

Teacher education reconstruction in the digital intelligence era: insights from the US evolutionary logic

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Abstract. The evolution of teacher education paradigms is not a linear succession but a dialectical process in which three enduring concerns—quality, efficiency, and equity—are continually renegotiated and reconfigured in response to changing historical conditions. This article traces the transformation of teacher education in the United States from the university-based professionalization paradigm (1.0), through the market-driven efficiency paradigm (2.0), to the community-embedded humanistic paradigm (3.0). This trajectory reveals the core tensions and internal logic of teacher education reform and thus provides a necessary starting point for envisioning future paradigms. Generative artificial intelligence and related digital-intelligence technologies have created an epochal rupture that existing paradigms cannot adequately address. The article argues that a future-oriented paradigm must achieve a dialectical synthesis of historical experience: preserving the professional ethos of the 1.0 paradigm, refining the data-informed orientation of the 2.0 paradigm, and deepening the equity commitment of the 3.0 paradigm. On this basis, it proposes a systematic reconstruction of teachers' core competencies within a human-machine-society collaborative framework.

Keywords: teacher education, digital-intelligence era, artificial intelligence, human-machine collaboration, educational equity

1. Introduction

The reform and development of teacher education has always been a response to and product of specific social and historical contexts. Exploring its evolutionary course is not only a sorting-out of the development thread of education, but also a pursuit of the underlying logic and core values behind educational transformation. At present, China is in a critical period of building a "New Teacher Education" system. In April 2022, eight departments including the Ministry of Education jointly issued the Plan for Strengthening Teachers in Basic Education in the New Era, clearly setting forth the goal of "building a high-level teacher education system" [1], aiming to comprehensively improve the quality of teacher education in China through systematic reforms. In August 2024, the Opinions of the Central Committee of the Communist Party of China and the State Council on Carrying Forward the Spirit of Educators and Strengthening the Building of a High-Quality Professional Teacher Force in the New Era further emphasized that "teachers are the foundation of education and the source of education revitalization; to strengthen a country, one must first strengthen education, and to strengthen education, one must first strengthen teachers" [2], further highlighting the foundational and

pioneering value of teacher education in the talent cultivation system from the perspective of national strategy. Meanwhile, we stand at a historic turning point: digital-intelligence technologies represented by Generative Artificial Intelligence (GAI) are reshaping social structure and educational ecology with unprecedented reach, depth of integration, and speed of development. They have not only changed the tools and methods of teaching and learning, but also fundamentally challenged our traditional perceptions of knowledge, competence, and even the existential value of the teaching profession.

The evolutionary course of teacher education in the United States, as a representative reference case, presents a clear development trajectory of "problem emergence—reform response—new problem generation". A systematic review of its development path helps us discern the structural contradictions and practical limitations of different teacher education paradigms in responding to social change. This review is not a simple enumeration of historical events, but a future-oriented "intellectual archaeology" designed to excavate the logical foundation of teacher education reform. The historical evolution has left us with three key legacies: first, it uncovers the inescapable core tensions in teacher education reform; second, it demonstrates the effectiveness and limitations of different reform approaches in practice; third, it has solidified the core values that teacher education must uphold. A deep understanding of these historical experiences is an indispensable prerequisite and foundation for constructing a constructive vision for the future.

2. Dialectical legacies: core tensions in the evolution of the american teacher education system

Since the 21st century, European and American countries have fully recognized the importance of teacher quality for educational quality, regarding teachers as "the primary resource for educational development", and thus continuously promoting the reform and upgrading of the teacher education system. Against this backdrop, a "new teacher education" reform movement emerged in the United States, which has prompted pre-service teacher education to move from the 1.0 paradigm, through 2.0, toward 3.0 [3]. Scholars in the field of American teacher education, Kerry Kretchmar and Ken Zeichner, classified American teacher education paradigms from the perspective of institutional evolution: the 1.0 system is a university-centered traditional training model with the core goal of developing teachers' professional competence; the 2.0 system is characterized by alternative preparation pathways, improving the efficiency of teacher supply through fast-track programs; the 3.0 system represents a transformative development direction, emphasizing the collaborative construction of a "third space" between universities and communities, aiming to cultivate teachers' critical social awareness and capacity for community engagement, and regarding education as an important practice to promote social equity [4]. The evolution of the American teacher education system is essentially a process of adjusting the weight and reconstructing the understanding of the three core values of professionalism, efficiency, and humanistic development under different historical backgrounds, centering on the fundamental question of "how to cultivate good teachers".

