WIP: What Are AI Bachelor Degrees About? A Comparative Analysis

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***Abstract*—As the Artificial Intelligence (AI) industry rapidly expands in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) of China, the demand for AI talent continues to grow, higher educational institutions need to continuously update its AI education to adapt technological progress. However, there is currently a lack of understanding on AI education in the GBA. This work-in-progress research paper analyzes the current state of AI bachelor degrees within the GBA and compares it with the well-established curricula in the United States (US). The study selected a sample from the top 8 universities based on QS rankings and employed an enhanced AI course literacy categories model for the inductive and comparative analysis of AI course settings. The preliminary study highlights differences between universities in the GBA and the US in terms of course content depth and teaching strategies. The GBA universities emphasize a balanced and comprehensive curriculum that ensures all students have a solid foundation in both AI theories and technologies. In contrast, US universities prioritize a broader, interdisciplinary approach that fosters innovation and development of practical skills. The findings suggest that GBA universities could benefit from adopting some of the strategies used by US universities, such as adjusting the proportion of elective courses and increasing the availability of interdisciplinary courses. This would promote personalized student development and interdisciplinary learning, better preparing students to meet the challenges and opportunities of the AI era.**

Keywords—Artificial Intelligence (AI) Education, Higher Education, Comparative Analysis

I. INTRODUCTION

The ongoing rapid development of generative artificial intelligence (AI) is driving innovation and improvements in higher education [1], especially in the field of AI education. Higher education institutions must design AI curriculum that meet the workforce needs of businesses, equipping students with the knowledge, skills, and abilities required to apply AI [2], and adapt to the challenges of the new era. AI education encompasses two aspects: the application of AI in education, and education (teaching) about AI [3]. In higher education, most academic literature discusses the former, with the US and China leading in the number of publications in this field [4]. However, there is less research on education (teaching) about AI [5], especially on AI as a major.

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The Chinese Government has strongly supported and deploys AI education through policy documents, developing it into a core disciplinary and establishing major at specific universities [6]. Until 2024, 536 universities in China offer AI majors (TABLE I.) with the aim of training specialized AI talents. Despite these efforts showing a solid foundation for education (teaching) AI in China, there is still a lack of literature on AI as a major, revealing a gap in research in this area.

TABLE I. ANNUAL INCREASE IN THE NUMBER OF UNIVERSITIES IN CHINA OFFERING AI MAJORS (2018-2023)

Years	Number	Years	Number
2018	35	2021	95
2019	180	2022	58
2020	130	2023	38
Total Number：536			

[a.] The data results are based on the annual "Approval Results of Undergraduate majors' setup in Colleges and Universities" published by the Ministry of Education of China on its official website. http://www.moe.gov.cn/srcsite/A08/moe_1034/s4930/201903/t20190329_376012.html

On the other hand, the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) is one of the world's four major bay areas, along with the San Francisco, New York, Tokyo Bay Areas. Most AI companies and talent are concentrated here [7]. With accelerated regional cooperation, competition for AI talent in the GBA has become increasingly intense [8]. Universities play a crucial role in training talent to meet the region's evolving needs. However, unlike other bay areas, the development of higher education in the GBA is more complex due to historical and policy differences, operating under "one country, two systems," "three legal systems," and "three custom zones" [9]. For example, the governments of Hong Kong and Macao rarely interfere in university decisions and primarily use English for instruction, whereas universities in Guangdong have less autonomy and the language of instruction is Chinese [10][11]. These policy and government support differences impact the characteristics and skill requirements of AI talent in each region [12]. Therefore, studying how universities in these regions organize and teach AI courses is significant not only for the GBA but also provides valuable insights for the global development of AI education.

To fill the research gap, this study compares AI undergraduate programs from universities in the GBA and the US, selected the sample from the top 8 universities based on QS rankings. The aim is to understand the current state of AI bachelor's degrees and to compare the differences in AI curricula between the GBA and the US, providing a reference for the development of AI major in GBA universities. Specifically, we aim to address the following two research questions:

RQ1: How do higher educational institutions in the GBA and the US teach AI at the bachelor's level in the AI era?

