effectiveness. We address AI's potential across educational levels. AI also raises ethical problems, ranging from data security to the impact on individual student learning. We will further assess curriculum implications and critically analyse AI's broader societal

repercussions––including labour rights in academia––as institutions negotiate this potential pedagogical transition.

This research paper attempts to give an unbiased, thorough, and thought-provoking perspective on AI's involvement in higher education, emphasising both the possibilities and drawbacks of this convergence of technology and education.

2.0 BACKGROUND AND DEVELOPMENT OF ARTIFICIAL INTELLIGENCE

The term "artificial intelligence" was first coined by John McCarthy at the Dartmouth Conference in 1956. However, the history of AI infatuated academics interested in technological innovation long before 1956. Although they did not create the term, Alan Turing and John Von Neumann are known for building the technology at the foundation of AI. During the 1950s, as leaders in the transition from computers to decimal logic, as well as machines to binary logic, both scientists developed the architecture of contemporary computers that were capable of executing programs.[1] Turing is also credited with raising the question of possible artificial machine intelligence in his article "Computing Machinery and Intelligence" when proposing "the imitation game."[2] Thus came the formulation of the "Turing Test": a test to check a machine's ability to exhibit equivalent intelligent behaviour to that of a human.[3]

Such thinking eventually led scientists Allen Newell, Cliff Shaw, and Herbert A. Simon to creating the first artificial intelligence program in 1995, aptly named "Logic Theorist" as it was capable of mimicking human problem-solving skills and found elegant proofs to 38 of 52 mathematical theorems.[4]

Eventually, MIT graduate John McCarthy coined the term artificial intelligence, allowing Marvin Minksy of Carnegie-Mellon University to famously define AI as "the construction of computer programs that engage in tasks that are currently more satisfactorily performed by human beings because they require high-level mental processes such as perceptual learning, memory organisation and critical reasoning."[5] With thought powered by this definition and growing interest in artificial intelligence, scientists made great advances in technology such as the creation of Joseph Weizenbaum's "ELIZA" in 1966, which is known as the first chatbot, and the first intelligent humanoid robot in 1972, known as WABOT-1.[6]

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[1] Council of Europe. 2014. "History of Artificial Intelligence." Coe.int. 2014.
[2] Turing, Alan. 2004. "Computing Machinery and Intelligence (1950)."
[3] "History of Artificial Intelligence - Javatpoint." 2011.
[4] Ibid.
[5] Council of Europe. 2014. "History of Artificial Intelligence." Coe.int. 2014.
[6] "History of Artificial Intelligence - Javatpoint." 2011.

Later advancements of AI have led to "deep learning" techniques, originally created by John Hopfield and David Rumelhart. These techniques allowed computers to learn using experience, leading to the introduction of "Expert Systems" in the 1980s which were programmed to emulate the decision-making process of a human expert.[7] Because these systems were programmed by experts in certain fields on how to respond to a given situation, they allowed non-experts the opportunity to receive expert advice from the program without the need for human consultation.[8]

"Deep Blue," IBM's expert system, further pushed the boundaries of AI when it defeated master Garry Kasparov in a chess game in 1997. Although the game remained symbolic of technological advancements in artificial intelligence, the program only managed to perform within the limited parameters of a chess game and was still far from being able to model real-world complexities.[9]

Today, surrounded by large volumes of data and information referred to as "Big Data," the application of AI has become fruitful in many industries such as banking, marketing, technology, and entertainment, with the newest and most popular tool being ChatGPT.[10]

[7] Anyoha, Rockwell. 2017. "The History of Artificial Intelligence."
[8] Ibid.
[9] Council of Europe. 2014. "History of Artificial Intelligence." Coe.int. 2014.
[10] Anyoha, Rockwell. 2017. "The History of Artificial Intelligence."

3.0 LANGUAGE OF ARTIFICIAL INTELLIGENCE

"Language is at the heart of human intelligence. It therefore is, and must be, at the heart of our efforts to build artificial intelligence."[11]

The above quote implies that with mastery of language, AI will inevitably infringe upon the domain of human intelligence. The possibility hat human and artificial intelligence could become equal seems to be the source of both intense fear and frenzy surrounding AI. It is, however, built upon an error. This "intelligence error" stems from the misbelief that human intelligence is little more than calculation.[12] It suggests an inaccurate resemblance between human thought processes and that of machines.[13] The very word 'intelligence' seems to be problematic.

Such a misconception around "intelligence" has given AI a "mystical" quality which obscures the fact that AI is not "one thing" but many.[14] Almost all the academic articles used in this research differentiate between the many kinds of AI, such as human-like AI or machine-learning AI. Adding such a prefix helps clarify what kind of "intelligence" is being discussed. The language of AI must therefore be nuanced to avoid any confusion that mystifies AI's "intelligence".

This is important because "we are being duped into believing these AI tools are far more intelligent than they actually are."[15] AI language models can now answer questions *like a human*. However, they do not have access to meaning in the way a human would.[16] This is a key point where artificial and human intelligence differ. "Meta-intelligence is where I think the most attention needs to be paid," said Professor Rose Luckin from UCL, "AI does not understand itself. Humans can."[17]

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[11] Toews, Rob. *Language Is The Next Great Frontier In AI*. *Forbes*. (2022)

[12] Hasselberger, William. Review of *Can Machines Have Common Sense?*, by Erik J. Larson. *The New Atlantis*, no. 65 (2021): 94–109.

[13] Goodlad, Lauren M. E. & Baker, Samuel. *Now The Humanities Can Disrupt "AI"*. *Public Books*. (2023)

[14] Gillani, Nabeel, Rebecca Eynon, Catherine Chiabaut, and Kelsey Finkel. *Unpacking the 'Black Box' of AI in Education.* In *Educational Technology & Society* 26, no. 1 (2023): 99–111.