2.1. Teacher education 1.0: the ideal of professionalism and its "ivory tower" crisis

From the early 17th century to the early 19th century, there were no specialized educational institutions for teacher training in the United States, nor was there an institutionalized teacher training system established. Out of practical needs to cope with actual teaching demands, preliminary teacher training activities emerged at that time, including teacher training classes within academies and teacher training in monitorial schools [5]. These early practices laid an important foundation for the educational development of the time and the subsequent emergence of professional teacher education institutions. It was not until 1823 that Samuel R. Hall founded the

first private teacher training class in Concord, Vermont, kicking off normal education in the United States [6]. By 1839, the first normal school in the United States was established in Lexington, Massachusetts [7], officially launching the professionalization process of American teacher education, and various normal schools sprang up across the country thereafter. Starting from the 1950s, normal schools gradually transformed from independently established, single-purpose colleges into comprehensive colleges or universities with a stronger focus on research and academic rigor. After the 1960s, the vast majority of independent normal schools in various states were converted into schools or departments of education within comprehensive universities or colleges [8]. This process marked the formal establishment of the "University-Based Teacher Education" model—the teacher education system 1.0, and teacher education thus entered a stage of academic and systematic development.

The university-based teacher education paradigm is essentially a tradition of professionalism with universities as its stronghold. This model constructs the "scientific" legitimacy of the teaching profession through academic authority, emphasizing teachers' professional knowledge and academic background. Its basic theoretical assumption is that most of the knowledge required by teachers is acquired in universities, and the realization of teacher professionalization, the mastery of teaching knowledge and the formation of abilities must be based on systematic theoretical learning [9]. This has shaped a knowledge system and certification standards centered on higher education, forming a "university monopoly" in teacher education.

However, since the 1980s, this university-centered "fortress-style" training model has gradually exposed many problems. First, there is a disconnect between theory and practice. The academic orientation of university courses has created a huge gap with the complex, contextualized teaching practice in primary and secondary schools [10], leading to new teachers' inadaptability and inability to cope with complex and changing teaching environments. Second, the training model tends to be rigid. The unified, long-cycle training system can hardly respond quickly to the dynamic social demand for the quantity and types of teachers. With the deepening of basic education reform and demographic changes in the United States, the problem of teacher shortage has become increasingly serious, especially in some under-resourced areas and specific subject areas [11]. Finally, there is insufficient cultural responsiveness. As a multicultural society, the university-led training system in the United States has not fully integrated multicultural perspectives, resulting in teachers generally lacking cultural communication skills and appropriate teaching strategies when facing Indigenous students. Especially in some rural areas, Indigenous students not only face severe teacher shortages, but also find it difficult to have their diverse educational needs met by non-Indigenous teachers who lack training in local culture and language [12]. Furthermore, the extremely low proportion of Indigenous teachers [13] further restricts the popularization of culturally responsive education. This sluggish response on the "supply side" has ultimately shaken the monopoly position of the university-based model in teacher training.

2.2. Teacher education 2.0: market-driven efficiency pursuit and its equity paradox

Facing the multiple dilemmas of the 1.0 paradigm in terms of quality, efficiency and equity, a reform centered on "efficiency" and "accountability" gradually emerged, driven by multiple social forces. First is the influence of the deregulation orientation. Various defects of the traditional university-based model have given rise to a deregulation movement in teacher education across American society. It holds that the traditional university-based model is too rigid and closed to meet the requirements of teacher education in the new era, and that reforms were needed to stimulate the vitality and innovation of teacher education [14]. Second, policy impetus has served as a catalyst for reform. The No Child Left Behind Act (NCLB), passed in 2001, established a strong accountability system centered on standardized tests [15], taking students' academic performance as a key indicator to measure school and teacher performance, creating a policy breeding ground for "efficiency-

oriented" solutions that pursue rapid, quantifiable results. Finally, there is deep penetration of capital and skewed resource allocation. In the 2010 Education Innovation Competition launched by the U.S. Department of Education, non-university teacher education institutions represented by Teach for America (TFA) received \$50 million in grants, while proposals submitted by public universities and colleges received no funding at all. This shift in financial support has provided strong economic momentum for the development of the 2.0 system, driving the rapid expansion of non-university teacher education programs [4].

The core of the American teacher education 2.0 paradigm lies in breaking the university monopoly on teacher training through market-oriented mechanisms and alternative certification, and efficiently delivering teachers to society, especially to areas with severe teacher shortages, in a "short-cycle, low-cost, highly targeted" manner. The alternative teacher certification system provides channels for teacher candidates from non-traditional backgrounds to enter the teaching profession by offering diverse certification pathways and evaluation models. As a typical representative, Teach for America has attracted a large number of outstanding graduates from various majors at top universities to engage in education since its establishment in 1990. Through five weeks of intensive training, two years of teaching practice and ongoing professional support, it helps teacher candidates quickly grow into educators [16]. The emergence of this model has greatly enhanced the flexibility of the teacher supply system and its responsiveness to market demand. No longer constrained by the long training cycle of universities, it directly responds to the urgent needs of schools with a demand-driven logic. By 2023, seven common alternative teacher certification pathways had been formed in the United States, which differ from the traditional certification system in terms of power attributes, training orientation and evaluation mechanisms [17], together constituting the diverse practical landscape of the 2.0 system.