RQ2: How can the higher education sector in the GBA learn from the US AI curriculum?

II. Prior Research

A. AI Bachelor Degrees

There has been much research on the applications of AI in higher education [13], such as the application of AI technology in teaching [14], teaching AI in STEM [15], and AI software enhancing educational outcomes [16][17]. However, AI as a distinct academic discipline has seldom been studied. In fact, in 2019, the Ministry of Education in China approved the first batch of universities to offer AI undergraduate majors [18]. It is strange that, it seems to be a challenge to reflect the characteristics of AI major and to cultivate what kind of AI talent to this day. In China, the establishment of academic programs and their curriculum structures must adhere to the "National Standards for Teaching Quality of Undergraduate Programs in Regular Higher Education Institutions" issued by the Ministry of Education, to ensure uniformity. However, as a new major, AI major is not included in China's national standard documents, and most universities use the curriculum of computer-related majors as a reference for the AI major.

B. AI Literacy Frameworks

Possessing AI literacy may encourage more students with higher education to consider AI careers [19]. Therefore, fostering students' AI-related abilities is essential to enhance their AI literacy. AI literacy is defined as the ability of an individuals to acquire and use AI-related knowledge and skills to establish a good understanding of the principles and applications of AI [20]. It can be evaluated in four aspects: know & understand AI; use & apply AI; evaluate & create AI; AI ethics [21]. This paper adopts a model of AI course literacy categories (Fig. 1) based on these four aspects [22], which adds a fifth category, "Enabling AI," where all foundational courses that support students' learning of AI fall into this category, such as mathematics and statistics. Therefore, this study uses this model to review AI course offerings to determine whether students in AI bachelor's degree majors have obtained AI literacy abilities from these courses.

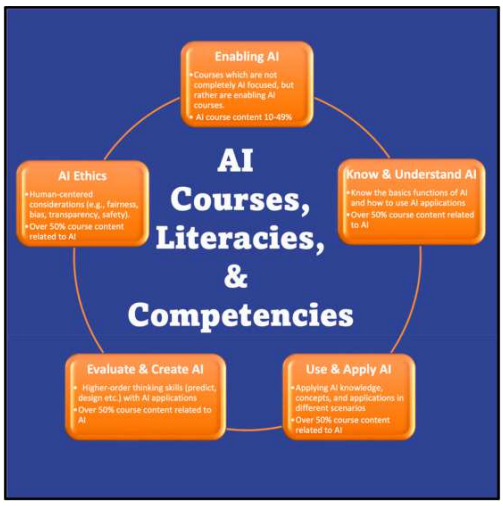


Fig. 1. AI course literacy categories model [22].

III. Methodology

A. Selected AI Curriculum Documents

The method employed in this study for selecting sample universities involved filtering institutions from the QS World University Rankings by Region 2024 [23], specifically targeting universities in China, including those in Guangdong Province, Hong Kong, and Macao, as well as those in the US. Then, visit the official websites of those universities in sequence to look for introductions to AI majors. Universities lacking Comprehensive information on AI majors were excluded from the statistics. The QS Rankings are widely recognized as a method for understanding the world's top universities. This ranking system was chosen because it aligns the same standard of data needs, making the collected data comparable. The primary data for this study were derived from the official university websites, which provided detailed introductions to AI major, including educational objectives, course titles, credits, instructional hours, learning outcome assessments, and the names of the degrees awarded. Information about the samples can be found in TABLE II.

