

## STRATEGIC MODELS AND HUMAN RESOURCE CHALLENGES IN GLOBAL K–12 AI EDUCATION

**Márk Kovács**

*Center for Teaching Methodologies and Innovation, University of Pannonia (Hungary)*

### Abstract

AI education has evolved into a global necessity, extending beyond the mere classroom use of AI tools to the integration of AI literacy within K–12 curricula. In this comparative educational policy analysis, we identify four distinct adaptation models currently shaping AI education globally. (1) The Centralized Innovation Model (China) pursues technological leadership and sovereignty. While plans mandate compulsory AI education across all grades by 2025, significant regional disparities in quality persist. (2) The Pragmatic Technocratic Model (e.g., Singapore, South Korea) prioritizes economic efficiency and a “smart society” vision. Here, AI functions as both curricular content and infrastructure (Singapore) or as a dimension of digital literacy (South Korea). (3) The Decentralized Market Model (US, UK) is grounded in institutional autonomy and industry–academia collaboration. Although this facilitates rapid adaptation, the lack of central coordination can exacerbate social inequities in resource-scarce regions. (4) The Humanistic–Civic Model (EU) foregrounds regulation and ethical frameworks, though excessive regulation risks stifling innovation. Across all models, the shortage of appropriately trained teachers constitutes a critical implementation challenge. The uneven distribution of pedagogical support risks creating a new digital divide. While teacher preparedness is a pivotal variable, top-down reforms often provoke resistance, potentially undermining implementation. We conclude that integrating AI into K–12 education is not merely a curricular or technological task, but fundamentally a human resource management challenge.

**Keywords:** *Artificial Intelligence, elementary secondary education, digital literacy, digital divide, teacher shortage.*

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### 1. Introduction

In the third decade of the 21st century, education systems worldwide are facing an unprecedented challenge: the explosive social diffusion of artificial intelligence (AI), particularly generative artificial intelligence. This process is unprecedented because never before has there been such a rapid, cross-continental, and simultaneous societal demand for education systems to respond to a specific phenomenon (Linderoth et al., 2024). The purpose of this study is to provide a comprehensive overview of the AI integration process in K–12 education through the analysis of international literature and documents issued by various governmental and international organizations. Our analysis proceeds along two main dimensions: we examine various educational policy models related to AI, and we analyze the critical issues of preparing and retaining the teaching workforce from a human resource management perspective.

The success of integrating AI into schools will likely be determined not by technology, but by the human factor. The literature points to a phenomenon termed the “second digital divide.” The first such divide stemmed from a lack of access to devices and the internet. In contrast, the second divide manifests in teachers’ ICT (and AI) competencies and the quality of pedagogical support (Lin et al., 2023). Students in wealthier, typically urban regions not only have access to AI tools but also have teachers capable of using them creatively to develop higher-order thinking skills. Conversely, in disadvantaged regions, AI is often only mentioned in passing. It might be used as a curiosity without methodological considerations or merely as a drill-and-practice tool. In some cases, due to a lack of teacher competence, it is not utilized at all (Chen et al., 2025). This realization leads to our hypothesis: the most significant bottleneck in K–12 AI education is not the curriculum or access to hardware and software, but rather the adequately prepared teacher.

## 2. Strategic models in AI education

For AI literacy to be introduced into a national education system, the curricular conditions for AI education must first be established, which requires clear governmental intent. By 2026, the intention to teach AI at the K–12 level had appeared in the official curricula of approximately a dozen countries. However, this has happened to varying degrees and in different formats, ranging from mandatory or elective subjects to pilot programs. In our analysis, we compare four models representing distinct approaches from four major, culturally and geographically distinct regions.

### 2.1. The centralized innovation model

Among the countries examined, China's strategy is the most ambitious and vertically integrated. The explicit goal of the New Generation Artificial Intelligence Development Plan, issued in 2017, is for the country to become the world's leading AI power by 2030. To achieve this, the Chinese AI education strategy employs a centralized, step-by-step approach focused on building an AI ecosystem. AI education is mandatory for the K–12 age group, and there is strong support in higher education for launching AI-focused programs and integrating AI into other disciplines, such as medicine, engineering, and social sciences (Wu et al., 2020). Educational policy has prioritized the practical development of teachers' AI literacy. This decision followed the realization that teachers' ability to apply AI strongly determines their AI knowledge, as well as their assessment and ethical competencies regarding the technology (Zhao et al., 2022). By the end of 2024, the Chinese government had developed the AI literacy of nearly 3 million teachers through centralized training programs.

