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Hearing on "China's Challenges and Capabilities in Educating and Training the Next Generation Workforce"

Panel III: The Role of Education in Promoting China's Strategic and Emerging Industries

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Co-Chairs Cleveland and Price, distinguished Commissioners and staff, thank you for the opportunity to testify on how China's education system strives to train a workforce for strategic and emerging industries. It is an honor to be here alongside esteemed experts on this panel. I will detail how China is using a slate of centralized plans to develop its artificial intelligence (AI) education system and assess the effectiveness of measures responding to these plans, which includes the Ministry of Education's work to standardize an AI major across 440 universities, along with the launch of more than 50 university AI institutes. I will close with some of the risks that these developments pose to the United States and provide here a set of four recommendations for how the United States can boost its own AI talent competitiveness. These recommendations are:

1. Starting at the secondary school level, U.S. education should evolve its focus from computer science education to additionally incorporate AI, and increase partnerships with industry to bring expertise into the classroom.

2. The National Institute of Standards and Technology (NIST) should work with U.S. industry to establish standards for AI and AI-related certifications, similar to the process it coordinated for cyber education.[1]

3. The Office of Personnel Management (OPM) should establish hiring criteria for federal AI and AI-adjacent jobs that are based on portfolios of work and certifications.

4. Congress should authorize increased funding to the National Science Foundation's (NSF) Innovative Technology Experiences for Students and Teachers (ITEST). ITEST should increase the number of AI education initiatives to develop K-12 students' interest in relevant career paths.

[1] Diana Gehlhaus, Luke Koslosky, Kayla Goode, and Claire Perkins, "U.S. AI Workforce: Policy Recommendations" (Center for Security and Emerging Technology, October 2021), https://cset.georgetown.edu/wp-content/uploads/CSET-U.S.-AI-Workforce-Policy-Recommendations.pdf.

China's Strategic Approach to AI

China's prioritization of, and progress in, AI has raised concerns in the United States and beyond—and rightly so, for several reasons. Key national security considerations include that this may further advance China's military-civil fusion (MCF) efforts, which could threaten U.S. national security if these efforts increase Chinese military competitiveness. The United States has been particularly concerned about the risks posed by the People's Liberation Army's (PLA) increasing prioritization and purchases of AI-enabled military technology, which China has stated it intends to use to gain "asymmetric advantages" (非对称) in a potential conflict with the United States.[2] Additionally, China's advancements in technologies including computer vision and voice recognition have led to mass AI surveillance of Uyghurs, Tibetans, and indeed anyone within China's borders, including foreigners.[3]

AI talent is the core driver of China's AI progress. The United States must thoroughly understand this landscape in order to lead in AI workforce competitiveness, and to nurture and retain the world's best and brightest.

The Chinese Party-state's strategic approaches to AI technology and industry are laid out in key documents including, but not limited to:

- National 13th Five-Year Plan for the Development of Strategic Emerging Industries (2016–2020, 十三五"国家战略性新兴产业发展规划)
- July 2017 New Generation AI Development Plan (AIDP, 新一代人工智能发展规划)
- 14th Five-Year Plan (2021–2025, 中华人民共和国国民经济和社会发展第十四个五年规划纲要).[4]

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[2] Ryan Fedasiuk, Jennifer Melot, and Ben Murphy, "Harnessed Lightning" (Center for Security and Emerging Technology, October 2021), https://cset.georgetown.edu/publication/harnessed-lightning

[3] Dahlia Peterson, "Designing Alternatives to China's Repressive Surveillance State" (Center for Security and Emerging Technology, October 2020), https://cset.georgetown.edu/publication/designing-alternatives-to-chinas-repressive-surveillance-state; Conor Healy and Donald Maye, "Punishing Journalists PRC Province's Latest Mass Surveillance Project, Won by Neusoft Powered By Huawei," IPVM, November 29, 2021, https://ipvm.com/reports/henan-neusoft; Cate Cadell, "China harvests masses of data on Western targets, documents show," *The Washington Post*, December 31, 2021, https://www.washingtonpost.com/national-security/china-harvests-masses-of-data-on-western-targets-documents-show/2021/12/31/3981ce9c-538e-11ec-8927-c396fa861a71_story.html.