TABLE II. Information on AI Majors at the 8 Sample Universities

University	HK1	HK2	M1	M2	GD1	GD2	US1	US2
Bachelor Degrees Name	Arts and Sciences in Applied Artificial Intelligence	Engineering in Artificial Intelligence	Science in Artificial Intelligence	Science in Artificial Intelligence	Engineering in Artificial Intelligence	Engineering in Artificial Intelligence	Science in Artificial Intelligence and Decision Making	Science in Engineering in Artificial Intelligence
Teaching Language	English	English	English	Chinese/English	Chinese	Chinese	English	English
Duration	4 years	4 years	4 years	4 years	4 years	4 years	4 years	4 years
Faculty Unit	Science	Engineering	Applied Sciences	Innovation Engineering	Future Technology	Computer Science and Cyber Engineering	Computing	Engineering

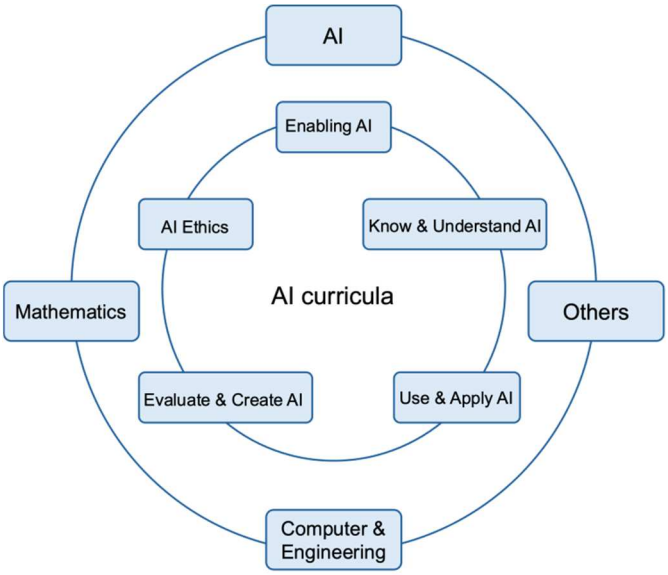


Fig. 2. The curriculum analytic framework applied in this research.

B. *Analytical Framework*

By scanning course documents and reviewing previous literature [20], it was decided that AI bachelor's degree courses could be categorized into four groups: AI, Computer & Engineering, Mathematics, Others. Then, using the model of AI course literacy categories, a more detailed analysis was conducted across all eight universities. Figure 2 presents the preliminary framework for course analysis proposed in this research, aiming to compare and analyze AI bachelor's degree courses through these dimensions. The goal is to understand the current curriculum settings from the perspective of cultivating AI literacy and to further identify the commonalities and unique aspects of course setups between GBA and US higher education institutions.

The following are examples of courses under four categories:

- **AI (courses directly related to AI):**

  Introduction to Artificial Intelligence; Natural Language Processing; Machine Learning and Intelligent Data Analysis; AI Ethics.

- **Computer & Engineering (courses related to computer science and engineering):**

  Introduction to Engineering; Programming Technologies; Design and Analysis of Algorithms.

- **Mathematics (Essential mathematical courses):**

  Linear Algebra; Mathematics of Computer Science; Calculus.

- **Others (General education courses):**

  Sustainable Leadership; Natural Science; Marxism Theory and Practice.

C. *Data Analysis*

This research have analyzed the AI major courses from six universities in the GBA in China, and compared them with data from two universities in the US where AI education is more mature, to understand what courses are currently being taught in AI major and to explore the similarities and differences between the GBA and the US. To achieve this objective, we employed an inductive approach to manually analyze the data, utilizing Microsoft Excel and Tableau as the tools. At present, we have completed the categorization of AI major courses from the eight universities according to the four categories of the aforementioned framework. Subsequently, we calculated the credit for each category and their percentages. To discern the differences between GBA and the US, we have also calculated the credit and weights for both compulsory and elective courses at each universities.

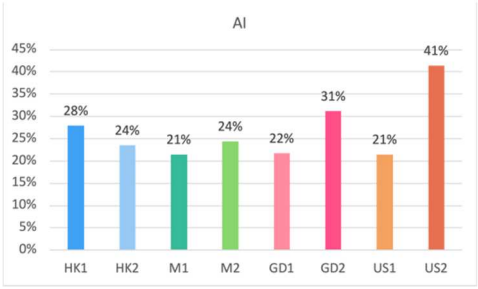


Fig. 3. Percentage of AI courses in 8 universities' AI major.