[15] Luckin, Rose. *Yes, AI could profoundly disrupt education. But maybe that's not a bad thing*. *The Guardian*. (2023)

[16] Bender, Emily M., Gebru, Timnit., MacMillan-Major, Angelina., and Shmitchell, Shmargaret. *On the dangers of stochastic parrots: Can language models be too big?*. In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency (FAccT'21)*. (2021)

[17] Luckin, Rose. *Is education ready for artificial intelligence? Machine learning and EdTech*. At the *Cambridge Summit of Education 2019*. (2019)

The human-like features of AI obscure this difference and must therefore be unmasked. In education, this may be accomplished by incorporating *Explainable AI*. "Explainable AI (XAI) refers to the ability of an AI system to provide clear and transparent explanations for its decision-making processes."[18] Such transparency allows for insight into the mind of AI beyond its humanised language. That is the first step to understanding AI's actual "intelligence".

Working with AI makes the intelligence of both humans and machines clearer as "we appreciate and comprehend the human mind better when we work to create an artificial one."[19] Thus, it is vital that society finds ways to clarify the different forms and functions of AI. Establishing a shared and nuanced language of artificial intelligence will better demonstrate to non-experts how AI differs from human intelligence. Only with clear and concise language is it possible to discuss how human and artificial intelligence can complement each other.

[18] Raccha, Ashwin and Seyam, Mohammed. *Explainable AI In Education: Current Trends, Challenges, And Opportunities*. In *SoutheastCon 2023*. (2023)

[19] Brynjolfsson, Erik. "The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence." *Daedalus* 151, no. 2 (2022): 272–87.

4.0 SUCCESSFUL INTEGRATION OF AI IN PROFESSIONAL ENVIRONMENTS

Though integration of the newest technologies such as AI in the business environment is a point of contention due to the threat to job security, the overall impact of incorporating such innovations is positive when resources are properly allocated. When companies invest heavily in key building blocks of intelligent automation, such as the Cloud and the IoT, outcomes are improved operational uptime.[20] This digitalisation also makes assets within companies less expensive to operate and maintain. Mining companies present an ideal example of this as these companies use autonomous vehicles, which can be remotely monitored to complete tasks, as well as robots, which work in underground mines to mitigate safety risks such as collapse, toxic atmosphere, or flood.[21] The use of these automated intelligence systems improves the overall work environment for mine workers while also cutting potential operational costs.

Other successful integrations of AI in the workplace include simple automation in the generation of documents, writing software code, drafting content, and conducting fact-checking or research. Although there is a certain apathy connected to the usage of AI in the workplace, it provides companies with a greater productivity rate and nearly absolute validity. That being said, AI is still new and imperfect in its accuracy. Therefore, care must be taken when implementing these practices in company settings.

[20] Berti, Joe, and Kay Murphy. n.d. "A New Model for Connected Assets." IBM.
[21] Ibid.

5.0 THE HISTORY OF TECHNOLOGY IN THE CLASSROOM

The advancement of technology has had a substantial impact on every aspect of society. Most notably, it has revolutionised the classroom and the educational development of youth across the globe. This radical shift in classroom operation began in the 1920s with the creation of radios, which enabled on-air classes to take place for the first time.[22] Today, social media applications play a pivotal role in education, demonstrating how even the most personal technologies can infiltrate the educational system. Recognizing the need for teachers to adapt to this rapidly changing technological landscape, groups like Scholastic Teachers have emerged, providing educators with the essential tools needed to harness the full educational benefits of social media applications.

The rise of Google—and the subsequent hike in portable laptop usage—has been of particular significance in the case of classroom development. In 2020, the volume of Google Classroom users doubled to over one hundred million, making at-home learning possible as stay-at-home restrictions were created around the world during the COVID-19 pandemic.[23]

Although classrooms have certainly flourished as technological developments have permeated society, some argue that education systems have not made enough effort to accommodate said developments. In fact, a study by Larry Cuban found that in preschool, K-12, and university levels, "The availability of information technologies in classrooms increased dramatically, yet teachers used them infrequently and altered their conventional forms of teaching very little."[24] Cuban argues that, while a vast chunk of educational funding has gone into providing schools with technology like Chromebooks and other portable electronic devices, said schools have focused little energy on assessing how to best implement these expensive tools. The burden of adaptation to technology, however, should not be placed on teachers. Rather, administrative steps must be taken to ensure that the classroom is finding new

[22] "The Evolution of Technology in the Classroom." Purdue University Online. https://online.purdue.edu/blog/education/evolution-technology-classroom.
[23] De Vynck, Gerrit, and Mark Bergen. "Google Widens Lead in Education Market as Students Rush Online. Bloomberg.com, April 9, 2020.
[24] Cuban, Larry. Oversold and Underused: Computers in the Classroom. Cambridge, MA and London, England: Harvard University Press, 2001.

approaches to maximise student learning. It is not enough to simply push funds toward informational technology; schools must also dedicate time to analysing best practices for educational enhancement through technology.

6.0 AI INCORPORATION IN THE CLASSROOM THUS FAR

Artificial intelligence's popularity, particularly in the form of chatbots, is still a relatively new phenomenon, and many university administrations are still looking for ways to implement AI in a fair and ethical manner. So far, the White House Office of Science and Technology Policy introduced a *Blueprint for an AI Bill of Rights*[25] in October of 2022, that provides practices and principles to ensure that AI is trustworthy and reliable. In Europe, the European Commission released "Ethical Guidelines on the Use of Artificial Intelligence (AI) and Data in Teaching and Learning for Educators."[26] The aforementioned documents are intended to facilitate a smooth transition to an AI-rich environment and mitigate the risks associated with unethical AI practices.

Amid concerns of AI replacing teachers, pushes have been made for artificial intelligence to "Always Center Educators,"[27] and allow for a streamlined grading system without devaluing the vital role that teachers play in the classroom. Furthermore, AI tools have been created with the intent of making the classroom more all-encompassing for students with special needs: for example, by providing voice assistance for hearing-impaired students.[28] The application of AI in such a manner will allow for more equitable exams and assessments at every level of education, furthering opportunities for groups who have historically received less support in their academic journeys.