[4] Translations available at: Original CSET Translation of "National 13th Five-Year Plan for the Development of Strategic Emerging Industries," [国务院关于印发"十三五"国家战略性新兴产业发展规划的通知], Central People's Government of the People's Republic of China, November 29, 2016, https://cset.georgetown.edu/publication/national-13th-five-year-plan-for-the-development-of-strategic-emerging-industries; Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, "Full Translation: China's 'New Generation Artificial Intelligence Development Plan' (2017)," *New America*, August 1, 2017, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017; Original CSET translation of "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035," [中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要], Central People's

These documents emphasize the importance of AI to China's national competitiveness and socioeconomic development, and contain aspirational goals that are both qualitative and quantitative. Qualitative goals range from high level to more granular (e.g., becoming the world's "primary AI innovation center" by 2030 as well as prioritizing research in computer vision, human-computer interaction, and intelligent decision control). Quantitative goals laid out in the AIDP for 2020, 2025, and 2030 set targets for the size of AI's core industry as well as the scale of related industries.

Within these strategic plans, the Chinese government explicitly highlights the key role that talent plays in supporting its AI techno-industrial ambitions. For example, the AIDP called for implementing AI training at every level of education, applying AI across all education levels, training a new generation of AI talent, and constructing an AI discipline through the establishment of an AI major and AI institutes.[5] Today, China's AI education starts early at the primary school level, and since 2018, the Ministry of Education has mandated AI to be part of high school information technology curricula.[6] Further goals include understanding AI safety and security, and an emphasis on AI ethics. There is also a distinct emphasis on "learning to abide by relevant laws," which could shape students learning about AI in ways that are most amenable to the Party-state's needs.

Several policies and initiatives that have emerged after the AIDP have been key to AI education implementation. These include, but are not limited to:

- Ministry of Education (April 2018): AI Innovation Action Plan for Colleges and Universities (高等学校人工智能创新行动计划)
- Ministry of Education, National Development and Reform Commission, and the Ministry of Finance (January 2020): Several Opinions on Using "Double First Class" Universities to Promote Disciplinary Integration and Accelerate Training of Graduate Students in the Field of Artificial Intelligence (关于"双一流"建设高校促进学科融合 加快人工智能领域研究生培养的若干意见)

Government of the People's Republic of China, March 12, 2021, https://cset.georgetown.edu/publication/china-14th-five-year-plan.

[5] State Council of the People's Republic of China, "The New Generation Artificial Intelligence Development Plan" [新一代人工智能发展规划], July 8, 2017, https://web.archive.org/web/20170721053549/http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm; translated by Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, "Full Translation: China's 'New Generation Artificial Intelligence Development Plan' (2017)," *New America*, August 1, 2017, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017.

[6] Dahlia Peterson, Kayla Goode, and Diana Gehlhaus, "AI Education in China and the United States" (Center for Security and Emerging Technology, September 2021), https://cset.georgetown.edu/wp-content/uploads/CSET-AI-Education-in-China-and-the-United-States-1.pdf; Chinese Ministry of Education, "The Ministry of Education Issues the 'General High School Curriculum Program and Curriculum Standards for Chinese Language, etc. (2017 Edition)" [教育部关于印发《普通高中课程方案和语文等学科课程标准（2017年版）》的 通知], December 29, 2017, https://archive.ph/RirvZ.

The "AI Innovation Action Plan" called for several goals to be met by 2020, such as the launch of 50 AI research centers or institutes, and the creation of 100 "AI+x" majors.[7] The AIDP defines the inherently interdisciplinary "AI+x" model as one that is designed to cross integrate professional education for AI plus another subject (the "x"), including mathematics, computer science, physics, biology, psychology, sociology, law, and other disciplines."[8] This demonstrates China's desire to incorporate non-STEM field perspectives to form a more holistic approach to AI education. As detailed below, my research shows that China may have exceeded both of these goals: China has launched more than 50 AI institutes, and 440 universities offer a standardized AI major; however, it is unclear how many of these universities explicitly incorporate the interdisciplinary "AI+x" approach.