However, this efficiency-oriented reform has also sparked widespread controversy. First, there is the risk of teacher "deprofessionalization". Reducing complex educational practice full of contextual wisdom into a series of standardized teaching techniques that can be mastered in a short period of time essentially weakens teachers' professional autonomy and theoretical depth, reducing their role from "reflective practitioners" to "technical implementers" [18]. Second, there is the "equity paradox" of education. Although its original intention is to serve the most educationally disadvantaged areas, it systematically assigns the least experienced teachers to the most vulnerable student groups [17]. Coupled with the high turnover rate of participants in some alternative teacher education programs [19], this not only fails to fundamentally solve the problem of teacher stability, but may also cause secondary damage to the local educational ecology due to continuous personnel turnover, which may solidify rather than eliminate educational inequality in the long run. While solving the immediate problem of whether there are teachers available, this model may come at the cost of long-term teaching quality, which constitutes the core controversy of the 2.0 paradigm.

2.3. Teacher education 3.0: humanistic community embeddedness and its scaling dilemma

Reflection on the instrumental rationality of the 2.0 paradigm, together with deep concern about structural inequality in education, has jointly given rise to a return to the value of "humanization", moving the American teacher education system toward 3.0. Grounded in the theories of social justice and culturally responsive teaching, this system is committed to cultivating teachers who are not only knowledge transmitters, but also "community cultural understanders" and "promoters of social equity" [4]. Its core practice lies in breaking down institutional barriers between universities, schools and communities, and building a multi-stakeholder collaborative "third space" [20], shifting teacher education from a single university-led model to a collaborative system with the participation of communities, primary and secondary schools, non-profit organizations and other parties [21].

The Grow Your Own (GYO) program is a representative practice of the 3.0 paradigm. Based on local teacher training, this program has significantly enhanced teachers' understanding and adaptability to community culture by recruiting local teacher candidates and incorporating local cultural experience into curriculum design, effectively improving teacher retention rates and teaching effectiveness in poor areas [22]. Meanwhile, the integration of local knowledge enables teachers to better meet the needs of community students, thus alleviating the educational disconnect caused by cultural differences [23]. This community-centered teacher education model not only strengthens teachers' sense of belonging and responsibility, but also promotes the optimal allocation of regional educational resources. The Schools Within the Context of Community (SCC) program promoted by Ball State University has further deepened this model. Through cooperation with the Whitley Community, pre-service teachers are fully immersed in the community for one semester, completing theoretical study, teaching practice and community participation in real social and cultural contexts, so as to systematically cultivate their ability to implement culturally responsive and social justice teaching in complex situations [24]. This not only improves the professional literacy of pre-service teachers, but also promotes community development and cultural inheritance.

For a long time, evaluations of the 3.0 paradigm have mostly been based on its qualitative advantages, such as high cultural fit [25]. However, a recent quantitative study on the GYO program of the Teacher Academy of Maryland (TAM) has provided strong empirical support for the effectiveness of this paradigm and revealed its far-reaching social value. The study shows that high school students who participated in the program had an average 47% higher probability of becoming teachers later in life, with an 80% increase among African American women. In addition, participants saw an average 5% increase in wages, and African American female participants saw an 18% wage increase [26]. This study elevates the GYO program from a mere teacher supply strategy to a dual empowerment tool that can simultaneously promote educational equity and community economic development. It proves that the 3.0 paradigm is not only an educational ideal, but also a practical model with socioeconomic returns. Nevertheless, the 3.0 paradigm still faces the challenge of large-scale replication. Its success is highly dependent on the cultural capital and social networks of specific communities, and how to establish replicable and evaluable professional standards while maintaining local characteristics remains an unresolved challenge.

3. Epochal rupture and historical lessons: constructing the logical starting point of teacher education

The evolution of American teacher education from 1.0 to 3.0 is not a simple process of linear substitution or survival of the fittest, but a dialectical process full of tensions and mutual negation, in which different value orientations game with each other, coexist, and undergo weight adjustments under specific historical contexts. This historical process has left valuable "intellectual legacies" and a clear "logical starting point" for us to think about the future development of teacher education. However, just as the education community is attempting to carry out comprehensive innovation on the basis of historical experience, digital-intelligence technologies represented by generative artificial intelligence have brought about an "epochal rupture" completely different from the past, posing a brand-new epochal proposition for teacher education. Therefore, the logical starting point for constructing a new paradigm that can respond to the future must be a dialectical synthesis of historical experience—it must face up to and respond to practical problems, while carrying out creative transformation and reconstruction of the core values accumulated in history.

3.1. Historical lessons: a re-examination of the three core tensions

One of the most intractable contradictions in the field of teacher education is the gap between the professional depth of theoretical knowledge and the practical relevance of teaching practice. As early as 1904, American educator John Dewey acutely pointed out the split between theory and practice in teacher education and explored possible paths to bridge this gap [27]. This split is rooted in the institutional gene of the teacher education 1.0 system: universities provide abstract theories, while primary and secondary schools are only regarded as places to apply theories. This linear "training model" inherently separates knowledge from action [28]. The relationship between theory and practice constitutes the core driving force behind the evolution of the system. The 1.0 system emphasizes the systematicness of subject knowledge and the scientific nature of theoretical foundations, with the original intention of strengthening the professional status of teaching. However, its obsession with "professional depth" has led it into the dilemma of being divorced from practice. This crisis gave birth to the market-driven 2.0 paradigm, whose "on-the-job training" model attempts to respond to this crisis through an extreme practice orientation, but goes to the other extreme of sacrificing theoretical depth for immediate on-the-job competence. The community-embedded 3.0 paradigm attempts to integrate theory and practice in real social and cultural contexts. The tension between theory and practice is the core driving force for the continuous exploration and development of teacher education. Any attempt to bridge this gap cannot be reduced to "disseminating" research results, but must touch upon deep-seated changes at the systemic, pedagogical and even organizational levels [28].

