CREATION AND DEVELOPMENT OF HUMAN RESOURCES IN THE ERA OF AI

— IMPLICATIONS FOR JAPAN FROM DOMESTIC AND INTERNATIONAL EXAMPLES —

Akiko Fujii
Foresight Center
Mitsui & Co. Global Strategic Studies Institute

SUMMARY

- Governments, educational institutions, and businesses around the world are reviewing how they educate and develop human resources, while launching new initiatives in preparation for the era of artificial intelligence (AI). The core competencies necessary in the era of AI are a) technical competency, b) critical thinking competency, and c) design competency.
- Education for developing these three competencies can be divided into four phases: (1) AI literacy education, (2) training human resources to use AI, (3) fostering top-level AI researchers and developers, and (4) upskilling generations that have not been educated about AI. In all phases, it is important to launch initiatives quickly and to correct course when necessary.
- Japan needs to expand its base of professionals who can use AI and avoid a talent shortage against the backdrop of the declining birthrate and aging population. Japanese companies should be involved in the above four phases of education through their businesses, donations, and policy recommendations.

1. CULTIVATING THE NECESSARY COMPETENCIES FOR THE ERA OF AI

There has been tremendous interest in the remarkable development of generative AI applications such as ChatGPT and Midjourney, which allow users to create text and images by simply typing in instructions. AI technology continues to evolve, with rapid advances in the accuracy of image recognition, speech recognition, and natural language processing (NLP).

It is said that the technological singularity—the point at which AI significantly surpasses human intelligence—will be reached by the 2040s. While there are high expectations for the increased convenience and other benefits that AI technology will bring, there is concern that jobs will be lost to AI.[1] In such an era, there is no clear answer to the question of what new skills employees should possess and how they can acquire them. In this paper, the age in which the use of AI technology becomes commonplace is called the "era of AI." With reference to examples in Japan and overseas, the paper discusses the nature of human resource development required in the era of AI and the approaches taken by companies.

[1] The Future of Employment, a 2013 paper by then-associate professor Michael A. Osborne et al. at Oxford University, predicted that in 20 years, about 47% of jobs in the US may disappear, having been replaced by computerization. A subsequent joint study by the same team and the Nomura Research Institute (2015) was applied to the Japanese labor environment, and the results shocked Japanese society by announcing the prospect of 49% of jobs in Japan disappearing. In a March 2023 paper, OpenAI indicated that 80% of the US workforce could have at least 10% of their work tasks affected by large language models (LLMs), and that 19% of workers will have at least 50% of their tasks affected. That month, Goldman Sachs announced that 300 million workers worldwide are at risk of unemployment as a result of generative AI.

1-1. Awareness of the issues

AI technology drives the growth of nations and businesses while enhancing their competitiveness through the automation and acceleration of identification and predictive analysis tasks.[2] People who understand and can successfully use AI technology are becoming more essential for nations and businesses. As a result, traditional education methods can become obsolete, and so new approaches are being introduced around the world.

1-2. What are the core competencies in the era of AI?

What competencies will be important in the era of AI? Based on prior studies[3], the core competencies can be classified into three categories: a) technical competency, b) critical thinking competency, and c) design competency.

Technical competency is the ability to understand and use technology. Specifically, it refers to knowledge and skills in mathematics, data science, and AI technologies.

Critical thinking competency includes the uniquely human attributes of creativity, empathy for others, resourcefulness, and ethical value judgment. It is unclear how far the technology will advance in the future, but at this point, it is difficult to replace these skills with AI. When it comes to processing data, humans are inferior to AI, but overall intelligence is not determined by processing volume or speed alone.

Design competency means being able to design new forms of society, as well as new products and services. With the emergence of tools that enable no-code and low-code[4] development and operation, sense and imagination with respect to how to use AI technology will become increasingly important.[5]

2. EDUCATIONAL PHASES FOR COMPETENCIES NEEDED IN THE ERA OF AI

This paper categorizes the educational phases of core competencies in the era of AI into (1) AI literacy education, (2) training human resources to use AI, (3) fostering top-level AI researchers and developers, and (4) upskilling generations that have not been educated about AI, and outlines some examples from Japan and overseas.