The "Accelerate Training of Graduate Students" plan calls for increasing the number of graduate students studying AI, especially at the doctoral level, by using the "Double First Class University" (双一流大学) initiative. This is a 2017 program under Xi Jinping that superseded previous reforms such as Projects 211 and 985 to create "world-class" universities and leading "first-class" disciplines.[9] The "Double First Class" plan was updated in February 2022 to bring the tally to 147 universities.[10] The "Accelerate Training of Graduate Students" plan furthermore stated that AI will be incorporated into the "Special Enrollment Plan for the Cultivation of High-

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[7] Chinese Ministry of Education, "AI Innovation Action Plan for Institutes of Higher Education" [高等学校人工智能创新行动计划], April 2, 2018, https://web.archive.org/web/20180420032740/http://www.moe.gov.cn/srcsite/A16/s7062/201804/t20180410_332722.html. Full CSET translation available at: Original CSET Translation of "AI Innovation Action Plan for Institutions of Higher Education", [教育部关于印发《高等学校人工智能创新行动计划》的通知], Ministry of Education, April 2, 2018,https://cset.georgetown.edu/wp-content/uploads/Notice-of-the-Ministry-of-Education-on-Issuing-the-Artificial-Intelligence-Innovation-Action-Plan-for-Institutes-of-Higher-Education.pdf
See an MOE "interpretation" document: Chinese Ministry of Education, "The Ministry of Education Interprets the "AI Innovation Action Plan for Institutions of Higher Education" [教育部解读《高等学校人工智能创新行动计划》], June 8, 2018, https://web.archive.org/web/20180712013232/http://www.moe.gov.cn/jyb_xwfb/xw_fbh/moe_2069/xwfbh_2018n/xwfb_20180608/mtbd/201806/t20180611_339062.html.

[8] State Council of the People's Republic of China, "The New Generation Artificial Intelligence Development Plan" [新一代人工智能发展规划], July 8, 2017, https://web.archive.org/web/20170721053549/http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm; translated by Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, "Full Translation: China's 'New Generation Artificial Intelligence Development Plan' (2017)," *New America*, August 1, 2017, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017.

[9] Dahlia Peterson, Kayla Goode, and Diana Gehlhaus, "AI Education in China and the United States" (Center for Security and Emerging Technology, September 2021), https://cset.georgetown.edu/wp-content/uploads/CSET-AI-Education-in-China-and-the-United-States-1.pdf.

[10] Zou Shuo, "'World-class' universities list expanded," *China Daily*, February 15, 2022, https://perma.cc/2349-EYP4; full updated list and the key disciplines available here: Chinese Ministry of Education, "List of Higher Education Institutions and Key Disciplines for the Second Round of "Double-First Class" [第二轮"双一流"建设高校及建设学科名单], 2022, https://perma.cc/K7Q9-ZA7L.

level Talents in Key Fields Urgently Needed by the State" (国家关键领域急需高层次人才培养专项招生计划).[11]

Additionally, the "Accelerate Training of Graduate Students" plan places a strong emphasis on partnering with industry, stating that university-industry partnerships are "highly encouraged."[12] It proposes a revolving door between industry and academia, asking that leading AI companies train university instructors in the latest cutting edge methods, and allowing company researchers to have "double employment" at universities. It places an emphasis on going beyond the theoretical and preparing talent to advance AI industry progress by asking AI companies to train graduate students and design "scenario-driven, application-oriented" courses that focus on solving industry needs. Training can include joint construction of projects through industry alliances, creation of joint R&D labs, entrepreneurship and skills competitions, and certification trainings.

