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Practical Pathways for High-Quality Development of Elderly Education Under Digital Intelligence Transformation

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Abstract

Population aging and digital intelligence transformation are now converging; however, digital intelligence technologies have not yet been fully adapted into educational services accessible to the elderly. Drawing on the TOE framework, this paper examines the challenges that hinder the high-quality development of elderly education amid digital intelligence transformation. Three key issues emerge: age-friendly adaptation at the technological level remains superficial; practitioners at the organizational level lack digital intelligence literacy; and policy positioning at the environmental level remains marginal. Through cross-regional analysis, the paper identifies two models—the "high resource–high integration" model and the "low resource–low integration" model—clarifies how these three factors interact under varying regional conditions, and provides differentiated recommendations for advancing high-quality elderly education in regions with diverse resource bases.

Keywords

Digital intelligence transformation; elderly education; TOE framework

1. Introduction

Digital intelligence transformation rests on digital technologies such as the Internet of Things and big data together with intelligent technologies such as artificial intelligence and machine learning, and it drives a systematic shift in organizational form and governance mode from digitization toward intelligence (Chen et al., 2025). Unlike intelligence alone, digital intelligence describes the use of digital and intelligent technology to realize an "intelligent, efficient and automated lifestyle and work style" (Wang et al., 2024). As population aging and the digital intelligence transformation of education converge, the high-quality development of elderly education needs digital intelligence to deliver personalized learning services and to reshape governance, which in turn supports active aging and the lifelong learning system. High-quality development of elderly education is understood here as a healthy development model that takes the lifelong learning needs of older adults as its starting point, treats quality and service satisfaction as its goals, optimizes the supply of public goods, and keeps supply and demand in long-term balance (Cheng, 2021). Existing research has explored this terrain at the macro, meso, and micro levels and has produced substantial results. Macro-level work concentrates on policy design and institutional supply, meso-level work on

how institutions operate and cooperate, and micro-level work on the learning experience of older adults. The literature nevertheless remains fragmented, and a middle-range theoretical framework capable of integrating the interaction among technology, organization, and environment is still missing. This study therefore uses the TOE framework to move beyond a single perspective and to unpack the circular coupling among technological, organizational, and environmental factors, so as to supply evidence for narrowing the digital divide and advancing the high-quality development of elderly education.

2. The TOE Framework

Tornatzky and Fleischer proposed the TOE framework in 1990 to provide an analytical logic for understanding technology adoption in organizations, covering three contexts: technological, organizational, and environmental (Tornatzky et al., 1990). The framework has since been widely applied in education, and its value lies in reading adoption as the joint product of three sets of conditions rather than of technology alone. The technological context concerns the inherent characteristics of the technology itself (Awa et al., 2017). The organizational context refers to internal features of the organization, including its size, structure, mode of operation, and quality of human capital (Yang et al., 2022). The environmental context covers the external conditions an organization faces, such as industry characteristics, government policy, relations with other organizations, and supporting technical infrastructure (Tornatzky et al., 1990; Mu et al., 2026). Elderly education institutions do not adopt technology for competitive advantage as enterprises do; they answer to public value, and the weight of each dimension shifts accordingly. Applied to elderly education, the three dimensions need to be specified in light of the field's public service attributes, the characteristics of educational organizations, and the needs of older learners. The technological context is measured chiefly by how well digital intelligence technology fits elderly education: whether the technical system is available, easy to use, and compatible, and whether it reduces learning obstacles, improves the teaching experience, and raises service quality. The organizational context refers to the internal conditions elderly education institutions rely on when pursuing digital intelligence transformation, covering governance structure, teachers' digital intelligence literacy, and the level of management and operation. The environmental context refers to the external institutional and social conditions on which elderly education depends, expressed in how policy support and regional digital infrastructure shape the transformation practice of institutions.