2-1. AI literacy education

AI literacy education develops the foundational skills that will be essential in the era of AI. Estonia, which is renowned as a digitally advanced country, has a history of over 10 years of digital education in schools. The country also incorporates digital technology topics and elements into traditional subjects such as language, mathematics, and the arts to help students understand the connection between society and technology. The US and Canada are notable in that universities, educational institutions, and private companies have collaborated to establish non-profit organizations to develop curricula for learning the skills and knowledge needed to use AI technologies.[6]

In Japan, programming was made compulsory in elementary schools in the academic year 2020 and in junior

---

[2] PwC estimates that AI technology will boost global GDP by 14% ("Sizing the Prize," June 2017), while Goldman Sachs estimates a 7% boost ("The Potentially Large Effects of Artificial Intelligence on Economic Growth," March 2023).

[3] See, for example, Matthias Carl Laupichler et al., "Artificial intelligence literacy in higher and adult education: A scoping literature review," *Computers and Education: Artificial Intelligence*, Volume 3, 2022.

[4] No-code refers to tools and environments that can be developed and used through screen design alone and without writing program code (instructions for the computer to execute), while low-code refers to the same that require a small amount of coding.

[5] Shane Gu, OpenAI's representative in Japan, notes that Japan has lagged behind the rest of the world in the field of AI research and development, but since AI has advanced to the stage where it can be used by ordinary people as well as experts, Japan has the potential to leapfrog other countries in the areas of application and UX design (design that enhances user convenience and comfort) due to the strengths of Japan, such as a refined esthetic sense and artisan's attention to detail (NewsPicks, "Generative AI 'ChatGPT' and New Possibilities for Japan" [in Japanese], published February 1, 2023).

[6] In the US, non-profit organizations are active such as AI4All, which runs a summer program to teach AI to minority students, and AI for K-12, where college professors lead in creating and publishing curricula and other resources online to teach AI technology to elementary, middle, and high school students.

high schools in 2021. "Information" as a compulsory subject was introduced in high schools in 2022 and will be included in the Common Test for University Admissions in 2025. Knowledge about AI will also be taught in these subjects.

In Finland[7], Singapore[8], India[9], and elsewhere, the governments are providing AI literacy resources for the entire population, regardless of age. In terms of AI literacy, since children will be educated in the future, there have been views such as *"the kids will be alright. It's the adults we need to worry about"*[10]. Lifelong learning is a response to this concern.

2-2. Training human resources to use AI

In training human resources to use AI, it is important to reflect the actual needs of businesses to avoid a mismatch between the skills demanded by the labor market and those taught in the educational process. Germany and Austria have an excellent system of vocational education and training (VET) in this regard: the dual system combines on-the-job training in a company for two or three days a week with school attendance the rest of the time.

In Japan, technical colleges are likely to be the key to AI-related human resource development.[11] About 10,000 students nationwide enroll in these colleges each year, and it is now common for students to learn the basics of AI technology even if they are majoring in areas other than information engineering, such as mechanical, electrical, or electronic engineering. Meanwhile, some universities are beginning to encourage students to minor in AI and data science. Unlike overseas, curriculum structures incorporating majors and minors used not to be common in Japanese universities. Since the Japanese government revised the law in 2019 to clarify minors at universities, more Japanese universities have introduced a major/minor system. Also, the number of female students majoring in AI technology and data science has tended to be low. Recently, however, to train women who can play an active role in growth fields, a number of AI and data science related departments have been established at women's colleges and universities.

2-3. Fostering top-level AI researchers and developers

The US, China, the UK, and other European countries are leaders in AI research and development in terms of quality and quantity.[12] These countries are also home to prestigious schools that produce highly skilled AI experts. In the UK, it was noted that there was insufficient university and graduate school capacity for the number of students who want to study AI technology[13]. In response, government and industry funds[14] were used to add AI master's degree programs at several universities in the country starting in 2019. In China and the US

---

[7] The Finnish government commissioned a startup to create a course called Elements of AI, initially for the public and now available on the web for free. This is also used in middle and high school classes. Upon completion, students can receive credits from the University of Helsinki.