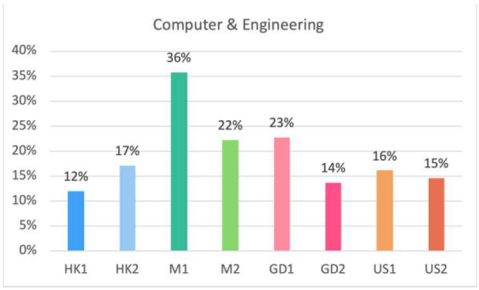


Fig. 4. Percentage of Computer & Engineering courses in 8 universities' AI major.

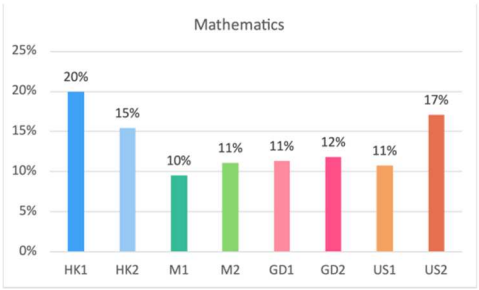


Fig. 5. Percentage of Mathematics courses in 8 universities' AI major.

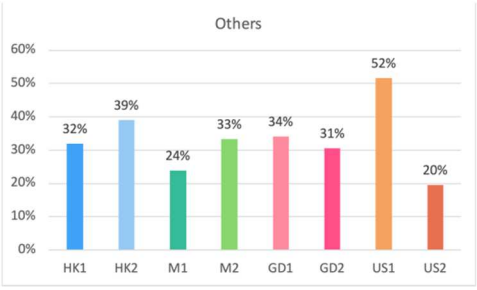


Fig. 6. Percentage of courses in Others category in 8 universities' AI major.

IV. Preliminary Findings

Through the analysis of course credits in AI majors at eight universities, we inductively overall course setup across different universities. In this WIP analysis, we share four charts that display the proportion of courses each university offers under four categories.

RQ1: AI Course Offerings at GBA and US Universities

In the AI category (Fig. 3), the distribution ranges from as low as 21% to a high of 41%, and it can be observed that the universities in the GBA have a higher overall allocation of courses in the AI category compared to US1 University, but significantly less than US2 University. Specifically, within the GBA, Guangdong's universities have higher proportion of AI courses than Hong Kong, which in turn has more than Macao. This may be attributed to Guangdong receiving more policy funding and support within the GBA, leading to a higher proportion of AI courses.

The Computer & Engineering figure shows a stark contrast (Fig. 4), with the proportion of courses peaking at 36% for M1 university and as low as 12% for HK1 in the GBA. The US universities perform similarly in this category. Comparing the AI category, it is evident that universities in Macao and Guangdong within the GBA tend to include more towards computer & engineering in their AI majors curriculum. This finding indicates that the focus on AI subjects might be diluted, potentially hindering students' deep specialization in AI.

The Mathematics category courses show variability across institutions, with proportions ranging from 10% at M1 to 20% at HK1 (Fig. 5). Notably, HK1 leads with the highest proportion, underscoring its emphasis on mathematical foundations in AI education, followed by US2 at 17% and HK2 at 15%. Other institutions, including M2, GD1, and US1, maintain a consistent presence at 11%. This distribution suggests a general consensus on the fundamental role of mathematics in AI majors across most institutions, with Hong Kong universities placing a slightly higher emphasis compared to others.

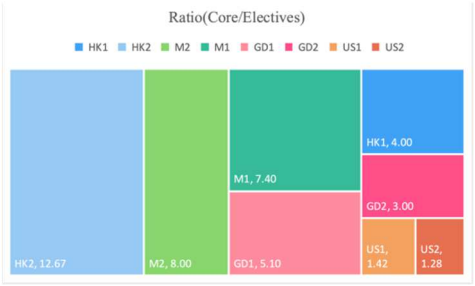
The Others category (Fig. 6), which includes humanities, social sciences, and natural sciences courses, shows significant variation, with US1 has the highest proportion at 52%, indicating a strong emphasis on a broad-based education. In contrast, US2 has the lowest proportion at 20%. Within the GBA, the distribution is more evenly spread, with proportions ranging from 24% at M1 to 39% at HK2. Comparing the Others category with other course categories, it is evident that most institutions, except for US2 and GD2, allocate a significant proportion of their curriculum to the Others category, nearly equal to that of AI courses. This suggests that GBA institutions aim for well-rounded development in AI students, while US institutions may have different educational goals, resulting in contrasting outcomes.