Assessment of AI Education Initiatives

In response to these plans, the Ministry of Education (MOE) standardized an AI major in 2019.[13] Figure 1 in the Appendix shows the numbers of majors approved each year, which as of 2022 stands at 440 universities. This includes all of the Ivy League-equivalent C9 League (as identified by the Chinese government in 2009), as well as all of the Seven Sons of National Defense. The Seven Sons are universities directly supervised by the Ministry of Industry and Information Technology (MIIT), and their core mission is to support China's defense research and military-civil fusion.[14]

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[11] Chinese Ministry of Education, National Development and Reform Commission, and Ministry of Finance, "Certain Opinions on Promoting Curricula Merging at "Double World-Class" Institutes of Higher Education and on Accelerating the Cultivation of Graduate Students in the AI Field" [关于"双一流"建设高校促进学科融合加快人工智能领域研究生培养的若干意见,]January 21, 2020, https://archive.vn/f7iGx; full CSET translation available at: Original CSET Translation of "Notice on the Publication of "Certain Opinions on Promoting Curricula Merging at 'Double World-Class' Institutes of Higher Education and on Accelerating the Cultivation of Graduate Students in the AI Field" by the Ministry of Education, the National Development and Reform Commission, and the Ministry of Finance" [教育部 国家发展改革委 财政部印发《关于"双一流"建设高校促进学科融合 加快人工智能领域研究生培养的若干意见》的通知], The PRC Ministry of Education (教育部), National Development and Reform Commission (NDRC; 国家发展和改革委员会; 发展改革委; 发改委), and Ministry of Finance (财政部), January 21, 2020, https://cset.georgetown.edu/publication/notice-on-the-publication-of-certain-opinions-on-promoting-curricula-merging-at-double-world-class-institutes-of-higher-education-and-on-accelerating-the-cultivation-of-graduate-students-in-the.

[12] Ibid.

[13] Dahlia Peterson, Kayla Goode, and Diana Gehlhaus, "AI Education in China and the United States" (Center for Security and Emerging Technology, September 2021), https://cset.georgetown.edu/wp-content/uploads/CSET-AI-Education-in-China-and-the-United-States-1.pdf.

[14] The Seven Sons include the Beijing Institute of Technology, Beijing University of Aeronautics and Astronautics (Beihang), the Harbin Institute of Technology, Harbin Engineering University, Northwestern Polytechnical University, Nanjing University of Aeronautics and Astronautics and Nanjing University of Science and Technology.

The fact that all Seven Sons have the AI major is notable given their defense-focused mission. The aforementioned "Double First Class" plan is designed to further mesh these seven universities into the military-civil fusion R&D pipeline, and therefore originate innovations—including in AI—that help both the military and civilian sectors.[15] Further, all of the Seven Sons universities offer the AI major, and about half have AI institutes. Previous CSET research has found that three-fourths of graduates recruited by Chinese defense state-owned enterprises are from the Seven Sons, raising concerns that those equipped with AI skills and capabilities are directly entering the defense workforce.[16] CSET research headed for publication later this year has found that the PLA and defense-affiliated universities are also actively seeking technical AI talent through Chinese job posting boards.

China also exceeded its goal of having at least 50 AI institutes. My non-exhaustive, ongoing tally currently includes 18 AI research institutes (人工智能研究院) and 36 AI colleges (人工智能学院), with four universities hosting both. Research institutes include a mix of talent training, basic research, and applied research for direct industry applications, while AI colleges are more focused on education than research. Slightly over half of the 36 AI colleges offer the AI major, otherwise they offer majors that are AI-adjacent, such as Data Science and Big Data Technology.

In terms of quality, there is a high representation of AI majors, AI institutes, or both, at China's elite universities. Elite universities include the Double First Class universities, the Seven Sons of National Defense, and the C9 League. However, with a few exceptions (such as Peking University), the 95 institutions that added the AI major in 2022 were mainly lower tier, including multiple vocational colleges in rural areas. While this could expand China's AI talent pipeline, it also runs the risk that China's centralized push could lead to widespread integration of AI education, but with poorly designed curricula and insufficient instructional resources. This risk is especially pronounced in under-resourced areas, which could produce underwhelming results.