AI's impact on the classroom is arguably most noteworthy in foreign language courses. When discussing AI in this context, it is imperative to note the distinction between automated writing evaluation (AWE) tools and machine learning (ML) tools. AWE tools like Grammarly, for instance, play a significant role in enhancing written language proficiency. They offer instant feedback on grammar, vocabulary, and style, empowering learners to write more accurately and confidently in a foreign language. ML tools, however, encompass tools like Google Translate, which automatically translate text or speech from one language to another. AWE tools are typically encouraged in the

[25] White House Office of Science and Technology Policy. "Blueprint for an AI Bill of Rights: Making Automated Systems Work for the American People." October 2022.
[26] European Commission, Directorate-General for Education, Youth, Sport and Culture. 2022. "Ethical Guidelines on the Use of Artificial Intelligence (AI) and Data in Teaching and Learning for Educators." Publications Office of the European Union.
[27] Lucariello, Kate. "The Role of AI in Assisting Teachers and in Formative Assessments of Students." THE Journal, January 6, 2023.
[28] Ibid.

classroom, and provide an abundance of benefits to accelerate learning. On the other hand, ML tools are more difficult to endorse in the classroom. While it is important not to generalise all ML tools as "bad", their use can often veer into academically dishonest practices. The distinction between these two tools proves that there is no one-size-fits-all approach to AI implementation and policy.[29]

Ethical considerations are not the only contention surrounding AI: many voice concern over the inaccuracy in responses from AI chatbots like ChatGPT. Users often confuse the capabilities of Large Language Models like ChatGPT, leading to widespread misuse of such applications. Most commonly, students find themselves infuriated when tools like ChatGPT provide them with incorrect sources. However, ChatGPT "does not have the ability to match relevant sources to any given topic,"[30] thus leading to fabrication or misrepresentation of sources. AI tools like ChatGPT are also likely to provide incorrect information on current events because they are based on datasets that are hardly ever fully updated. To combat these (and other) issues pertaining to AI inaccuracy, the public must be educated on the actual benefits of Large Language Models and similar AI tools, as well as what limitations to these tools might exist.

The source of these tools' inaccuracies is based on their core functionalities. As discussed, AI Large Language Models do not "know" things, or have "intelligence". Rather, they mimic patterns that they have been fed in their training.[31] Instead of directly answering a question, ML tools often assess how answers to a question are typically formatted, and provide a response based on that assessment, thus limiting their ability to reach complete accuracy in responses.

[29] Alharbi, Wael. "AI in the Foreign Language Classroom: A Pedagogical Overview of Automated Writing Assistance Tools." Education Research International (2023), vol. 2023, Article ID 4253331, 15 pages. Accessed 2023.

[30] Welborn, Aaron. "CHATGPT and Fake Citations." Duke University Libraries, March 14, 2023.

[31] Caulfield, Jack. "Is CHATGPT Trustworthy?: Accuracy Tested." Scribbr, June 22, 2023.

7.0 POTENTIAL OF AI IN CLASSROOMS

The first AI teaching assistants, such as the AI-enabled online learning platform Happy Numbers, have already made their debut in classrooms.[32] AI-powered tools are being used to support online learning, create adaptive assessments for students, and enhance the learner-instructor interaction in schools.[33] On the teaching side, AI is being used to gather performance analytics to help instructors better understand students' performance.[34] This section will focus on the potential of AI in classroom grading, student self-learning, sub- and university implementation, and tools for diverse student backgrounds.

7.1 Classroom Grading

Formative assessments are a key aspect of AI implementation in education. AI programs can be used to generate real-time feedback on assessments,[35] enabling students to understand their mistakes immediately[36] and revise during the learning process.[37] Implementing AI grading can also promote fair and consistent grading by eliminating subjective human bias.[38] The CEO of Copyleaks, a plagiarism detection software, summarised,

> "I think generally once humans are in the process, you will always have bias. Think about a human grader grading thousands of assignments. The solution we provided is focused on high volumes of exams [...] Naturally, humans are affected

[32] Zhang, Ke, and Ayse Begum Aslan. 2021. "AI Technologies for Education: Recent Research & Future Directions." Computers and Education: Artificial Intelligence 2 (January): 100025.

[33] Seo, Kyoungwon, Joice Tang, Ido Roll, Sidney Fels, and Dongwook Yoon. 2021. "The Impact of Artificial Intelligence on Learner–Instructor Interaction in Online Learning." *International Journal of Educational Technology in Higher Education* 18 (1): 54; Zhang and Aslan 2021

[34] Seo et al. 2021

[35] Zhu, Mengxiao, Ou Lydia Liu, and Hee-Sun Lee. 2020. "The Effect of Automated Feedback on Revision Behavior and Learning Gains in Formative Assessment of Scientific Argument Writing." Computers & Education 143 (January): 103668.

[36] Mirzaeian, Vahid R., Hamedreza Kohzadi, and Fatemeh Azizmohammadi. 2016. "Learning Persian Grammar with the Aid of an Intelligent Feedback Generator." Engineering Applications of Artificial Intelligence 49 (March): 167–75; Roschelle, Jeremy, James Lester, and Judi Fusco. 2020. "AI and the Future of Learning: Expert Panel Report." Digital Promise.

[37] Lee, Hee-Sun, Amy Pallant, Sarah Pryputniewicz, Trudi Lord, Matthew Mulholland, and Ou Lydia Liu. 2019. "Automated Text Scoring and Real-Time Adjustable Feedback: Supporting Revision of Scientific Arguments Involving Uncertainty." Science Education 103 (3): 590–622.

[38] Balla, Erika. 2023. "Automated Grading Systems: How AI Is Revolutionizing Exam Evaluation - DataScienceCentral.Com." Data Science Central. May 31, 2023.