The strength of the Chinese centralized innovation model lies in its scalability, scientific foundation, and—aligning with China's social structure—the firm political will behind it, which reliably aids its implementation. However, its main weakness is massive regional inequality. Although the central government attempts to support rural schools with digital platforms and teacher exchange programs, research indicates that the digital divide remains significant, particularly regarding access to quality education (Chen et al., 2025).

### 2.2. The pragmatic technocratic model

The AI education model of the "East Asian Tigers" is characterized by efficiency, rapid adaptation, and the economic utilization of technology. In Singapore and South Korea, the primary function of education—and AI education within it—is to maintain economic competitiveness.

Singapore's National AI Strategy builds on the principle of human–AI collaboration and development through individual learning paths. Singaporean educational policy treats AI not merely as subject matter to be taught, but as the fundamental infrastructure of the educational ecosystem. In line with this philosophy, their AI education strategy simultaneously aims to develop students' AI literacy within curricular frameworks (Kundu & Bej, 2025) while promoting the use of AI-based tools for personalized and data-supported instruction.

In South Korea, the local national core curriculum was revised in 2022, redefining AI literacy not just as a technical skill, but as a cognitive toolset. Nevertheless, AI literacy is not yet the primary curricular priority; instead, it appears as a dimension of digital media literacy (Choi et al., 2025). A key element of system-level sustainability is ensuring continuous professional development for educators. The government has allocated significant resources for this purpose, setting a goal to retrain tens of thousands of teachers as AI specialists. The South Korean teacher training model is based on the AI-TPACK framework, which combines technological knowledge with subject-specific methodology (Jun et al., 2022). The government's vision is that AI will take over routine tasks of knowledge transfer and assessment, allowing teachers to focus their pedagogical work on mentoring and socio-emotional development.

### 2.3. The decentralized market model

In the decentralized, market-driven Anglo-American educational systems, central state control is weaker than in the previously discussed countries, while market players, non-profit organizations, and local autonomy play a more dominant role. In the US, there is no unified, mandatory federal AI curriculum. Consequently, regulations implemented by individual states are based on federal guidelines and voluntary national initiatives, which can differ significantly from one another (Joshi, 2025). At the federal level, it is crucial to mention the executive order that marked a political turning point for AI education in the US in 2025 by elevating the issue to the highest level of government. The federal narrative reveals a dual goal: exploring how teaching AI literacy serves labor market preparation (N. Wang & Lester, 2023), while also focusing on student rights, data privacy, and equity (Adams et al., 2023).

The greatest challenge for AI education in the US is the skill level of teachers and the risk of a widening AI divide across different geographic regions and social groups. One consequence of decentralization is that wealthier school districts, often supported by tech companies, can provide excellent AI education, while poorer regions fall behind (Jackson, 2025; Trucano, 2023). Fewer than a third of teachers feel prepared to use AI (Joshi, 2025), and a deepening digital divide is particularly evident in non-white communities (White et al., 2024).

Similarly, the UK lacks a central, comprehensive AI act or an AI curriculum that applies to the entire school system. However, government strategies, guidelines, and manuals do exist, centered around a few core principles. These principles articulate the intention for the UK to be a global leader in AI and data technologies (Gellai, 2023), explicitly viewing the education system as a strategic sector in achieving this goal.

The British approach specifically reinforces the role of the teacher as the primary educator. In this context, AI is treated as a supplementary tool rather than a replacement for teachers (Y. Wang, 2024). The government aims to use AI to reduce teacher workload and increase efficiency and is actively seeking solutions to this end. There is a strong critical discourse regarding the introduction of AI in schools, highlighting the danger that commercial platforms—increasingly acting as knowledge monopolies—are expanding their influence over schools while utilizing student data as a resource (Gray, 2020).

2.4. The humanistic-civic model

The European Union's educational policy regarding AI is characterized by the tension between the pressure of global economic competitiveness and an ethical regulatory framework based on fundamental European values. The EU envisions an AI future where the technology does not replace the educator but rather augments their capabilities and opportunities, all while students become critically AI-literate.