If the tension between theory and practice is internal to teacher education, the tension between preparation efficiency and quality assurance reflects the relationship between the education system and external social demand. Under conditions of teacher shortage, it becomes a direct confrontation between market logic and professionalism. Alternative certification programs epitomize this conflict: they seek to fill vacancies quickly through faster and more accessible pathways. Yet efficiency gains may come at the cost of quality. More than 62% of alternative programs provide no clinical practice before candidates enter classrooms, nearly 40% rely entirely on online coursework, and mentor support is often inadequate [29]. This tension reflects a neoliberal challenge to traditional professionalism through market efficiency, deregulation, and accountability. The components most often reduced are central to teachers' professional formation; short-term gains therefore risk weakening long-term professional competence and eroding public trust.

The third tension is reflected in the game between national-level standardized requirements and local and individual-level personalized demands. Standardization aims to guarantee educational equity at the macro level through unified curricula, assessments and quality benchmarks; personalization emphasizes respect for differences and pursues responses to individual traits at the micro level. As a top-down macro solution, the 1.0 paradigm attempts to establish unified professional standards through academic authority, but its "one-size-fits-all" model ignores local cultural contexts and individual differences, resulting in insufficient cultural responsiveness. As a correction, the 3.0 paradigm turns to problem-solving paths at the local and individual levels. Although it has achieved remarkable results in meeting the cultural needs of specific communities, it faces challenges in large-scale promotion and the construction of universal standards. This dilemma indicates that the tension between standardization and personalization is a complex problem nested at multiple scales: macro (national/system), meso (community/school) and micro (individual student).

3.2. A new challenge for the digital-intelligence era: the "threefold rupture" brought by digital-intelligence technologies

First, the most profound rupture in the digital-intelligence era occurs at the level of knowledge production and cognitive authority. In the traditional education system, teachers' authority is largely built on their status as

"knowledge authorities"—they are the owners, interpreters and transmitters of knowledge. However, the emergence of generative artificial intelligence is fundamentally undermining this foundation. These systems, which can instantly generate fluent and seemingly authoritative texts, are becoming a new "omniscient teacher" in the educational ecology. They are not only a retrieval tool, but also a "knowledge machine" capable of integrating, reorganizing and even "producing" knowledge [30]. This transformation has led to a quiet reconstruction of cognitive authority. Studies show that students increasingly tend to regard AI as a trustworthy core learning source, and even prefer to turn to instant, clear AI rather than teachers or peers when seeking feedback [31]. The deep-seated crisis of this phenomenon is that AI is playing the role of a "surrogate agent of cognition", taking over cognitive work that should be done by learners, such as information retrieval, argument construction and text synthesis [32]. The risk of such cognitive outsourcing is not merely that AI may provide false information, but that it may lead to the degradation of human cognitive abilities. When knowledge is presented as an easily accessible "product", the value of the intellectually challenging "process" that underpins knowledge generation—such as inquiry, reflection, criticism and synthesis—is devalued [33]. This directly threatens the core goal of education: cultivating learners to transform from "knowledge consumers" into "knowledge creators". Therefore, this rupture poses a fundamental challenge to teacher education: when teachers are no longer the sole authority on knowledge, what is their core value?

Second, teaching organization has expanded from teacher-student interaction as the core to a composite interaction involving teachers, students and intelligent systems. If the core of the traditional teaching model is teacher-student interaction, then teaching in the digital-intelligence era is evolving into a completely new form—"Human-AI Collaborative Teaching". In this new model, AI is no longer a passive tool for assisting teaching, but deeply participates in core teaching links as a "collaborative partner", including curriculum design, classroom management and student assessment [34]. However, this human-AI collaboration is not a simple superposition of tasks; it puts forward new requirements for teachers' roles and abilities. Teachers' roles are shifting from "sages on the stage" to "guides" of complex cognitive systems, and they need to possess new professional abilities to evaluate AI suggestions, design human-AI integrated learning experiences, and dynamically manage the process of human-AI interaction [35]. This transformation has profoundly restructured teachers' professional labor. On the surface, it has alleviated some of the burden on teachers, but in reality, it has brought about new, higher-order educational tasks. This means that future teacher education must go beyond the training level of "how to use technical tools" and turn to cultivating teachers' comprehensive wisdom to manage complex human-AI ecosystems.