Overall, these charts reflect the differences in AI course setup strategies between GBA and US universities, highlighting distinct educational philosophies. The GBA focuses on balanced AI with other course categories for comprehensive development. In contrast, US universities vary significantly, with US1 emphasizing a broad-based education and US2 focusing on in-depth AI research. However, the analysis still reveals the strategies of AI course setups in the US, which either place more emphasis on foundational skills education and interdisciplinary learning or focus more on in-depth AI research and development, which is important for comprehending AI curriculum structures and talent development strategies.

RQ2: Learning from US AI Curriculum

The tree-map (Fig. 7) displays the weights of compulsory and elective courses at eight universities, with larger areas indicating a higher weight for compulsory courses. Universities in the GBA assign a higher weight to compulsory courses (HK2 Ratio 12.67, M2 Ratio 8.00, M1 Ratio 7.40), contrasting with US universities that offer students more freedom of choice (US1 Ratio 1.40-1.42, US2 Ratio 1.28). This suggests that GBA universities employ a standardized and unified educational approach to ensure all students possess solid foundational knowledge and skills to meet educational standards and industry needs. Conversely, during the previous data collection, it was also evident that the two US universities provide a wide range of elective courses for students to choose from, both within their AI-related courses and across other disciplines. This strategy reflects a greater emphasis on individualization and diversity in US universities, which greatly aids in fostering students' interdisciplinary learning and potentially accommodates diverse interests and career aspirations within the field of AI.

Therefore, universities in the GBA might consider adjusting the proportion of elective courses to allow students to select courses based on personal interests and career planning. More importantly, offering more interdisciplinary courses within the available choices could promote interdisciplinary learning among students, enhancing their ability to integrate and apply diverse skills and knowledge in AI.



a. The numbers on the chart indicate the ratio of compulsory to elective credits, with the value shown as a dimensionless quantity (e.g., HK2 ratio of 12.67 means that compulsory credits constitute 12.67 times the number of elective credits within the program)

Fig. 7. Weights of compulsory and elective courses in 8 universities' AI major (expressed as a dimensionless quantity).

V. Conclusions And Future Work

This preliminary study indicates that there are differences between universities in the GBA and the US in terms of the depth of AI major course content and course offering strategies. The results show that GBA universities place a greater emphasis comprehensive development in the setup of AI and other course categories. They adopt a relatively uniform educational approach to ensure that students have a foundational knowledge and skills in theory and technology, which contrasts sharply with the differences in AI course offering strategies observed in US universities. The findings also suggest that universities in the GBA could learn from the strengths of US institutions by considering an appropriate adjustment of the proportion of elective courses and increasing interdisciplinary courses to promote personalized student development and interdisciplinary learning.

Furthermore, our future work will employ an AI course literacy framework for a more in-depth analysis. The current work will lay the foundation for future quantitative and qualitative studies, which may include the incorporation of surveys and interviews, such as feedback from students on the AI major, teaching methods, and employment outcomes for graduates, to provide a deeper exploration of the preliminary findings.

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References

[1] Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*, *13*(9), 856.

[2] Cantú-Ortiz, F. J., Galeano Sánchez, N., Garrido, L., Terashima-Marin, H., & Brena, R. F. (2020). An artificial intelligence educational strategy for the digital transformation. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *14*, 1195-1209.

[3] Holmes, Wayne; Meng, Sun; Yuan, Li; (2023) Artificial Intelligence and Education: Digging Beneath the Surface. The Chinese Journal of ICT in Education , 2023 (2) pp. 16-26.