[8] Singapore offers the basic "AI for Everyone" and the applied "AI for Industry" courses to its citizens. The latter is subject to a fee but is subsidized (Singapore Economic Development Board, "Two new AI education initiatives to train 12,000 AI professionals over the next three years" [in Japanese], October 21, 2018).

[9] AI for All is a four-hour, multilingual Indian adaptation of Intel's AI for Citizens course.

[10] Melissa Heikkilä, "AI literacy might be ChatGPT's biggest lesson for schools," *MIT Technology Review*, April 12, 2023.

[11] Yutaka Matsuo, Professor of the Graduate School of Engineering of the University of Tokyo, expressed hope saying that it is beneficial to have technical colleges spread throughout Japan, as there are many excellent hardware manufacturers in different regions, as well as globally recognized niche companies that need AI human resources. He believes that this form of regional development could be advantageous, suggesting that if technical college students established companies and collaborated with local businesses, venture capital would flow in from Tokyo ("Technical college students are Japan's treasure and have the strength to drive the AI era" [in Japanese], *The Nikkei*, November 15, 2018). Professor Matsuo conceived the Japan technical college Deep Learning Contest (DCON) in 2019, and the event has since been held annually with the cooperation of many sponsors.

[12] In "Who Is Winning the AI Race: China, the EU, or the United States?" January 25, 2021, Daniel Castro and Michael McLaughlin note that while India, Israel, and Australia have made significant AI-related progress, the US, China, the UK, and other European countries have the overall advantage in terms of talent, research, enterprise development, adoption, data, and hardware.

[13] Department for Business, Energy and Industrial Strategy et al., "Industrial Strategy: Artificial Intelligence Sector Deal," last updated May 21, 2019, p.26.

[14] Eleven companies including DeepMind, QuantumBlack, Cisco, BAE Systems, and Cambridge Consultants.

as well, new AI-related academic faculties and programs are being established one after another.

As described above, outside of Japan, the issue is the shortage of education providers for students who want to study AI technology. In contrast, the challenge in Japan is to increase the number of students who wish to study advanced AI technologies, given the low percentage of students majoring in STEM fields[15] compared to other countries.

Germany is focusing on the use of AI technology in industry, recognizing the strength of the US and China in the application of AI technology for consumer products[16]. For Japan, with limited human and financial resources, a key strategy may be to use AI technology to further enhance the areas in which it is already strong, such as manufacturing and medicine.

2-4. Upskilling generations that have not been educated about AI

In-house upskilling is a typical example of retraining for generations that have not been educated about AI. Outside of Japan, AI-related in-house retraining is active not only at IT firms but also in non-IT firms such as Levi Strauss and Walmart. There is a growing view that spending on internal training leads to a greater reduction in overall costs than hiring people with digital skills from outside the company.[17] In Japan, the introduction of in-house retraining for digital literacy, including AI technology, is also progressing, but relatively limited to major IT firms such as Hitachi, Toshiba, Canon, NTT DATA, and Yahoo Japan.

However, for the extended employment of older workers in the future, it is necessary to engage in retraining regardless of company size or industry sector. Specifically, one urgent task is to transform existing human resources into those with AI literacy, who can easily use AI tools and discuss AI-related issues with younger personnel who have been educated about AI. This applies to “prompt” engineering, for example (the instructions given to a generative AI are called “prompts”). The way the prompt is phrased can affect the quality of the AI’s output. For this reason, acquiring the skills and know-how to write effective prompts is becoming increasingly important. Learning prompt engineering has a lower barrier to entry compared to learning programming from scratch. The retraining of generations without AI education should be designed by considering their difficulties and reluctance, and by identifying the technical competencies that must be strengthened.