> by external factors, and there could be a day where I am waking up a bit tired or angry, and it can affect the way I am grading the exams."[39]

This comment was in reference to Copyleaks' newly developed AI-assisted grading tool aimed at eliminating human bias and discrepancies in grading.[40] Automated grading systems such as the one discussed above adhere to an established set of standards, administering a more objective assessment of student work.[41] These AI graders have proven effective in mitigating grading bias, displaying a lower margin of inconsistency as compared to human graders.[42] Automated grading systems have the additional benefit of generating results much faster than manual grading.[43] This reduces the grading workload for instructors by eliminating the handling of simple and objective questions.[44] By automating routine administrative tasks, AI can streamline the workflow for educators and give them more time to build relationships with students and foster students' learning and development.

7.2 Student Self-learning

The ability of AI to analyse individual student performance and tailor learning resources to suit each student's specific needs is paramount to AI's performance as a learning tool. AI tutoring systems adapt learning content in accordance with student-specific learning patterns and knowledge levels to provide tailored guidance, support, and feedback.[45] These learning systems have been found effective in promoting accessibility[46] and improving the e-learning user experience.[47] AI-powered tools such as chatbots and virtual tutors can engage students in active learning by providing anonymity that classrooms lack.[48] AI has been shown to boost active learning by saving time, providing

[39] Paykamian, Brandon. 2023. "Can Artificial Intelligence Help Mitigate Grading Bias?" GovTech. May 8, 2023.
[40] Paykamian 2023
[41] Balla 2023
[42] Paykamian 2023
[43] Balla 2023
[44] Seo et al. 2021
[45] Seo et al. 2021
[46] Xu, Dongming, and Huaiqing Wang. 2006. "Intelligent Agent Supported Personalization for Virtual Learning Environments." Decision Support Systems 42 (2): 825–43.
[47] Cheung, B., L. Hui, J. Zhang, and S. M. Yiu. 2003. "SmartTutor: An Intelligent Tutoring System in Web-Based Adult Education." Journal of Systems and Software 68 (1): 11–25; Köse, Utku. 2017. "An Augmented-Reality-Based Intelligent Mobile Application for Open Computer Education." In Mobile Technologies and Augmented Reality in Open Education, edited by Gulsun Kurubacak and Hakan Altinpulluk, 154–74. IGI Global; Xu & Wang, 2006
[48] Seo et al. 2021

on-the-spot assistance, and making learning more conveniently accessible.[49] The use of these learning systems also reduces total study time and eliminates the need for last-minute studying by providing content that is tailored to each student's learning style.[50] AI tools become particularly valuable in after-hours studying when instructors are unavailable and are also a convenient option for students who are hesitant to ask questions publicly or believe their questions are too trivial to ask.[51]

These chatbots are also a significant advancement for educators, allowing them to analyse student data to identify students' learning strengths and areas for improvement.[52] They work by examining extensive data sets––of test results, online forum interactions, etc.––to identify students who are at risk of falling behind academically[53] as well as students with exceptional academic aptitude.[54] They can also provide pertinent data presenting how individual students learn, which allows instructors to better tailor their teaching methods.[55] By anticipating future educational outcomes, these methods enable early intervention and allow educators to assist struggling students before they fall behind.[56]

7.3 Potential of Sub-University Implementation of AI

Educational technology advancements are altering traditional teaching methods and improving learning outcomes at the K-12 level. Real-time student analytics, as mentioned, provide immediate insights into each student's in-class activities, allow for

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[49] Kuhail, Mohammad Amin, Nazik Alturki, Salwa Alramlawi, and Kholood Alhejori. 2023. "Interacting with Educational Chatbots: A Systematic Review." Education and Information Technologies 28 (1): 973–1018.

[50] Jin, Sung-Hee, Kowoon Im, Mina Yoo, Ido Roll, and Kyoungwon Seo. 2023. "Supporting Students' Self-Regulated Learning in Online Learning Using Artificial Intelligence Applications." International Journal of Educational Technology in Higher Education 20 (1): 37.

[51] Jin et al. 2023

[52] Zawacki-Richter, Olaf, Victoria I. Marín, Melissa Bond, and Franziska Gouverneur. 2019. "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where Are the Educators?" International Journal of Educational Technology in Higher Education 16 (1): 39.

[53] Khan, Ijaz, Abdul Rahim Ahmad, Nafaa Jabeur, and Mohammed Najah Mahdi. 2021. "An Artificial Intelligence Approach to Monitor Student Performance and Devise Preventive Measures." Smart Learning Environments 8 (1): 17; Chui, Kwok Tai, Dennis Chun Lok Fung, Miltiadis D. Lytras, and Tin Miu Lam. 2020. "Predicting At-Risk University Students in a Virtual Learning Environment via a Machine Learning Algorithm." Computers in Human Behavior 107 (June): 105584.

[54] Hodges, Jaret, and Soumya Mohan. 2019. "Machine Learning in Gifted Education: A Demonstration Using Neural Networks." Gifted Child Quarterly 63 (4): 243–52.

[55] Cutumisu, Maria, Doris B. Chin, and Daniel L. Schwartz. 2019. "A Digital Game-Based Assessment of Middle-School and College Students' Choices to Seek Critical Feedback and to Revise." British Journal of Educational Technology 50 (6): 2977–3003.

[56] Khan et al. 2021

more personalised instruction in mixed-ability classes, and allow educators to deliver specific, timely feedback.[57] The augmented reality glasses "Lumilo" streamline this process even further by alerting instructors to students who need help with material without those students having to seek support proactively.[58] Furthermore, AI's ability to analyse large data sets goes beyond simple metrics like attendance by delving into comprehensive cross-references previously unknown to educators in order to identify underlying factors affecting student performance, thereby improving overall academic results and lowering dropout rates.[59] As discussed above, personalised learning systems also provide resources tailored to individual students' learning needs, replacing traditional techniques with adaptable, interactive multimedia content. Such personalised techniques have resulted in superior performance on multiple evaluations when compared to traditional teaching methods, highlighting the efficacy of technology-enhanced, student-centred education in a K-12 setting.[60]

7.4 Potential of University-Level Implementation of AI

The use of AI is transforming both academic and administrative components in higher education. AI has the capacity to simplify research by streamlining complex data jobs, improving accuracy, and expediting scientific discovery.[61] Simultaneously, it can reduce time spent on tedious administrative tasks, resulting in increased staff efficiency.[62] Moving our focus towards e-learning, we see an improvement in online education as a result of AI personalising learning experiences, providing quick feedback, and creating a more engaging virtual learning environment.[63] AI-integrated mobile learning and augmented reality (AR) have similarly been found to improve learning experiences.[64] In a broad-scale study, the AI-powered SmartTutor system indicated that individualised

[57] Akgun, Selin, and Christine Greenhow. 2022. "Artificial Intelligence in Education: Addressing Ethical Challenges in K-12 Settings." Ai and Ethics 2 (3): 431; Crompton, Helen, and Diane Burke. 2022. "Artificial Intelligence in K-12 Education." SN Social Sciences 2 (7): 113.