[4] Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*, *20*(1), 22.

[5] Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2023). A review of AI teaching and learning from 2000 to 2020. *Education and Information Technologies*, *28*(7), 8445-8501.

[6] Knox, J. (2020). Artificial intelligence and education in China. *Learning, Media and Technology*, *45*(3), 298-311.

[7] Fang Zhongxiong, Ji Li, Cheng Cong. (2022). Analysis of talent demand in my country's artificial intelligence industry. Journal of Beijing Industrial Vocational and Technical College (02), 59-62.

[8] Zhang, Z., Li, J., Chen, Y., Chen, F., & Liu, Z. (2024). Mapping the educational Frontier: Unleashing the Potential of artificial intelligence talents through cooperative planning in the Guangdong-Hong Kong-Macao greater bay area. *Heliyon*, *10*(2).

[9] Xie, X., Liu, X. & McNay, I. One country with two systems: The characteristics and development of higher education in the Guangdong–Hong Kong–Macau Greater Bay Area. *Humanit Soc Sci Commun* **10**, 1 (2023). https://doi.org/10.1057/s41599-022-01483-z

[10] Li, Y. X., & Yuan, X. Y. (2019). The logic and approach of deepening higher education reform and promoting the integrated development of Guangdong, Hong Kong and Macau. *Res High Educ China*, *11*, 41-47.

[11] Xie, A., Postiglione, G. A., & Huang, Q. (2021). The Greater Bay Area (GBA) Development Strategy and Its Relevance to Higher Education. ECNU Review of Education, 4(1), 210-221. https://doi.org/10.1177/2096531120964466

[12] Zhang, Z., Li, J., Chen, Y., Chen, F., & Liu, Z. (2024). Mapping the educational Frontier: Unleashing the Potential of artificial intelligence talents through cooperative planning in the Guangdong-Hong Kong-Macao greater bay area. *Heliyon*, *10*(2).

[13] Chiu, T. K. (2024). Future research recommendations for transforming higher education with generative AI. Computers and Education: Artificial Intelligence, 6, 100197.

[14] Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. Educational technology research and development, 71(1), 137-161.

[15] Lin, C. H., Yu, C. C., Shih, P. K., & Wu, L. Y. (2021). STEM based artificial intelligence learning in general education for non-engineering undergraduate students. Educational Technology & Society, 24(3), 224-237.

[16] Wu, R., & Yu, Z. (2024). Do AI chatbots improve students learning outcomes? Evidence from a meta - analysis. British Journal of Educational Technology, 55(1), 10-33.

[17] Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial intelligence for assessment and feedback to enhance student success in higher education. Mathematical Problems in Engineering, 2022, 1-19.

[18] Ministry of Education of China. (2019, March 25). Notice of the Ministry of Education on the Announcement of the Record and Approval Results of Undergraduate majors Setup in Regular Higher Education Institutions. (In Chinese) http://www.moe.gov.cn/srcsite/A08/moe_1034/s4930/201903/t20190329_376012.html

[19] Yue, M., Jong, M. S. Y., & Dai, Y. (2022). Pedagogical design of K-12 artificial intelligence education: A systematic review. *Sustainability*, *14*(23), 15620.

[20] Wilton, L., Ip, S., Sharma, M., & Fan, F. (2022, July). Where is the ai? ai literacy for educators. In *International Conference on Artificial Intelligence in Education* (pp. 180-188). Cham: Springer International Publishing.

[21] Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, *2*, 100041.

[22] Southworth, J., Migliaccio, K., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. *Computers and Education: Artificial Intelligence*, *4*, 100127.

[23] Qs quacquarelli symonds limited.(2024). QS World University Rankings by Region.https://www.topuniversities.com/regional-rankings

[24] Kong, S. C., Cheung, W. M. Y., & Zhang, G. (2023). Evaluating an artificial intelligence literacy programme for developing university students' conceptual understanding, literacy, empowerment and ethical awareness. Educational Technology & Society, 26(1), 16-30.