Table 1. Major national AI education strategy models around the world (compiled by the author).

|                     | China (Centralized Innovation)                       | Singapore / South Korea (Pragmatic Technocratic)     | USA, UK (Decentralized Market)                    | European Union (Humanistic-Civic)                                 |
|---------------------|------------------------------------------------------|------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------|
| Main Strategic Goal | Global technological dominance, talent development   | Economic efficiency, personalization, "Smart Nation" | Serving labor market needs, innovation            | Social participation, equity, ethical use                         |
| Curricular Model    | Multi-level, spiral, mandatory and elective elements | Modular, subject integration                         | Varies by state, market-driven materials          | Transversal competence, project-based integration                 |
| Ethical Focus       | Security, control, national interest                 | Responsible use, data protection                     | Corporate data security, bias, privacy            | Human rights, agency, social impact, democracy                    |
| Government Control  | Strong central control (Top-down)                    | Strong central control + pragmatic adaptation        | Weak central control, strong local/market players | Decentralized, builds on teacher autonomy, varies by member state |
| Main Challenge      | Urban-rural divide, teacher shortage                 | Social resistance (parents), teacher overload        | Unequal access, lack of coordination              | Motivating teachers, depth of integration                         |

The EU AI Act (2024), which is binding across the entire European Union, must be integrated into the education systems of individual member states. This legislation uses strict regulations to protect the rights of European citizens—and specifically students—against potential overreach by artificial intelligence and the market or state actors operating it. A prime example is the case of emotion recognition systems. While the regulation does not ban their use, it classifies them as high-risk. Similarly, AI systems used for educational support, such as adaptive learning platforms, have been placed in the high-risk category. In the future, this strict regulation may cause competitive disadvantages for EU citizens and students.

In summary, the speed of legislation and vision-creation in the EU far exceeds the adaptability of schools' infrastructural and human resources. At the same time, the European framework is currently the safest and most transparent AI education system in the world. An additional risk is that over-regulation could slow the entry of innovative EdTech startups into schools, compared to the more flexible models seen in the US or East Asian states.

### 3. Human resource management in public education in the age of AI

Ultimately, the success or failure of AI-related educational reforms depends on the human factor. The literature unanimously identifies teacher preparedness as the most critical variable (Aravatinos et al., 2026). Education systems must develop complex human resource management strategies covering recruitment, training, retraining, professional development, and retention. A major component of the second digital divide is teachers' lack of AI competence (Rawal, 2024). Teachers frequently perceive the introduction of new technology as a "top-down pressure" that ignores real classroom needs and increases cognitive load (Huang & Yu, 2025). These feelings often lead to resistance and the sabotage of reforms.

The disciplinary approach to teaching AI literacy is not uniform across different education systems. However, the most common solution is to link it to one of the STEM fields, having STEM teachers deliver AI instruction. However, the shortage of STEM teachers is a global problem, and the rapid spread of AI could make it even worse.

#### 3.1. The Problem of AI teacher training

Not every country envisions AI education as a separate subject, but China is pioneering in this area as well. In 2025, Beijing Normal University (BNU) launched the first bachelor's degree program in AI education. Until they can graduate enough qualified AI educators, schools are encouraged to employ industry professionals on a part-time basis. In the US, alternative certification programs allow professionals who hold degrees but lack teaching qualifications to enter the teaching profession through accelerated, practice-oriented pathways. Singapore targets top university students through its Turing AI Scholars Programme, offering attractive scholarships and clear career paths to draw them into AI education and research.

Many countries intend to implement AI professional development systems for in-service teachers. When AI first emerged on a mass scale, many regions launched short, one-off, workshop-style AI training sessions for teachers, often lacking pedagogical context. However, these did not yield the expected success, as fragmented training programs without clear pedagogical objectives have minimal impact. South Korea opted for the "core teachers" model to disseminate AI pedagogical knowledge more broadly. They selected and intensively trained a group of educators to become "AI education core teachers," tasking them with passing on their AI knowledge within their own workplaces and schools. Unfortunately, these teachers often become isolated, overworked, and face resistance from their colleagues. In several other countries, the government provides centralized, institutionalized AI teacher training solutions.

Certain AI teacher training models in Finland and the US are built on the logic of professional learning communities (PLCs). In these communities, educators share their experiences and co-develop teaching materials. This collaborative, mutually supportive learning and working environment increases teachers' commitment to teaching AI while simultaneously reducing their AI-related anxiety (Bautista et al., 2025).

### 4. Conclusion

The world is not unified when it comes to AI education. The major powers, China and the US, focus on technological innovation and economic dominance. Meanwhile, Europe seeks to protect its own values in this domain as well, prioritizing civic competencies and ethics. Between these two extremes, Singapore and South Korea are attempting to navigate a pragmatic middle path. It is not yet clear which path will lead to definitive success and the full integration of AI into education; investigating this will be the task of future research. However, what is already evident is that the key to successful implementation is proper human resource management. The countries achieving real results are those that handle recruitment and training at a systemic level and can offer clear career paths for those wishing to participate in AI teaching. There is no single, universally applicable solution for AI education.

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