3. Challenges to the High-Quality Development of Elderly Education Diagnosed through the TOE Framework

3.1 Age-Friendly Technology: Surface-Level Changes Disconnected from Cognitive Fit

Smart devices remain poorly adapted to older users, so friendliness is often more apparent than real. Much of the age-friendly modification now on offer stops at the interface level: developers enlarge fonts or simplify buttons to lower the operational threshold, while the cognitive patterns of older adults receive little attention. Research on interface design and older adults' cognition indicates that linear hierarchies on smart devices yield higher task efficiency and greater satisfaction among older users than mixed navigation structures do (Shi et al., 2021). When age-friendly adaptation addresses only visual presentation and ignores how older adults process information, digital intelligence technologies and tools rarely become genuinely easy to use.

3.2 Organizational Transformation: Insufficient Digital Intelligence Literacy among Practitioners

Digital intelligence transformation places new capability demands on practitioners in elderly education. High-quality development depends on teachers and managers who understand how elderly education works and who possess digital intelligence literacy. In practice, however, many practitioners' digital intelligence literacy has not kept pace with transformation, and they struggle to embed technical means in teaching and service. Training, where it is offered, tends to stop at device operation rather than addressing how data and intelligent tools can reshape curriculum and service design. Institutions face a parallel shortfall in digital intelligence operating capacity. Curriculum development, resource management and student services still lean on traditional experience, and a data-driven operating mechanism has yet to take shape, so investment in technology is not readily converted into gains in operational efficiency.

3.3 Environmental Coordination: Marginal Policy Positioning

In policy terms, elderly education has long occupied a marginal position in institutional arrangements and has been treated as an appendage of the pension system rather than as a part of the lifelong learning system in its own right. Elderly education struggles to secure support commensurate with its needs in key areas such as investment in digital infrastructure. Demand for professional development at the organizational level rarely enters the priority sequence of public resource allocation, and the returns on digital platform construction at the technological level are slow to become visible; together these produce a double pressure on the high-quality development of elderly education. Technology, organization, and environment form a dynamic interactive cycle: policy orientation determines how resources are allocated, resource input shapes organizational service capacity, service level affects how well technology lands, and technical practice and service feedback in turn prompt policy response and revision.

4. Practical Pathways for the High-Quality Development of Elderly Education Based on the TOE Framework

Using the TOE framework, this study addresses the problems facing elderly education at the levels of age-friendly technology, organizational transformation, and environmental coordination. Drawing on existing practice, it explores pathways for the high-quality development of elderly education under digital intelligence transformation, as shown in Figure 1.

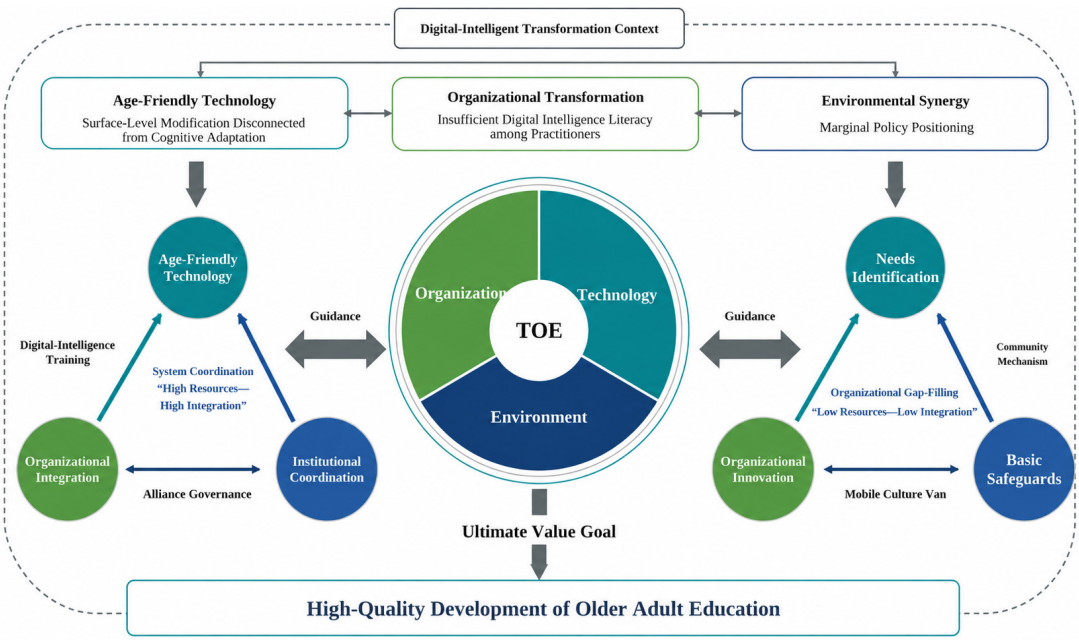

Figure 1. Framework for the High-Quality Development of Elderly Education under the TOE Framework.

