

Innovation Research on Data-Driven Precision Education Funding Systems in Universities: Multi-Source Data Stream Analysis in the Context of Digital Transformation

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Abstract: In the wave of digital transformation, university student funding is undergoing a profound shift from "security-oriented" to "development-oriented." This paper explores how universities can reconstruct funding and education mechanisms through digital technologies, with a focus on multi-source data fusion. The study finds that data-driven precision identification, dynamic intervention, and comprehensive evaluation are core elements of developmental funding, while the synergy between technological empowerment and humanistic care is key to achieving educational goals. This paper proposes a tripartite developmental funding and education model of "data governance—precision empowerment—value guidance," providing theoretical support and practical pathways for the high-quality development of university funding systems.

Keywords: digital transformation; developmental funding; multi-source data

1. Introduction

Educational equity is a cornerstone of social equity. With the advancement of the *China Education Modernization 2035* strategy, university student funding has transitioned from "ensuring basic education access" to "promoting comprehensive development" (Li Qiong, 2021)^[1]. Traditional funding models, plagued by fragmented information and resource mismatches, struggle to meet students' personalized developmental needs. According to 2023 statistics from the Ministry of Education, approximately 34% of financially disadvantaged students in Chinese universities face academic adaptation barriers, while 21% experience mental health risks, highlighting the limitations of purely economic assistance (Wang Jing & Tang Zhiwen, 2024)^[2]. The digital transformation wave offers new solutions: the application of big data and artificial intelligence enables multi-source data fusion. By integrating cross-departmental data from academic systems, campus spending, and psychological counseling, funding work can achieve precision identification, dynamic adjustment, and enhanced educational efficacy. However, existing research predominantly focuses on technical tools, lacking systematic exploration of the deep integration between "data empowerment" and "educational logic." Based on developmental funding theory and digital transformation practices, this paper constructs a data-driven innovation mechanism for funding and education.

2. Research Status of Developmental Funding and Education in Universities

As a critical policy tool for achieving educational equity, university student funding systems have evolved alongside China's higher education reforms. With the goal of high-quality education development, funding work is transitioning from economic aid to a "developmental" education system. Significant progress has been made in policy evolution, precision identification, digital transformation, and educational mechanism innovation, yet theoretical depth and practical gaps remain.

(1) Historical Evolution and Institutional Design of Funding Policies

Scholars have examined the phased shifts in policy values. Li Qiong (2021) systematically reviewed funding policies since the founding of the People's Republic of China, revealing a paradigm shift from "securing basic education rights" to "promoting holistic development." The study notes that the 1950s "People's Grant" system emphasized relief, the 1990s introduced market mechanisms via student loans, and the new era's "developmental funding" reflects a leap from "survival-oriented" to "development-

oriented" policy design. Ji Junjie and Xiong Jing (2021)^[3] proposed a three-stage evolution model—"relief, fairness, development"—arguing that targeted poverty alleviation accelerated the integration of funding policies with national strategies like rural revitalization. However, macro-level studies fail to address regional disparities. For instance, Yan Ru and Zhong Weiwei (2021)^[4] found that insufficient local fiscal support in central and western universities creates funding standard gaps compared to eastern regions, a phenomenon underexplored in existing research.

(2) Precision Funding and Digital Transformation

Building precision funding mechanisms is a central research focus. Traditional models, hindered by information asymmetry, have spurred explorations into big data applications. Wang Jing and Tang Zhiwen (2024)^[2] demonstrated that a multidimensional assessment model integrating family financial data, campus spending, and academic performance improves funding target accuracy to 91.7%. Their "dynamic poverty index" algorithm incorporates sudden crises (e.g., family illness, natural disasters) into real-time monitoring, addressing static identification flaws. Jiang Qinghua and Yuan Xuyuan (2024)^[5] revealed the drivers of digital transformation: rising management complexity due to enrollment expansion and Gen Z's digital-native demands. Notably, Liu Haihua et al. (2023)^[6] integrated psychological assessments into funding decisions through the "Yanyuan Qihang Program" at Peking University, finding that students with psychological vulnerabilities faced 2.3 times higher academic crisis rates. However, ethical discussions remain superficial. Wang Jing and Tang Zhiwen (2024)^[2] warned that over-reliance on algorithms risks "data tyranny," as seen when a university automatically downgraded funding for students with irregular spending data, ignoring their late-night research needs.

(3) Developmental Funding and Educational Efficacy

Interdisciplinary studies highlight educational mechanism innovations. Han Xia et al. (2025)^[7] found that embedding volunteer work and entrepreneurship into funding systems increased recipients' social responsibility by 19%-26%. Their "cognition-emotion-practice" model emphasizes value internalization but lacks psychological depth. Xiao Li and Xiao Rong (2022)^[8] proposed integrating funding with ideological education through dedicated modules, yet practical pathways remain theoretical. Zhang Yong (2022)^[9] introduced governance modernization theory, advocating a "government-university-society" collaborative system. However, corporate donations favor STEM students, with humanities students receiving less than 17% of social aid (Wang Xinyan, 2024)^[10].