Third, educational equity has further extended from issues of resources and opportunities to governance issues of data, algorithms and usage capabilities. It forces us to re-examine and define the core connotation of educational equity. In traditional concepts, educational equity mainly focuses on the equalization of resources (such as funding, teachers) and opportunities (such as school enrollment). However, as algorithms increasingly penetrate educational decision-making, new forms of inequality are emerging, which may exacerbate or even solidify the original social gaps. First is the risk of algorithmic bias. Since AI systems make decisions by learning historical data, they will inevitably replicate or even amplify the social biases hidden in these data. Numerous studies have confirmed that in key links such as enrollment, student risk assessment and academic evaluation, algorithms may produce systemic unfair treatment to specific groups based on race, gender or socioeconomic status [36]. Such seemingly "objective and neutral" technical decisions may actually become a new, more insidious form of systemic discrimination. Second is the emergence of a "new digital divide". The digital divide in the past was mainly reflected in the gap in hardware equipment and network access. In the era of generative AI, however, the core of the divide is shifting to differences in "digital capital"—that is, the complex skills, cognitive strategies and social support networks required to use AI tools effectively and

critically [37]. This means that even if all students have access to AI, those from advantaged families who can receive better guidance and training will be able to more effectively convert AI into capital for improving academic performance and future development, while students from disadvantaged groups may fall into superficial use or even be misled due to lack of guidance, further widening the gap. Therefore, future teacher education must incorporate privacy protection, bias identification, interpretability, informed consent and equity compensation into professional training, so that teachers can identify and correct inequalities caused by technology in specific teaching contexts.

3.3. A bridge to the future: "dialectical synthesis" as the theoretical basis

Facing the profound rupture brought by digital-intelligence technologies, future teacher education should pursue a dialectical synthesis of historical experience on the premise of responding to the problems of the times. It must uphold the core of professionalism of the 1.0 paradigm to respond to the crisis of humanistic value brought by AI; it must refine the data-informed orientation of the 2.0 paradigm to respond to the challenges of algorithmic governance; it must deepen the commitment to social justice of the 3.0 paradigm to respond to the structural inequality exacerbated by the digital divide.

First, uphold and reshape the core of professionalism of the 1.0 paradigm. In an era where everyone can easily access information, the value of teachers is precisely reflected in those aspects that machines cannot replace. The foundation of teachers' authority must shift from "cognitive authority" (I know more than you) to "wisdom authority" (I can guide you to become a better person). This requires us to return to and adhere to the professional spirit pursued by the 1.0 paradigm, but reshape its connotation. The core of this new-era professionalism is to defend the irreducibly human dimension of education [38]. As technology advances, teachers must increasingly exercise forms of judgment and care that algorithms cannot provide—including ethical judgment, emotional resonance, value guidance, and attention to students' inner lives. However, this adherence is not a simple return to the past, but "transcendence" on the basis of "upholding fundamentals". The professional spirit of teachers in the new era must incorporate AI literacy and AI ethics as indispensable dimensions [39]. Teachers need to understand the working principles, capability boundaries and potential risks of AI in order to use it critically in teaching and guide students to become responsible digital citizens. Therefore, the professionalism of future teachers is a professionalism that deeply integrates humanistic spirit and scientific and technological literacy.

Second, retain and refine the data-informed orientation of the 2.0 paradigm. The 2.0 paradigm introduced data into teacher education. Although its application methods are often criticized for being too utilitarian, its emphasis on evidence-based decision-making is inherently valuable. Facing the complex ethical challenges of the algorithmic era, future teachers must develop this data awareness, transforming it from a performance appraisal tool into a professional ability to promote educational equity and personalized development. Its core is to cultivate teachers' "critical data literacy". Critical data literacy goes beyond basic skills in interpreting, analyzing, and communicating data; it emphasizes a habit of inquiry and reflection [40]. Teachers with this literacy not only use data, but also interrogate it: Where does this data come from? Whose interests does it serve? Which groups' voices may it have omitted? What assumptions are hidden behind the way data is presented? Through systematic training, improving teachers' ability to collaboratively conduct data analysis and decision-making in real contexts is the key to resisting algorithmic bias and ensuring technology is used for good. Therefore, future teacher education requires treating data as a "text" that needs to be interpreted critically, rather than an unquestionable "fact", thus empowering teachers to become "gatekeepers" of educational equity in the algorithmic era.

Third, deepen and expand the commitment to social justice of the 3.0 paradigm. The greatest contribution of the 3.0 paradigm is that it places social justice at the core of teacher education and emphasizes the role of teachers as agents of social change. In the digital-intelligence era, this commitment has become more, rather than less, important and must be extended. Future teacher education must extend the 3.0 paradigm's community-based commitment to social justice into digital environments. This means that promoting educational equity should not only focus on the cultural needs of specific communities, but also be committed to bridging the new digital divide that is constantly widening due to differences in "digital capital". Teachers of the future must become advocates and practitioners of "digital equity". This requires teacher education not only to teach students how to use technology, but also to guide them to critically reflect on the relationship between technology and social power. Furthermore, it requires teachers to proactively use technical tools to design and create culturally responsive learning environments that can empower marginalized groups [41]. This marks the transformation of teachers' role from "interpreters" of social justice to "actors", who can strive for a fairer and more inclusive future for all students at the intersection of technology and humanities.