4.1 The "High Resource–High Integration" Model: Improving System Performance through Policy, Technology, and Organizational Coordination

Where digital intelligence infrastructure is well developed and governance systems are mature, the priority for the digital intelligence transformation of elderly education is to connect age-friendly technology adaptation, workforce development, and institutional provision in one chain. The central task is to improve the fit between technology platforms and older adults' cognition, between technology investment and organizational service capacity, and between governance structures and collaborative governance. Zhejiang illustrates how the three elements coordinate under high resources and high integration. The province set up an elderly education alliance that draws in multiple departments and pools their resources. Standardized development guidelines spell out consultation mechanisms, educational standards and incentive arrangements, producing a governance system built around "six unifications"

and "six linkages." Bringing together Party building, teaching staff, digital intelligence, teaching, management and services places technology platforms, organizational operations and policy support within one governance framework. Jing'an District Spare Time University in Shanghai takes a different route and works through organizational capacity. It runs continuing training for full-time and part-time teachers at the district university for older adults, for community education workers, and for volunteers who help older adults with smart technologies, turning digital thinking and device skills into teaching and service capacity.

4.2 The "Low Resource-Low Integration" Model: Addressing Resource Constraints through Organizational Innovation

Remote areas, rural ones in particular, face weak digital infrastructure and limited external resources at once. Access to digital intelligence services is therefore the most immediate obstacle to high-quality development there. Such areas cannot simply copy the pathways used where resources and integration are both high; they need instead to identify what older adults actually require, allocate limited resources carefully, and mobilize grassroots organizations. In terms of the interaction among the three TOE elements, technology should serve the identification of needs, organizational innovation should build digital intelligence service capacity at the grassroots level, and environmental support should guarantee a floor of basic equity. Equipment delivered without maintenance or guidance is quickly left idle, so the fit between service design and local conditions matters more than the volume of investment. The "Nourishing Later Life through the Arts" older adult reading service project in Zhenping County offers a telling example. Sitting in the heart of the Qinba Mountains, the county has a thin supply of elderly education resources and limited digital infrastructure. To reach older adults in remote towns and villages who have few learning opportunities, it relies on a closely integrated urban and rural public cultural service community mechanism. The county has built the "Zhenping County Digital Needs Database for Older Adults" and uses fixed service sites, including Party and community service centers, cultural stations, and older adult activity centers, together with mobile cultural service vehicles equipped with tablet computers and WiFi hotspots. Services are delivered on request according to what older adults want to learn, carrying digital intelligence learning opportunities directly into remote towns and villages.

5. Conclusion

This study uses the TOE framework to examine the high-quality development of elderly education through the interaction of technology use, organizational operation, and the external environment. Theoretically, it situates the framework in the public service function of elderly education and shows that technological effectiveness has to be converted through organizational capacity and is bounded by the institutional environment. The two models, derived from differences in resource base and integration capacity, extend the framework's explanatory reach to regional variation and to divergent transformation pathways. Neither model is a fixed template, and a region may move between them as its resource base changes. Practically, digital intelligence transformation in elderly education should not take platform construction as an end in itself. Regions with a stronger resource base should strengthen regional coordination and write age-friendly technology adaptation and personnel development into governance mechanisms, forming a stable chain that converts resources into services. Regions with fewer resources can use grassroots networks to identify real needs and organizational innovation to allocate scarce resources more efficiently. Limitations remain. The cases here serve mainly to illustrate the theoretical argument and do not amount to a systematic comparison across regions or across types of elderly education institutions, so the generalizability of the conclusions still awaits empirical testing. Future work can enlarge the sample and combine interviews, questionnaires and longitudinal data to examine the conditions under which each model applies, to compare their costs and to assess their practical outcomes, further advancing the high-quality development of elderly education.

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