CSET research has shown that China's STEM education system has been very effective in producing a large number of PhD graduates, while the quality of PhD education is steadily improving.[17] The quantity of such graduates is especially stark when compared to the lower number of STEM PhDs produced by the United States. By 2025, CSET projects that Chinese universities will produce over 77,000 STEM PhD graduates yearly, versus approximately 40,000 in the United States.[18]

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[15] Audrey Fritz, "How China's military–civil fusion policy ties into its push for world-class universities," The Strategist (blog) on Australian Strategic Policy Institute, May 19, 2021, https://www.aspistrategist.org.au/how-chinas-militarycivil-fusion-policy-ties-into-its-push-for-world-class-universities.

[16] Ryan Fedasiuk and Emily Weinstein, "Universities and the Chinese Defense Technology Workforce" (Center for Security and Emerging Technology, December 2020), https://cset.georgetown.edu/wpcontent/uploads/CSET-Universities-and-the-Chinese-Defense-TechnologyWorkforce-1.pdf.

[17] Remco Zwetsloot, Jack Corrigan, Emily Weinstein, Dahlia Peterson, Diana Gehlhaus, and Ryan Fedasiuk, "China is Fast Outpacing U.S. STEM PhD Growth" (Center for Security and Emerging Technology, August 2021), https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth.

[18] Remco Zwetsloot, Jack Corrigan, Emily Weinstein, Dahlia Peterson, Diana Gehlhaus, and Ryan Fedasiuk, "China is Fast Outpacing U.S. STEM PhD Growth" (Center for Security and Emerging Technology, August 2021), https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth.

For AI education specifically, the undergraduate AI major itself may be too new to concretely measure whether or not it is adequately plugging up workforce shortages, since the 35 programs approved in 2019 will only begin graduating students later this spring, and enrollment numbers for these programs are often neither publicized nor broken out in official education statistics. It is worth noting that beyond the AI major, there are 34 other majors created between 2016–2021 that involve "intelligence" (智能) across engineering, agriculture, and medical fields—these may also help to plug AI workforce gaps.[19]

How autonomous are universities?

In developing China's AI talent, the influence of government policy has been paramount in setting standardized high school and undergraduate AI curricula. However, universities do possess some autonomy in shaping the content of their AI research. Accordingly, China's AI education is most influenced by three factors. Ranked in order of importance, these are government policy, universities' access to talent and know-how—from both their own professors' expertise and the AI companies with which they have partnerships and talent exchanges—and lastly, student demand.

First, in terms of government policy, the State Council calling for their establishment in the AIDP formed the catalyst for their widespread adoption nationwide. Indeed, it is commonplace to find university AI institute websites mentioning the AIDP and the "AI Innovation Action Plan" as reasons for their creation.[20] Only a few universities had AI programs and institutes prior to the "AI Innovation Action Plan" and the AIDP.

Likewise, since the AI major is a standardized engineering major approved by the MOE under the code 080717T, there are certain curricula designs and learning objectives built into the major. A Chinese AI company called KXCY AI working with several elite Chinese universities suggests that the AI major's goals are to meet national economic and technological development needs, develop knowledge of basic AI theories, and learn R&D skills, among others.[21] Furthermore, colleges and universities with existing AI programs were encouraged by the MOE in 2018 to expand their scope to establish "AI+x" majors.[22]

Second, while universities primarily launched university AI institutes and applied to the MOE to offer the AI major due to central government AI policies, institutes are slightly more operationally independent compared to the AI major. This is because the major has more set

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[19] "Beyond the hype, what is the true potential of AI-type majors?" [热度背后，人工智能类专业究竟前景如何？] Gathering Intelligence Community (blog) [集智社群], August 25, 2022, https://perma.cc/2NZ2-868R.

[20] Example from Dalian University of Technology's School of AI (focused on graduate research) at "About Our Institute" ["学院概况], Dalian University of Technology, https://perma.cc/V4SD-EMF6.