In sum, a dialectical synthesis of historical experience provides the logical foundation for China's "New Teacher Education" initiative. Preserving the humanistic core of professionalism safeguards the purpose of education amid technological change; developing critical data literacy subjects technology to ethical scrutiny; and extending the commitment to social justice into digital environments helps ensure that technology serves the free and comprehensive development of every learner. Together, these principles provide the value framework for designing teacher education for the future.

4. Future reconstruction: core propositions and a Chinese path for a wisdom-emergent teacher education paradigm

Building on these value commitments, this article defines "wisdom-emergent teacher education" as a preparation paradigm in which teachers retain ultimate professional responsibility while interacting continuously with intelligent technologies, schools, communities, and other stakeholders. Within this process, individual knowledge, practical experience, and public values are tested against one another in addressing concrete educational problems, generating new professional judgments. "Emergence" therefore does not mean that technology automatically produces wisdom; it refers to institutional arrangements that enable high-quality collaboration among multiple forms of knowledge.

4.1. Core proposition: human responsibility governs "human-machine-society" collaboration

This paradigm requires four interrelated core competencies. First is ethical and value-based judgment: deciding whether and how technology should enter teaching in light of educational purposes, students' rights, and public responsibility. Second is intelligent instructional design: integrating subject knowledge, principles of learning, classroom evidence, and AI capabilities into transparent and adaptable learning tasks. Third is critical data and AI literacy: understanding the sources, limitations, and biases of data and models, verifying outputs, and making judgments from multiple forms of evidence. Fourth is relational and context-sensitive practice: recognizing difference, building trust, and incorporating local knowledge through teacher-student interaction, peer collaboration, and community participation. Together, these competencies address professional depth, pedagogical adaptability, algorithmic governance, and contextual equity, and form the foundation of professionally wise teaching.

4.2. Practical mechanisms: promoting institutional coordination, curriculum redesign and continuous support

First, establish a bounded multi-stakeholder collaborative governance mechanism. Universities, primary and secondary schools, governments, technology companies and communities can jointly provide expertise, practice settings, and resources, but the structure of rights and responsibilities must be clarified: universities and schools are jointly responsible for training quality; governments formulate public rules and guarantee support for disadvantaged areas; communities participate by articulating needs and evaluating programs; technology companies provide technical services without replacing educational decision-making. In processes involving student data, algorithmic evaluation and automated recommendations, mechanisms for purpose limitation, manual review, risk recording and accountability tracing should be established.

Second, redesign curricula and clinical practice around authentic problems. Teacher education cannot simply add an "AI tools course"; instead, technological judgment should be embedded in subject pedagogy, curriculum design, educational assessment and the practicum. Candidates need to go through the complete cycle of "proposing educational problems—choosing or rejecting technology—verifying generated content—implementing teaching—collecting multi-source evidence—reflecting and revising", guided jointly by university teachers, primary and secondary school mentors and community partners. The focus of evaluation should shift from whether one can operate tools to whether one can explain the reasons for choices, identify risks and improve student learning.

Finally, establish an adaptive professional support system that connects pre-service and in-service stages. Digital platforms can support access to resources, cases, peer learning, and continuous feedback, but learner profiles can only be used as formative support and must not become fixed labels of teachers' abilities. Evaluation should draw on teacher growth portfolios, classroom evidence, student feedback, and peer review, and pre-service training, induction guidance and in-service study should be connected into a continuous cycle, so that teachers can constantly update their judgments amid technological changes, rather than repeatedly receiving fragmented tool training.

4.3. Chinese path: transforming institutional advantages into verifiable reform effectiveness

China's "New Teacher Education" initiative should not replicate the American model. Instead, it should translate such institutional strengths as the capacity to mobilize resources, a comprehensive teacher education system, and rich application contexts into reforms that combine national professional standards with local innovation. At the national level, baseline standards can be established for teachers' AI literacy, data ethics, clinical practice, and protection of students' rights. Provinces and teacher education institutions can then conduct small-scale, evaluable pilots responsive to urban-rural, regional, educational-level, and subject-area differences, expanding them on the basis of evidence rather than treating platform coverage as proof of reform effectiveness.

The central task is to protect teachers' agency and the public character of teacher education. Technology platforms and companies may participate in preparation, but curriculum goals, assessment standards, and rules for data use should be determined jointly by professional education stakeholders. Teachers should be neither passive implementers of technical solutions nor one-sided objects of algorithmic performance evaluation. Participatory design, appeal mechanisms for algorithmic decisions, and deliberation within professional communities are needed to ensure that technology supports teacher development rather than displacing professional judgment.

Reform should also be evaluated against equity-oriented criteria. Resources and pilot support should prioritize county-level and rural areas, border regions, and high-need subject areas. Beyond preparation

efficiency and rates of tool use, evaluation should examine teacher retention, instructional improvement, protection of students' rights, regional disparities, and community satisfaction. Digital-intelligence technologies will create genuine public value for teacher education in China only when institutional coordination produces sustained improvements in the professional capacity of teachers in under-resourced settings.