3. CONCLUSION

Under the AI Strategy 2019, the Japanese government has set the goal of having all elementary, middle, and high school students become literate in mathematics, data science, and AI by the academic year 2025, and developing approximately 2,000 experts per year (including approximately 100 top-class personnel per year) who excel in AI technology. Time will tell how these efforts play out, but with corporate support, more effective human resource development can be accomplished.

In light of the educational phases that have been classified in this paper, it is easy to see why companies should be involved in (4) upskilling generations that have not been educated about AI. Retraining employees is expected to improve business performance through company-wide operational efficiency and automation, make effective use of existing human resources through reassignment, and increase motivation. It can also attract excellent new staff by improving the company’s social reputation. However, Japanese companies should not ignore (1) AI literacy education, (2) training human resources to use AI, and (3) fostering top-level AI researchers and developers. This is due to society’s need to increase the number of people familiar with AI technology and

[15] Science, Technology, Engineering, and Mathematics.
[16] Gerd Mischler, “KI für Industrie: Deutschland riskiert seine Führungsrolle,” December 10, 2019.
[17] For example, Gallup estimates that the cost of replacing an individual employee ranges from 0.5 to 2 times the employee’s annual salary (Shane Mcfeely and Ben Wigert, “This Fixable Problem Costs U.S. Businesses $1 Trillion,” March 13, 2019).

prevent talent shortage in the face of the declining birthrate and aging population.

Specific measures with regard to (1) include direct involvement in and advice on curricula in cooperation with governments and educational institutions, corporate-sponsored courses[18], and expanding market opportunities for the development and sale of educational materials[19]. Possible approaches to (2) and (3) include collaboration with technical colleges, universities, and other learning institutions, as well as human and financial assistance[20]. In addition, it is important to communicate requests and recommendations to the government and educational institutions in order to develop the human resources needed by industry.

Finally, the figure below illustrates the points that are particularly essential for Japan in creating and nurturing human resources in the era of AI, based mainly on the examples presented in this report. AI technology is constantly evolving, and it will be necessary to correct course through trial and error. These points will be instructive for companies as they get involved in the field of AI.

Figure: Key points for the creation and development of human resources in the era of AI

	a) Technical competency	b) Critical thinking competency	c) Design competency
(1) AI literacy	Encouraging interest in (rather than aversion to) algorithms, programming, etc. (using robotics resources, games, etc.)	Understanding the benefits and risks of AI technology and developing creative thinking to solve social problems using technology	Demonstrating the connection between social issues and AI technology (e.g., interweaving AI-related topics and elements across disciplines)
(2) Human resources who use AI	Developing as many people as possible who understand AI technology beyond their primary expertise	Enhancing liberal arts education to develop human resources who can think across disciplinary boundaries in the use of AI technology	Increasing opportunities to gain insight into real-world business needs (on-the-job training and internships)
(3) Top-level AI researchers and developers	Applying AI research to areas where Japan has strengths and conducting research and development in these areas (e.g., manufacturing and medicine)	Fostering the ability to anticipate the purpose, use, consequences, and emerging issues of AI development, while looking ahead to the future and maintaining an ethical perspective	Improving the understanding of user and business perspectives while maintaining a high level of technical competence
(4) Upskilling existing workforce	Using no-code, low-code, prompt engineering, etc., to eliminate resistance	Improvement of decision-making skills in assessing AI technology and humans to determine their respective strengths and appropriate roles, and the creative thinking to make the most of each	Existing experienced personnel can discuss AI with the newly educated younger generation in a common language.

Source: Compiled by MGSSI

[18] As an example, Murata Manufacturing has been delivering lessons in STEAM fields (STEM plus Arts) to elementary and junior high school students in the vicinity of its offices.

[19] For example, WAO Corporation, a nationwide operator of preparatory and cram schools, provides programming classes using Sony Global Education's KOOV robot programming resources.

[20] For instance, chaired by the president of Sansan, a technical college named the Kamiyama Educational Institute opened in April 2023 in Tokushima Prefecture, having secured seed funding and a scholarship fund from corporate donations. Companies are increasingly turning to technical colleges that produce industry-ready technical experts.