[58] Holstein, Kenneth, Bruce M. McLaren, and Vincent Aleven. 2018. "Student Learning Benefits of a Mixed-Reality Teacher Awareness Tool in AI-Enhanced Classrooms." In Artificial Intelligence in Education, edited by Carolyn Penstein Rosé, Roberto Martínez-Maldonado, H. Ulrich Hoppe, Rose Luckin, Manolis Mavrikis, Kaska Porayska-Pomsta, Bruce McLaren, and Benedict Du Boulay, 10947:154–68. Lecture Notes in Computer Science. Cham: Springer International Publishing.

[59] Crompton and Burke 2022

[60] Akgun and Greenhow 2022

[61] Daraio, Cinzia, Andrea Bonaccorsi, and Léopold Simar. 2015. "Efficiency and Economies of Scale and Specialization in European Universities: A Directional Distance Approach." Journal of Informetrics 9 (3): 430–48.

[62] Gupta, Babita, Subhasish Dasgupta, and Atul Gupta. 2008. "Adoption of ICT in a Government Organization in a Developing Country: An Empirical Study." The Journal of Strategic Information Systems 17 (2): 140–54.

[63] Zawacki-Richter et al., 2019

[64] Köse 2017

educational resources were well received by students and teachers.[65] Furthermore, AI extends into student services, mimicking and augmenting guidance counselling activities.[66] Advanced tools analyse past student data to provide personalised course suggestions and career advice, successfully guiding students through academic decisions and future career routes, and suggesting alternatives based on individual performance and preferences.[67] This comprehensive use of AI across operational and instructional dimensions represents a paradigm shift in the dynamics and potential of higher education.

7.5 AI Tools and Diverse Student Backgrounds

By incorporating elements of cultural sensitivity within technology media, AI in education can be designed to respect and understand varied cultural backgrounds. This has proved valuable in broadening students' understanding of these complicated concepts.[68] AI tools can also be employed to accommodate students with differing learning needs, including those with special education needs.[69] This could significantly narrow the educational gap between students who thrive in prescribed learning environments and those who do not. AI tools can also help students who do not speak the language of instruction by providing translation services and linguistic support.[70] These three additional tools for students with diverse backgrounds foster a more inclusive and equitable educational landscape for all learners.

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[65] Cheung et al. 2003
[66] Zeide 2019
[67] Ibid.
[68] Sanusi, Ismaila Temitayo, and Sunday Adewale Olaleye. 2022. "An Insight into Cultural Competence and Ethics in K-12 Artificial Intelligence Education." In 2022 IEEE Global Engineering Education Conference (EDUCON), 790–94.
[69] Wang, Ting, Brady D. Lund, Agostino Marengo, Alessandro Pagano, Nishith Reddy Mannuru, Zoë A. Teel, and Jenny Pange. 2023. "Exploring the Potential Impact of Artificial Intelligence (AI) on International Students in Higher Education: Generative AI, Chatbots, Analytics, and International Student Success." Applied Sciences 13 (11): 6716.
[70] Akgun and Greenhow 2022

8.0 LIMITATIONS OF AI AND ETHICS OF INCORPORATING AI IN UNIVERSITIES

8.1 Privacy and data security: student data

A greater dependency on technology like AI comes with an increased risk of "negative repercussions"[71] as the system may be vulnerable to cyberattacks. These are actions done by third parties in order to "interfere with equipment performance [...], obtain unauthorized access, or tamper with stored data."[72] A 2023 study from cybersecurity company Sophos states that 80 percent of lower education and 79 percent of higher education were attacked by ransomware in the first three months of 2023.[73] These threats included DDoS assaults, phishing, and social engineering attacks.[74] Research has shown that hackers deliberately targeted schools and student information due to their limited information about cyber security.[75] This is clearly in violation of the privacy of participating students as AI systems handle confidential and sensitive information.[76] This data not only includes information about a student's educational progress, but also highly sensitive information such as passport and Social Security numbers, information about parents or guardians, and psychological evaluations and well-being reports.[77]

8.2 Impact on Learning Outcomes

Apart from its vulnerability to data breaches, the greater dependency on AI in classrooms can also come with negative impacts on student well-being and learning outcomes. Firstly, 70% of higher education students taking part in a 2023 study indicate that they "miss student engagement"[78] while using AI-powered platforms in classrooms. This demotivated those students, emphasising engagement and participation as important aspects of classroom education. Moreover, AI use can encourage students to participate in unethical behaviour and lose out on genuine learning.[79] According to Metro News, over

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[71] Butt, Usman et al, "Ransomware Attack on the Educational Sector." in *AI, Blockchain and Self-Sovereign Identity in Higher Education*, ed. by Hamid Jahankhani et al (Springer Cham, 2023), 279.
[72] Butt 282
[73] *The State of Ransomware 2023* (Sophos, May 2023), 4.
[74] Butt 296
[75] Ibid.
[76] Butt 302
[77] Butt 297
[78] Nipun, Musarrat Saberin et al. "Influence of Artificial Intelligence in Higher Education; Impact, Risk and Counter Measure." in *AI, Blockchain and Self-Sovereign Identity in Higher Education*, ed. by Hamid Jahankhani et al (Springer International Publishing AG, 2023), 154.
[79] Nipun, Musarrat Saberin et al. "Influence of Artificial Intelligence in Higher Education; Impact, Risk and Counter Measure.", 154.

a million visits to AI platform ChatGPT were made during the winter exam period across eight UK universities.[80] This could cause a loss in crucial skills such as research, critical thinking, and revision: AI-powered writing programs can reduce the goal of writing to a grade[81] as opposed to developing critical thinking and academic skills.