5. Conclusion

This article has shown that the evolution of teacher education in the United States from the 1.0 to the 3.0 paradigm is best understood not as linear replacement, but as a continuing renegotiation of professionalism, efficiency, and equity. Each paradigm addressed deficiencies in its predecessor while generating new tensions: university-based professionalization strengthened disciplinary and pedagogical foundations but became detached from practice; market-oriented alternatives improved responsiveness but risked weakening professional depth and reproducing inequality; and community-embedded approaches advanced cultural responsiveness and social justice but remained difficult to scale. These historical lessons demonstrate that no single legacy is sufficient for the digital-intelligence era.

In response, the proposed wisdom-emergent teacher education paradigm places teachers' ultimate professional responsibility at the center of human-machine-society collaboration. It integrates ethical and value-based judgment, intelligent instructional design, critical data and AI literacy, and relational, context-sensitive practice. For China, this framework requires bounded multi-stakeholder governance, curricula organized around authentic educational problems, continuous professional support across pre-service and in-service stages, and equity-oriented evaluation. The objective is not to maximize technology use, but to ensure that technology strengthens professional judgment, protects students' rights, and expands educational opportunity.

The study is primarily historical and conceptual, and its U.S.-centered analysis cannot by itself establish the effectiveness of the proposed paradigm across diverse institutional and cultural settings. Future research should therefore examine pilot programs through comparative and longitudinal designs, with particular attention to teacher learning, classroom practice, student rights, community participation, and outcomes in under-resourced regions. Such evidence will be essential for determining how a dialectical synthesis of historical experience can be translated into sustainable and publicly accountable teacher education reform.

References

- [1] Ministry of Education, Central Publicity Department, Central Institutional Organization Commission, ... (2022, April 11). *Notice of eight departments including the Ministry of Education on issuing the Plan for strengthening teachers in basic education in the new era (No. Teacher (2022) 6)*. http://www.moe.gov.cn/srcsite/A10/s7034/202204/t20220413_616644.html
- [2] Central Committee of the Communist Party of China, & State Council. (2024, August 6). *Opinions of the Central Committee of the Communist Party of China and the State Council on carrying forward the spirit of educators and strengthening the building of a high-quality professional teacher force in the new era*. https://www.gov.cn/gongbao/2024/issue_11566/202409/content_6973187.html
- [3] Zhu, G., & Xun, Y. (2022, September 8). Teacher education system in the United States moves toward 3.0. *East China Normal University*. <https://www.ecnu.edu.cn/info/1095/60905.htm>
- [4] Kretchmar, K., & Zeichner, K. (2016). Teacher prep 3.0: A vision for teacher education to impact social transformation. *Journal of Education for Teaching*, 42(4), 417–433.

- [5] Wang, P. (2012). *Research on the development of primary and secondary school teacher education in the United States* [Doctoral dissertation, Huazhong Normal University].
- [6] Teng, D. (1998). *History of foreign education and foreign education*. Hebei Normal University Press.
- [7] Labaree, D. F. (2004). *The trouble with ed schools*. Yale University Press.
- [8] Zhao, H. (2010). The evolution of American teacher education models. *Contemporary Educational Science*, (15), 44–46, 51.
- [9] Zhao, C. (2004). University-based teacher education model: Concepts, implementation and reflection. *Journal of Shandong Normal University (Humanities and Social Sciences Edition)*, 49(4), 136–138.
- [10] Zhang, J. (2011). The crisis of American "university-based" teacher education and its reform trend. *Curriculum, Teaching Material and Method*, 31(9), 94–98.
- [11] Chen, S., & Wang, Y. (2019). The current situation of teacher shortage in American public primary and secondary schools and improvement strategies. *Educational Science*, 35(2), 78–84.
- [12] Lee, T. S. (2015). The significance of self-determination in socially, culturally, and linguistically responsive (SCLR) education in Indigenous contexts. *Journal of American Indian Education*, 54(1), 10–32.
- [13] Manuelito, K. D. (2003). Building a native teaching force: Important considerations (Report No. ED482324). *ERIC Digest*. <https://www.eric.ed.gov/?id=ED482324>
- [14] Huang, J., & Hong, M. (2015). Deregulation-oriented teacher preparation quality assessment and its controversies: An analysis of NCTQ's Teacher Preparation Quality Assessment Report (2013). *Studies in Foreign Education*, 42(3), 109–117.
- [15] Xiao, S., & Han, Y. (2017). Development and trends of gifted education in the United States since the 21st century: An analysis based on NCLB and ESSA. *Studies in Foreign Education*, 44(6), 3–14.
- [16] Bi, J., Peng, H., & Zhou, J. (2018). The path and challenges of American "TFA" influencing teacher education reform: From the perspective of policy network. *Primary and Secondary Schooling Abroad*, (12), 58–67.
- [17] Wei, L. (2023). Characteristics and tensions of American selective teacher certification system: An interpretation based on neoliberal teacher education thought. *Higher Education Exploration*, (6), 57–68.
- [18] Wang, J., & Ju, Y. (2008). The dilemma of market-oriented teacher education model in the United States. *Higher Education Development and Evaluation*, 24(5), 99–105.
- [19] Wishart, W. B. (2010). *Attrition and mobility: Analysis of the educational and employment history of teacher education graduates at the University of Tennessee, Knoxville* [Doctoral dissertation, University of Tennessee].
- [20] Beck, J. S. (2018). Investigating the third space: A new agenda for teacher education research. *Journal of Teacher Education*, 71(4), 379–391.
- [21] Zeichner, K. (2016). *Independent teacher education programs: Apocryphal claims, illusory evidence*. National Education Policy Center, University of Washington.
- [22] Bhargava, M., & Jerome, L. (2020). Training teachers for and through citizenship: Learning from citizenship experiences. *Societies*, 10(2), Article 36.
- [23] Valenzuela, A. (2017). *Grow your own educator programs: A review of the literature with an emphasis on equity-based approaches*. IDRA EAC-South, University of Texas at Austin.
- [24] Dai, W., & Wang, Y. (2023). A study on American community-engaged teacher education programs: Taking Ball State University as an example. *Higher Education Exploration*, (4), 85–90.
- [25] Learning Policy Institute. (2023, August 8). *Addressing teacher shortages: Insights from four states*. <https://learningpolicyinstitute.org/blog/addressing-teacher-shortages-insights-four-states>
- [26] Blazar, D., Goings, R., Gao, W., Lagos, F., & Gershenson, S. (2024). *Do grow-your-own programs work? Evidence from the Teacher Academy of Maryland* (EdWorkingPaper No. 24-958). Annenberg Institute at Brown University.
- [27] Shulman, L. S. (1998). Theory, practice, and the education of professionals. *Elementary School Journal*, 98(5), 511–526.

