https://doi.org/10.37420/j.cer.2026.025

Research on the Equalization Allocation Mechanism and Implementation Pathways of High-Quality Digital Resources for Compulsory Education in the Border Region of Sichuan - Gansu - Qinghai Provinces

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Abstract:

In recent years, the Ministry of Education and other relevant authorities have spearheaded the formulation of specialized educational development plans for the border region of Sichuan, Gansu, and Qinghai provinces—encompassing 17 counties across five prefectures in these three provinces. While these efforts have accelerated the development of educational informatization in the region, issues such as imbalanced progress in digital education among the three provinces and structural inadequacies in the supply and demand mechanisms for digital educational resources have become increasingly prominent, hindering the region's pursuit of high-quality educational development. Against this backdrop, this study establishes a performance evaluation framework for the advancement of educational informatization in the Sichuan-Gansu-Qinghai border region. It analyzes the current status, challenges, and underlying causes of compulsory education informatization in the area. Subsequently, grounded in local realities, a system dynamics model is constructed and policy simulations are conducted to explore the mechanisms for equalizing the allocation of high-quality digital resources. Based on the findings, actionable implementation pathways are proposed.

Keywords:

Sichuan-Gansu-Qinghai Border Region, ompulsory Education, Equalization of High-Quality Digital Resources, Resource Allocation Mechanism

1.Introduction

In recent years, as the value of sub-frontier zones in borderland governance strategies has gained increasing recognition, these regions—serving as geographical, economic, political, and cultural corridors connecting interior heartlands with primary frontier areas—represent "dual-peripheral" spaces that are inextricably linked to main frontier zones. They epitomize areas of unbalanced and insufficient development, constitute concentrated regions where hostile forces intervene, and represent hotspots for non-traditional security threats. Historically, as central authorities of dynastic states strategically administered contemporary western China's

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primary borderlands, they profoundly recognized the critical strategic importance of governing sub-frontier regions such as present-day Gansu, Qinghai, and Sichuan, undertaking extensive practical explorations. In 2015, the Central Committee of the Jiusan Society, in collaboration with provincial committees of the three provinces, completed the Research Report on Coordinating Development in Tibetan-populated Convergent Zones at the Junction of Sichuan, Gansu, and Qinghai, which was submitted to the Political Bureau of the CPC Central Committee, prompting important directives from national leaders. The following year, the Ministry of Education issued the Guiding Opinions on Promoting Educational Development in the Border Regions of Sichuan, Gansu, and Qinghai to guide the three provinces in formulating specialized educational development plans for these convergent zones. While compulsory education informatization in this region has entered a rapid development trajectory, increasingly prominent issues such as unbalanced educational informatization development across sub-regions and imperfect mechanisms for digital educational resource supply and demand have constrained high-quality educational development.

Through literature review and field investigation, we find that the optimal allocation of digital educational resources, as a key to effective utilization of high-quality digital resources, represents one of the core issues urgently requiring resolution in both practice and theoretical research on compulsory education informatization in the Sichuan-Gansu-Qinghai border convergent zones. Concurrently, the report of the 20th CPC National Congress included advancing education digitalization in Party Congress documentation for the first time. President Xi Jinping emphasized that educational digitalization constitutes a critical breakthrough for China to open new tracks and create new advantages in educational development. In January 2025, the Outline of the Education Powerhouse Construction Plan (2024–2035) explicitly proposed enhancing lifelong learning public service provision, implementing the National Education Digitalization Strategy, and promoting AI-facilitated educational transformation [1]. In April of the same year, nine ministries jointly issued the Opinions on Accelerating Education Digitalization, which clearly stipulates: "Prioritize support for rural areas, ethnic regions, and poverty-alleviated areas" and "construct cross-level, cross-regional, and cross-departmental educational data sharing networks to facilitate data circulation" [2]. Based on these policy frameworks, this study will examine problems in digital resource allocation for compulsory education in the Sichuan-Gansu-Qinghai border convergent zones, investigate mechanisms for equalized allocation, and subsequently propose effective pathways suitable for achieving equitable development of high-quality digital resources for compulsory education in this region.

2. Literature Review

2.1 Research on Digital Education Resource Construction

International and domestic scholarly research on digital education resource construction primarily revolves around four dimensions: environmental platforms, resource creation, resource management, and resource utilization. Serving as foundational infrastructure, research on environmental platforms encompasses platform architectures based on SOA (Service-Oriented Architecture) and cloud computing integration, security assurance technologies, SCORM-standardized transformation applications, and copyright protection strategies within open resource contexts. Resource creation concentrates on the design and development of instructional resources, repositories, and curricula, with research trajectories evolving from early explorations of media

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formats and development technologies toward contemporary concerns with co-creation, sharing, and ecologically sustainable development models. Research on resource management focuses on co-construction and sharing mechanisms, with an evolutionary path progressing from sharing framework design to deeper theoretical model construction incorporating information ecology and knowledge-sharing theories, and developing diversified collaborative models such as "public construction with mass sharing" and "regional co-construction." Recent research further emphasizes precision delivery and user co-creation [3]. Resource utilization research underscores integration and application, proposing hierarchical strategies for resource integration and interoperability technologies, while analyzing integration models and effectiveness based on extensive regional case studies [4]. Overall, this field has established a research continuum spanning technological infrastructure, content production, mechanism operation, and pedagogical application.