[21] "Learning path and talent training model for AI major (080717T)" [人工智能专业（080717T）学习路径及人才培养模型], 广州跨象乘云软件技术 [Guangzhou Kuaxiang Chengyun Software Technology], January 25, 2020, https://archive.ph/8Hpo0.

[22] Xiaozhe Yang, "Accelerated Move for AI Education in China," ECNU Review of Education 2, no. 3 (September 2019).

curriculum building blocks, as it is MOE-approved, whereas institutes pursue avenues of AI research largely based on staff and academic expertise. Another influencing factor is partnerships with industry. While it is possible that university-industry partnerships are formed because they are "highly encouraged" in plans such as "Accelerate Training of Graduate Students," the companies' areas of expertise can significantly drive the content of those collaborations.

For example, voice recognition giant iFLYTEK—which is on the U.S. Entity List for human rights violations in Xinjiang—has partnered with public colleges and universities to launch several AI colleges across China. They include Chongqing University of Posts and Telecommunications (CUPT), Chongqing Technology and Business University, a vocational college in Chongqing, and an AI translation-focused institute at the Chongqing Nanfang Translation College Sichuan International Studies University.[23] Students are able to work directly with engineers on iFLYTEK's voice recognition projects.

Third, student demand could be another less influential driver, but this is less explicitly measurable as a reason for why universities create institutes or apply to the MOE to offer the AI major. One indicator is that students (and parents) have seen how AI development has taken China by storm. Accordingly, it has been the most popular AI major since 2020.[24]

Ongoing Challenges

Ongoing talent shortages are commonly reported by Chinese ministries, universities, companies, and other sources in critical AI and AI-adjacent areas such as AI R&D, semiconductors, and cybersecurity. Articles and reports cite employer surveys and the large numbers of unfilled vacancies in these fields, similar to in the United States.[25]

China's government ministries are aware of domestic talent supply shortages, and have quantified them. In 2020, China's Ministry of Human Resources and Social Security (MOHRSS)

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[23] "My A.I. Chongqing: iFLYTEK's Mountain City Covenant" [我A.I.重庆：科大讯飞的山城之约], iFLYTEK, September 14, 2020, https://perma.cc/TK82-6VAM The CUPT-iFLYTEK AI college was launched in 2018, with expected enrollment of 1,200 undergraduate students and 900 graduate students by 2020. See "Chongqing Morning Post: CUPT and iFLYTEK jointly established the School of Artificial Intelligence" [重庆晨报：重邮、科大讯飞联合成立人工智能学院], February 8, 2018, https://perma.cc/N3MA-S2S2.

[24] Zou Shuo, "AI now most favored major at universities," *China Daily*, March 3, 2021, https://archive.ph/jKNYz.

[25] See "China's top talent trends for 2020: tech innovation to drive job market," Hays, https://www.hayschina.cn/en/press-release/content/-2020-?s=d3d3LmhheXMuY24=; A. J. Cortese, "China's Tech Pivot (Part II): STEM Talent Shortage Stymies Core Innovation?" Macro Polo, May 10, 2022, https://macropolo.org/chinas-tech-pivot-stem-talent-shortage; China Information Security Evaluation Center (中国信息安全测评中心), "Research Report on the Status of China's Information Security Professionals (2018–2019)" (中国信息安全从业人员现状调研报告 [2018- 2019] 年度)," translated by CSET at: Original CSET Translation of "Research Report on the Status of China's Information Security Professionals (2018-2019)" [中国信息安全从业人员现状调研报告（2018-2019年度）], China Information Technology Security Evaluation Center , September 6, 2019, https://cset.georgetown.edu/publication/research-report-on-the-status-of-chinas-information-security-professionals-2018-2019.

released a report that quantified an AI talent gap of more than 5 million workers, with a domestic supply/demand ratio of 1:10 (0.1), meaning there is only one person for every 10 openings for AI engineers and technicians.[26] This talent is defined by MOHRSS as "engineering and technical personnel engaged in the analysis, research and development of artificial intelligence–related algorithms, deep learning and other technologies, and design, optimization, operation and maintenance, management and application of artificial intelligence systems."[27] That report also stated that if talent development is not strengthened, the talent gap will exceed 10 million by 2025.