Further research has indicated that AI-based teaching also misses components intrinsic to human teaching, such as pedagogical intuition, flexibility, and human connection.[82] AI-based teachers may struggle with assessing the great cognitive variability that their students show.[83] This causes the teaching to be quite inflexible and undynamic as the programs are unable to provide accommodated learning unless this was previously programmed into the software. This lack of pedagogical intuition and flexibility will negatively affect the motivation of students and the effectiveness of their learning. Similarly, AI teachers lack the ability to form a "genuine human connection"[84] with their students, as qualities such as empathy and trust are inherent to humans. This absence of a "human touch" will limit the motivation and support that some students need in order to effectively study as "learning is not an isolated process"[85] and is strongly influenced by social factors.

Lastly, previous research has shown that many datasets contain some sort of bias due to either inappropriate data selection or the design of the algorithm itself.[86] For example, students from "historically lower-performing schools" were more likely to receive lower marks than what they were used to receiving, whereas students from "traditionally high-performing private schools" were more likely to receive uncommonly high grades due to a 2020 AI-based predictive grading system.[87] Many datasets are biassed due to sampling

[80] King, Jasper. "Students made 1,000,000 visits to ChatGPT fuelling fears of a cheating epidemic." Metro, last modified March 22, 2023
[81] Goodlad, Lauren M.E. & Baker, Samuel, "Now the Humanities Can Disrupt 'AI'." Public Books, last modified Feb 20, 2023
[82] Tian, Yang. "Limitations and Advancements of AI Teachers in Classroom Instruction." Education and Teaching Research, no. 3 (2023): 67.
[83] Tian 68
[84] Tian 67
[85] Ibid.
[86] National Academies of Sciences, Engineering, and Medicine. *Human-AI Teaming: State-of-the-Art and Research Needs*. (Washington, DC: The National Academies Press, 2022).
[87] Gillani, Nabeel. "Unpacking the "Black Box" of AI in Education." *Educational Technology & Society* 26, no. 1 (2023): 106.

that is not representative of a target group[88] and this will only further exclude and discriminate against minorities within that group, such as students from different races, religions, and genders.[89]

[88] McSharry, Patrick E. "Promoting AI Ethics Through Awareness and Case Studies." *AI Ethics in Higher Education: Insights from Africa and Beyond,* ed. by Caitlin C. Corrigan et al, (Springer International Publishing, 2023), 73.
[89] Dimitriadou, Eleni & Lanitis, Andreas. "A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms." S*mart Learning Environments* 12, no. 10 (2023) : 19.

9.0 CURRICULA DESIGN

This section will offer a short survey of approaches to designing curricula and assessments in such a way as to prevent profitable academic dishonesty with Large Language Models (LLMs), and demonstrate that multimodal assessments offer the most straightforward and effective ways forward, rather than a shift in assessment criteria, automated detection, or reworking writing prompts.

One mooted approach is a shift in assessment criteria to place a greater emphasis on *originality* or *novelty*––in essence, on the demonstration of a form of creativity which the human student can possess and express, but which LLMs intrinsically lack and cannot effectively mimic. This has some immediate appeal: university should, intuitively, be a site for creating the new and centring originality as the core pedagogical value of university surely seems preferable to regurgitation. Yet, the notion that creativity is intrinsically beyond the capacity of LLMs, or any other AI technology, can be strongly disputed. The case for denying the potential creativity of mechanical systems would hinge upon following Henri Bergson in claiming that there is some capacity in human beings to create something which does not depend upon existing things, which is more than the rearrangement of pre-existing elements and ideas.[90] If creativity is already a reorganisation of what already exists, and can consist, as Margaret Boden has argued, of the "combination of familiar ideas in unfamiliar ways,"[91] then we would have to concede that generative AI is creative.[92] Thus, this shift in emphasis would not necessarily render AI cheating ineffective. Hence, recentering curricula around originality seems a fraught approach to tackling cheating on its own––how would the marker reliably distinguish between true creativity and mere rearrangement? Nonetheless, originality is a skill which universities ought to develop in students, and one which automated systems might never be able to truly capture, even if they can effectively imitate it. This might consist of nurturing students throughout the entire writing process, aiding the development of spontaneous ideas. The ability to think and express creatively, even if not intrinsically beyond the reach of AI, is certainly harder for it to replicate than rote-learning, and so will serve students better in future.

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[90] Henri Bergson, "The Real and the Possible" in *Key Writings*, eds. Keith Ansell Pearson and John Mullarkey (London: Bloomsbury Academic, 2014), p. 282.
[91] Margaret Boden, *The Creative Mind: Myths and Mechanisms* (London: Psychology Press, 2004), p. xi.
[92] Mingyong, Cheng, "The Creativity of Artificial Intelligence in Art" *Proceedings* 81, no. 1. p. 111

The prohibition of using LLMs for written work at university is a knee-jerk reaction and there does not appear to be any viable way of detecting and enforcing such a dictum. OpenAI's own research suggests that automated detection of AI usage is not reliable enough to make judgements on authorship.[93] The readily identifiable limitations of earlier models––lack of recent information, false citations, etc.––have already been surpassed by newer models, including the internet-connected BingAI and ChatGPT-4. The significant improvements in performance[94] from GPT-3 to GPT-4 also suggest that the technology's struggle to tackle obscure questions is also receding. More fruitful approaches to redesigning prompts might include asking students to make reference to real-world information/examples that will only be familiar to them through their studies––for instance, data collected through fieldwork––or the inclusion of non-textual elements in questions (e.g. diagrams).[95] But these will not be applicable to many subjects, and the latter may already be outdated with ChatGPT-4 gaining the ability to analyse images.[96]

Instead, we ought to look at multimodal assessments––in particular, the combination of written assessments with some form of oral assessment. Some institutions have begun implementing this as random "authenticity interviews", in order to deter cheating––students may be randomly asked to explain their written work to demonstrate their understanding.[97] Assessing students' actual grasp of material, rather than attempting to design their assignments around circumventing LLM usage, seems to be the most effective approach, whether or not the oral assessments are graded. Although it would be labour intensive, combining all students' written work with oral examination would have notable pedagogical functions, requiring a deeper mastery and understanding of students' field and their own argument to effectively answer questions and engage in dialogue. This direction ought to be taken seriously and explored further.