- [28] Korthagen, F. A. J. (2010). The relationship between theory and practice in teacher education. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International encyclopedia of education* (Vol. 7, pp. 669–675). Elsevier.
- [29] National Council on Teacher Quality. (2025, July 15). *What's the alternative? How some alternative certification programs are shortchanging teachers and students*. <https://www.nctq.org/research-insights/whats-the-alternative-how-some-alternative-certification-programs-are-shortchanging-teachers-and-students/>
- [30] Chen, X., & Qi, W. (2023). Knowledge machine production mode and new metaphors of education. *Educational Research*, 44(10), 33–43.
- [31] Jose, B., Cleetus, A., Joseph, B., Joseph, L., Jose, B., & John, A. K. (2025). Epistemic authority and generative AI in learning spaces: Rethinking knowledge in the algorithmic age. *Frontiers in Education*, 10, Article 1647687.
- [32] Lalwani, A. (2025, October 18). *Who thinks for us now? AI, authority, and the future of knowing*. <https://criticaldebateshsgj.scholasticahq.com/post/3509-who-thinks-for-us-now-ai-authority-and-the-future-of-knowing-by-ansh-lalwani>
- [33] SRHE News Blog. (2025, October 17). *Who gets to decide what counts as knowledge? Big tech, AI, and the future of epistemic agency in higher education*. <https://srheblog.com/2025/10/17/who-gets-to-decide-what-counts-as-knowledge-big-tech-ai-and-the-future-of-epistemic-agency-in-higher-education/>
- [34] Shukla, H., & Pandey, K. (2025). Human-AI collaboration in teaching and learning. *International Journal of Science and Social Science Research*, 2(4), 367–375.
- [35] The Cutting Ed. (2025, February 10). *Human-AI partnerships in education: Entering the age of collaborative intelligence*. <https://the-learning-agency.com/the-cutting-ed/article/human-ai-partnerships-in-education-entering-the-age-of-collaborative-intelligence/>
- [36] Boateng, O., & Boateng, B. (2025). Algorithmic bias in educational systems: Examining the impact of AI-driven decision making in modern education. *World Journal of Advanced Research and Reviews*, 25(1), 2012–2017.
- [37] Bassi, E., & Pagallo, U. (2026). Just hallucinations? The problem of AI literacy with a new digital divide. In I. Alvarez, M. Arias-Oliva, A. H. Dediu, & N. Silva (Eds.), *Ethical and social impacts of information and communication technology: ETHICOMP 2025* (Vol. 15939, pp. 123–134). Springer.
- [38] Yu, Y., Liu, Y., & Wu, Y. (2025). Original care of teachers' roles in the intelligent era. *China Educational Technology*, (10), 22–28.
- [39] Rütli-Joy, O., Winder, G., & Biedermann, H. (2024). Teacher educator professionalism in the age of AI: Navigating the new landscape of quality education. In *Artificial intelligence for quality education* (pp. 1–18). IntechOpen.
- [40] Mandinach, E. B., & Gummer, E. S. (2016). What does it mean for teachers to be data literate: Laying out the skills, knowledge, and dispositions. *Teaching and Teacher Education*, 60, 366–376.
- [41] Keith, H. R., Kinnison, S., & Garth-McCullough, R. (2023). *Putting equity into practice: Social justice education*. Every Learner Everywhere.