Another 2020 report, from China's Ministry of Industry and Information Technology's (MIIT) Talent Exchange Center, used internally collected data and data from the Chinese jobs platform BOSS (直聘, or Zhipin) to look specifically at the supply/demand ratios for AI-specific positions. It defined critical shortages as anything less than 0.4, or fewer than 4 people per 10 jobs available.[28] They found shortages across the board. This included ratios of 0.37 for AI chip engineers, 0.23 for machine learning engineers, 0.2 for natural language processing engineers, 0.13 in algorithm research positions and 0.17 in application development positions. In some fields this dipped below 0.1, with 0.09 for computer vision engineers and 0.08 for intelligent speech engineers. These latter statistics are particularly striking given Chinese companies' prominence in applications such as facial and voice recognition. Overall, these statistics help put into context why China is prioritizing plugging up these gaps with AI major programs and institutes.

Implications for the United States

CSET has found that by nature of the decentralized education system in the United States, compared to China this country does not have a uniform approach and is prioritizing computer science (CS) education.[29] While CS is an essential component of training talent with the knowledge, skills and abilities to potentially perform AI work, China has shown it is a step ahead through its incorporation of CS education into formalized AI study programs. These programs are designed to include some of the latest cutting edge AI research findings, and are directly informed by partnerships with leading Chinese AI companies.

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[26] Chinese Ministry of Human Resources and Social Security, "New Occupations — Analysis Report on Artificial Intelligence Engineers' Current Employment Status", [新职业—— 人工智能工程技术人员就业景气现状分析报告], April 30, 2020, https://archive.ph/Dvk4p.

[27] Ibid.

[28] Ministry of Industry and Information Technology Talent Exchange Center (工业和信息化部人才交流中 心), "Artificial Intelligence Industry Talent Development Report (2019-2020 Edition)" [人工智能产业人才发 展报告（2019-2020年版）], translated by the Center for Security and Emerging Technology (CSET) at https://cset.georgetown.edu/publication/artificial-intelligence-industry-talent-development-report-2019-2020-edition.

[29] Dahlia Peterson, Kayla Goode, and Diana Gehlhaus, "AI Education in China and the United States" (Center for Security and Emerging Technology, September 2021), https://cset.georgetown.edu/wp-content/uploads/CSET-AI-Education-in-China-and-the-United-States-1.pdf.

However, it is far from a foregone conclusion that China will "win" the race for AI talent. In fact, both countries face persistent structural challenges. These include the rural-urban divide, equitable access to quality AI education, and teacher quality.[30]

However, China also faces several unique structural issues that could impact its ability to compete in the longer term. These issues include an aging and now shrinking population due to declining birth rates from failed policies to boost births.[31] This may affect China's ability to produce STEM talent at its current high rate.

Furthermore, CSET research has shown that despite China's two decades of talent recruitment drives, nationals either do not return or do so part-time, mostly due to wariness of working in China and confronting its workplace politics.[32] A recent *Science* study found that for those that do return through the Youth Thousand Talents Plan (YTTP), recruits are of high caliber and show a productivity bump due to larger access to funding and research resources in China.[33] However, their performance is still outdone by top caliber scientists who chose to reject participation offers.[34]

Meanwhile, immigrant retention has been a core U.S. strength, with 91 percent of top Chinese students with U.S. AI doctorates still in the United States five years after graduating.[35] Long-term stay rates are also high: in 2017, about 77 percent of the international STEM PhDs from U.S. universities between 2000 and 2015 were still living in the United States.[36]

Amid ongoing strategic competition with China across dimensions including AI, the United States has several crucial opportunities to advance its own AI education and workforce pipelines. Incorporating AI education into existing CS initiatives while developing AI job competency and certification standards would add valuable clarity and direction to U.S. efforts.

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[30] Ibid.