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[93] OpenAI, "Educator FAQ", 2023

[94] Andrew Mihalache, Ryan S. Huang, Marko M. Popovic & Rajeev H. Muni, "ChatGPT-4: An assessment of an upgraded artificial intelligence chatbot in the United States Medical Licensing Examination", *Medical Teacher*, 2023.

[95] Simon Kaare Larsen, "Creating Large Language Model Resistant Exams: Guidelines and Strategies", Department of Science and Environment, Roskilde University, 2023.

[96] *Ibid*.

[97] Imperial College London, "Generative AI Tools Guidance", 2023.

10. CRITICAL ANALYSIS AROUND DEPLOYING AI

On the basis of its opacity, tendency to recreate systemic injustices, and the function it plays in today's economy as a mechanism that furthers the exploitation, precarisation, and alienation of labour, we ought to be critical of the rush to deploy AI, particularly in universities. We will illuminate these key concerns and suggest some practical demands which workers in the university setting should make to resist the use of AI technologies that weaken their rights.

A notable feature of recent AI models has been the tendency to recreate the forms of discrimination and structural injustice prevalent in the societies from whom their source data is drawn. Amazon's since-abandoned machine-learning-based recruiting tool, found in 2018 to have systematically penalised resumes that included the word "women's" or references all-women colleges,[98] has been among the most acute examples of this phenomenon. Observe, for instance, the racially unjust outcomes of deploying automated facial recognition systems.[99] Rather than a flaw in their creation, this must be understood as an intrinsic part of how AI systems operate in an already structurally unjust society. AI recreates what already exists, and so exacerbates and entrenches existing social inequalities.[100] Rather than being a tool to further social justice, it may be the case that AI cannot be just *until* societies are just, and so, while structural injustice persists, the implementation of AI should be heavily regulated. It is a matter of consensus that part of the role of the modern university should be the dismantling of discriminatory and oppressive structures. Hence, there should be wariness in allowing such technologies to determine the makeup and practices of these institutions.

This is coupled with the problem of opacity. There is a general tendency not to trust opaque systems––that is, automated systems which do not explain how they come to their decisions. This has been seen in doctors disregarding automated diagnostic tools, despite their accuracy, because they cannot readily understand the reasoning behind their judgements.[101] There seems to be a particular injustice experienced by people who

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[98] Jeffrey Dastin, "Amazon Scraps secret AI recruiting tool that showed bias against women", Reuters, 2018.
[99] Jane Bailey, Jacquelyn Burkell, Valerie Steeves, "AI technologies - like police facial recognition - discriminate against people of colour", in *The Conversation*, 2020.
[100] Ting-An Lin & Po-Hsuan Cameron Chen. "Artificial Intelligence in a Structurally Unjust Society". IN *Feminist Philosophy Quarterly 8 (3/4): Article 3*, p. 23.
[101] Creel, Kathleen A. "Transparency in Complex Computational Systems." *Philosophy of Science 87*, no. 4 (2020), pp. 570-571.

are turned over for a promotion, rejected for a job, denied social housing, or whose lives are otherwise affected by automated decision-making procedures which are obscure to them. Such obscurity also serves to mask the structurally unjust tendencies of automated systems highlighted above. In the Amazon example, a woman whose job application was unfairly rejected would be at a severe epistemic disadvantage, having been given no insight into how the decision was made and thus no opportunity to challenge it. However, opacity is not an inherent part of machine learning and there are frameworks which can make AI's processes readily intelligible.[102] Hence, where AI is deployed in these ways, workers ought to make two demands: the right to an explanation and the right to appeal to a human being.

Finally, the deployment of AI ought to be viewed within a broader consideration of power relations and its function in the global economy. Within the university, the deployment of AI should be placed within the broader logic of the marketisation of higher education, as a method of more efficiently extracting revenue. In this sense, AI does not just describe the technologies themselves but also "an organising idea––a framework that is used to make sense of the world in a particular way."[103] Analysed this way, Matteo Pasquinelli's "labour theory of machine intelligence"[104] reveals AI not to be a paradigm-shifting technology, but rather an extension of relations of power and a continuation of the trend of expanding precarious labour. AI is not truly autonomous but is constructed from enormous quantities of human labour, which is largely performed by gig workers in the Global South––with the illusion of AI autonomy to Global North users causing this labour to be termed "ghost work."[105] This is the other side of the replacement of traditional jobs in the Global North––rather than true automation, this can largely be seen as an extension of the existing trend of moving work into economies with weaker regulation and wages. Hence, the replacement of existing jobs with AI ought to be resisted not just on the basis of creating unemployment but also because it furthers the growth of increasingly exploitative models of production, both in the university and elsewhere.

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[102] Creel, Kathleen A. "Transparency in Complex Computational Systems." *Philosophy of Science 87*, no. 4 (2020), pp. 568–89.
[103] Dan McQuillan, *Resistant AI: An Anti-Fascist Approach to Artificial Intelligence* (Bristol, 2022; online edn, Policy Press Scholarship Online, 19 Jan. 2023).
[104] Matteo Pasquinelli, *The Eye of the Master: A Social History of Artificial Intelligence* (London: Verso, 2023)
[105] Mary Gray and Siddharth Suri, *Ghost Work: How to Stop Silicon Valley from Building a New Global Underclass* (New York: Houghton Mifflin Harcourt, 2019).