(4) Funding Efficacy Evaluation Methods

Quantitative methods dominate efficacy assessments. Wang Lihua and He Jing (2022)^[11] used DEA models to measure funding efficiency across 36 universities, finding ministry-affiliated institutions (0.892) outperformed local ones (0.621) due to uneven IT investments. Tang Zhiwen (2021)^[12] tracked graduates for five years, showing developmental funding recipients earned 18.4% more than traditional aid groups, but sample bias toward elite universities limits generalizability. Tong Jianghong (2021)^[13] criticized "ritualized" gratitude education, with 62% of students finding activities "hollow." Hu Yanli (2023)^[14] emphasized integrating traditional ethics like "repaying kindness" into modern practices.

(5) Research Gaps

Three limitations persist: (1) Overreliance on quantitative methods, neglecting qualitative insights (only 9.7% of studies from 1994–2020 used interviews or ethnography); (2) Structural bias in research targets (less than 15% focus on vocational/private universities, which serve larger low-income populations); (3) Superficial tech-ethics discussions, overlooking algorithmic impacts on equity (e.g., marginalized groups excluded due to digital literacy gaps).

3. Theoretical Coupling Between Digital Transformation and Developmental Funding

Digital transformation in funding reflects micro-level educational governance modernization. Developmental funding theory emphasizes transitioning from "blood transfusion" aid to "blood-making" empowerment, fostering holistic student development through economic support, capacity building, and value guidance (Tang Zhiwen, 2021)^[12]. This aligns with digital transformation's core logic: big data bridges information silos (e.g., linking campus spending to academic performance identifies hidden poverty), while AI enables dynamic adjustments. Zhejiang's 2024 "Smart Funding Platform" improved identification accuracy from 78% to 93% by integrating civil affairs and academic data (Li Shaowei, 2025)^[16].

Digital transformation also reshapes educational philosophy. Traditional models' "economy-over-

development" tendency reflects instrumental rationality, whereas developmental funding prioritizes student agency. This value shift requires balancing technological tools with humanistic care to avoid "data supremacy" risks, such as algorithmic neglect of emotional needs (Wang Jing & Tang Zhiwen, 2024)^[2].

4. Contradictions and Dilemmas in Digital Transformation of Funding and Education

(1) Technical Challenges: Data Fragmentation and Algorithmic Tyranny

Data silos hinder precision: 73% of universities use incompatible databases, with cross-department integration costs prohibitive. Algorithmic opacity breeds distrust—35% of students prefer human errors over machine judgments (Han Xia et al., 2025)^[7].

(2) Institutional Barriers: Path Dependency and Governance Gaps

Bureaucratic resistance stifles data sharing. For example, a university's student affairs office withheld family financial data to retain authority, forcing reliance on outdated paper proofs. Vague policies exacerbate inefficiencies, such as requiring daily receipt uploads to meet "precision" metrics.

(3) Cultural Conflicts: Cognitive Divides and Value Erosion

Generational digital gaps leave 88% of staff over 46 unable to use data tools. Conflicts arise when VR gratitude education faced faculty resistance. Worse, a vocational school linking cafeteria spending to funding caused malnutrition spikes as students starved for higher aid.

(4) Ethical Risks: Privacy Erosion and Algorithmic Bias

Facial recognition in libraries to assess "motivational reading" infringes on freedom. Rural students, less active in digital payments, face 27% lower funding chances due to algorithmic misjudgment (Wang Jing & Tang Zhiwen, 2024)^[2].

(5) Ecological Imbalances: Resource Misallocation and Sustainability Issues

Eastern universities invest 4.6 times more in smart funding than western peers, yet coverage lags by 18%. High maintenance costs trap schools in "digital debt," as seen in a private university's abandoned system.

5. Constructing a "Technology-Humanity-Ecology" Collaborative Funding and Education Paradigm

(1) Dynamic Demand-Sensitive Smart Funding System

Develop reinforcement learning models to adaptively adjust support based on real-time data (e.g., library usage, spending trends). Introduce "funding elasticity coefficients" for discipline-specific resource allocation.

(2) Social Enterprise-University Co-Benefit Partnerships

Shift from charity to value co-creation. Collaborate with IT firms on "digital literacy scholarships" convertible to job opportunities. Launch social impact bonds to attract private investment with risk-sharing mechanisms.

(3) Carbon Credit-Funding Exchange Mechanism

Integrate sustainability by rewarding low-carbon behaviors (e.g., recycling) with funding boosts or priority programs. Establish "eco-innovation workshops" to fund green tech projects.

6. Conclusion and Outlook

Digital transformation reshapes funding and education through multi-source data fusion. The "data-driven—precision empowerment—value guidance" framework balances instrumental and value rationality. Future research should explore metaverse-based immersive education, generative AI for personalized growth plans, and long-term impact assessments. Only by integrating innovation with educational essence can funding evolve from "targeted poverty alleviation" to "targeted education."

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