[31] Alexandra Stevenson and Zixu Wang, "China's Population Falls, Heralding a Demographic Crisis," *The New York Times*, January 16, 2023, https://www.nytimes.com/2023/01/16/business/china-birth-rate.html

[32] Remco Zwetsloot and Dahlia Peterson, "The US-China Tech Wars: China's Immigration Disadvantage," The Diplomat, December 31, 2019, https://thediplomat.com/2019/12/the-us-china-tech-wars-chinas-immigrationdisadvantage.

[33] Dyani Lewis, "China's Thousand Talents Plan to entice researchers home boosted their output," *Nature*, January 5, 2023, https://www.nature.com/articles/d41586-023-00012-5; Dongbo Shi, Weichen Liu, and Yanbo Wang, "Has China's Young Thousand Talents program been successful in recruiting and nurturing top-caliber scientists?" *Science* 379, no. 6627 (January 2023): https://www.science.org/doi/10.1126/science.abq1218.

[34] Ibid.

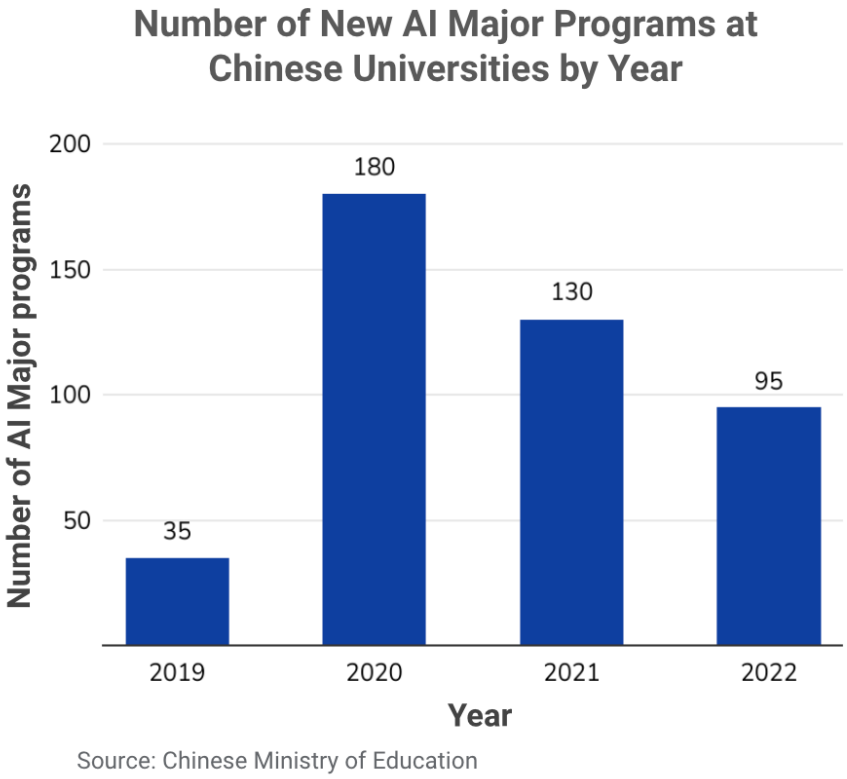
[35] Remco Zwetsloot, James Dunham, Zachary Arnold and Tina Huang, "Keeping Top AI Talent in the United States: Findings and Policy Options for International Graduate Student Retention" (Center for Security and Emerging Technology, December 2019), https://cset.georgetown.edu/wp-content/uploads/KeepingTop-AI-Talent-in-the-United-States.pdf.

[36] Jack Corrigan, James Dunham, and Remco Zwetsloot, "The Long-Term Stay Rates of International STEM PhD Graduates" (Center for Security and Emerging Technology, April 2022), https://cset.georgetown.edu/publication/the-long-term-stay-rates-of-international-stem-phd-graduates.

Thank you again for the opportunity to testify before the Commission on this important topic. I look forward to taking your questions.

Appendix

Figure 1: Number of AI Majors Offered Nationally, 2019–2022



Source: Chinese Ministry of Education