11. CONCLUSION

11.1 What is AI?

Artificial intelligence (AI) is a term that embodies a set of sciences and theories, as well as techniques including mathematical logic, probabilities, computational neurobiology, statistics, and computer science. The greatest purpose and intent of AI is to emulate and mimic the cognitive abilities of human beings, therefore, artificial intelligence encourages a future where machines can reason on input, learn from experience, and perform human-like tasks.

11.2 How has it been successful in the past?

The advancement of technology in education has been nothing short of revolutionary. This technological integration in education may be traced back to the 1920s. During this time, the birth of radios provided a revolutionary platform, allowing audio classes and ushering in a new type of distance learning. In recent years, the rise of social media's use in educational settings has demonstrated the flexible nature of technology's function in education. In response to this transition, organisations such as Scholastic Teachers have emerged, providing help to educators navigating the complexities of social media use in the classroom. Such precedents highlight the possible need for such organisations committed to the ethical deployment of AI in educational settings.

11.3 How can we build upon that success in education?

The implementation of AI in educational environments heralds a radical shift in traditional teaching and learning frameworks, promising a more equitable and personalised learning experience. AI benefits educators by relieving administrative duties and allowing them to focus on qualitative pedagogical engagement, from streamlining classroom grading to automating administrative tasks. Furthermore, AI's potential extends beyond enhancing established approaches to building accessible learning pathways for students with diverse backgrounds and learning needs. By providing real-time, individualised feedback and support, AI substantiates active, self-paced, and student-centred learning. The use of AI in sub-university and university settings demonstrates its adaptability in improving educational outcomes and establishing a culture of academic inclusion and excellence. Notably, AI's ability to recognise and respond to cultural diversity and special education needs highlights its position as an educational unifier. AI used correctly has the potential to usher in an era

of educational experiences that prioritise diversity, individuality, and holistic development, preparing students for a dynamic future terrain by transcending traditional constraints and biases.

11.4 What obstacles are there in the way of doing so?

Greater dependency on technology like AI comes with an increased risk of cyberattacks such as DDoS assaults, phishing, and social engineering attacks. This comes at the cost of students' privacy as AI systems handle confidential and sensitive information. Moreover, the incorporation of AI in classrooms may come at the cost of student well-being as these programs lack the pedagogical intuition, flexibility, and human connection that only a human teacher can provide. This lack of "human touch" and possible biases in the collection of data may negatively influence students' well-being and learning processes.

There is also a risk that current discriminatory tendencies will be unwittingly perpetuated, labour rights will be jeopardised, and bureaucratic authority will be amplified, allowing individuals to be exploited. As a result, protections such as protecting workers' rights, including the right to explanations and the ability to appeal decisions to a human being, must be in place.

Moreover, it is critical to recognise that the sheer presence of technology does not imply its efficient application. While there has been a dramatic increase in the availability of information technologies in classrooms, educators often use them sparingly and scarcely deviate from their traditional teaching methodologies. Machine translation tools are also worth mentioning, particularly in terms of their potential consequences for foreign language education. Although they show promise, there is considerable debate over their correctness and appropriateness. Finally, an intriguing anomaly in the area of AI is its occasional blunders in fabricating citations. This emphasises the significance of critical thinking and verification, especially in an age of technological marvels.

11.5 How do we redesign curricula to incorporate AI?

The first step is to better discern between Artificial and Human Intelligence. We must refine our terminology and knowledge of AI's various functions and forms, enhancing our capacity to see how they complement one another. Next, because large language models struggle to produce new ideas beyond simply reorganising pre-existing content,

it is critical that both teaching and evaluation systems prioritise and encourage creative thinking. This includes not just recognising completely new ideas, but also appreciating unique approaches of explaining, offering examples, communicating, and synthesising. Such a culture can be developed by engaging with students throughout the entire writing process rather than solely judging the final product. Another promising solution could be to implement multimodal evaluations, in which written work is supplemented with oral presentations or interviews.

11.6 How should we approach incorporating AI in formative assessments?

Formative assessments are one crucial area where AI has enormous potential. AI can be specifically developed to cater to specific impairment groups, such as providing voice assistance to hearing-impaired students. The main goal of incorporating AI into such examinations is to prioritise and centre instructors, ensuring that the technology supplements rather than replaces their function.

This endeavour requires a strategic and nuanced approach to ensure that assessments capture the breadth of students' understanding as well as the authenticity of their work. To begin, the concept of creativity in assessments must be extended beyond mere uniqueness, acknowledging that AI may creatively reorganise existing data. Assessments should instead focus on the synthesis of knowledge and application in a variety of circumstances, which is difficult for AI to mimic.

A solid formative assessment technique is built around multimodal assessments that mix written work with oral examinations. This technique can verify students' understanding of the topic matter as well as the originality of their presentations. Personalised information based on personal experiences, fieldwork, or unique datasets can also help to strengthen evaluations against AI imitation.

Given AI's expanding capabilities, assessments could incorporate real-world challenges as well as non-textual features, such as graphics, that students must analyse or explain, thus capitalizing on AI's limits in processing sophisticated and nuanced tasks. This, in conjunction with the constant modification of evaluation methodologies and the implementation of enforceable norms regulating AI usage, has the potential to foster an academic climate based on integrity.

Educating everyday consumers of AI on AI's role and potential is also essential, directing students towards ethical use and comprehension of AI as a supplementary tool rather than a crutch. This comprehension provides a way for AI to be favourably included, assisting with research and study, with the caveat that students' work must remain unique.

Diversifying assessment modalities to include project-based assignments, peer reviews, and reflective diaries can also result in more personalised replies and deeper involvement. This variety not only enriches the learning experience, but also generates a tapestry of assignments in which AI's contribution is supplemental rather than substitutive.

Weaving these threads together results in a dynamic assessment tapestry that is both AI-informed and integrity-focused, ensuring that formative evaluations continue to serve their primary purpose: gauging and encouraging actual student progress and intellectual growth.

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