2.2 Research on Educational Equity in China

Since the 1980s, foreign scholars have begun to focus on educational equity in China and have conducted related research. Over the past four decades, the focus of this scholarly inquiry has gradually shifted from macro-level issues, such as the transformation of educational modernization and strategies following the reform and opening-up, to more micro-level areas. These include specific reform practices, the measurement of educational equity, and the optimization of policies for educational equalization. Current research topics encompass insufficient educational service resources, the relationship between the household registration system and educational equality, the referencing and learning from international experiences, unequal distribution of educational resources in "border and remote areas," student nutritional status, as well as the development and participation outcomes of compulsory education in southwestern China [5]. Additionally, some scholars have conducted research from socio-economic and geographical perspectives. Furthermore, topics such as how non-governmental organizations intervene, legal mobilization and individual students' educational choices, and the influence of mothers' educational attitudes and teachers' experiences have also garnered scholarly attention [6].

2.3 Research on Education and Development in Tibet-related Regions of China

Issues such as low progression rates to higher education and low rates of re-education after basic education, coupled with low levels of student satisfaction and sense of educational attainment, characterize the "sharp fluctuations" in the educational development of Tibetan regions, where educational experiences often fail to meet the demands of the job market. Scholars have conducted research from various perspectives, including adult education, the impact of local socio-economic development on educational progress, the protection of girls' right to education, the effects and performance of the "Three Guarantees" policy on basic education, the role of culture in the equalization of bilingual education, the influence of religious and cultural traditions, and the learning and living conditions in boarding schools [7].

2.4 Literature Review

In summary, existing research still has room for improvement in terms of theoretical depth and methodological rigor. Most studies focus on application-oriented perspectives and model conceptualizations, generally lacking the construction of original, meso-level theoretical frameworks. Regarding research methods, there

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is a need to move beyond descriptive case analyses and adopt more rigorous approaches such as mixed-methods research and longitudinal tracking. Particularly in the dimension of "resource usage," current studies predominantly adopt a managerial perspective, offering insufficient exploration into end-users' adoption behaviors, contextualized experiences, and the mechanisms influencing learning outcomes. Future research should integrate theories such as learning analytics and technology acceptance to conduct refined empirical investigations. Simultaneously, studies should enhance international dialogue, engage with cutting-edge topics like artificial intelligence-enabled empowerment and learning science-driven digital educational resource design, while maintaining critical reflection on ethical risks in technology application and issues of digital equity. This will promote the advancement of research in this field, particularly in deepening the theoretical, methodological, and perspectival approaches focused on areas such as the equitable allocation of high-quality digital resources for compulsory education in the Sichuan-Gansu-Qinghai border region.

3. Design and Methodology

3.1 Research Design

This study integrates theories from management science, mathematics, computer science, and pedagogy. It adopts perspectives of resource collaborative allocation and public service equalization, and introduces system dynamics methods and policy simulation technology. The analysis focuses on the equalization allocation of high-quality digital resources for compulsory education in the Sichuan-Gansu-Qinghai border region. The research process is as follows: First, a performance evaluation index system is constructed to assess the development of educational informatization for compulsory education in this region. Subsequently, using the aforementioned evaluation tool, field research and analysis are conducted on the current level of informatization development, issues in the optimal allocation process of digital educational resources, as well as the causes and efficiency of the unequal allocation of high-quality digital resources in the region's compulsory education. Following this, based on the practical context of digital resource allocation for compulsory education in the area, a system dynamics model of the allocation mechanism for high-quality digital educational resources is constructed. Policy simulations are then performed to explore the internal operational mechanisms for optimizing the allocation of digital resources in compulsory education within the Sichuan-Gansu-Qinghai border region. Finally, specific pathways suitable for achieving the equalization allocation of high-quality digital resources in the region's compulsory education are proposed.

3.2 Research Objectives

3.2.1 Academic Theory Objectives

Firstly, to construct a performance evaluation index system for the development of educational informatization in compulsory education within ethnic minority regions. Secondly, to develop a system dynamics model for the allocation mechanism of high-quality digital educational resources in the Sichuan-Gansu-Qinghai border region.

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3.2.2 Decision-Support Objectives

Based on policy simulations using the system dynamics model, to establish monitoring and forecasting mechanisms for changes in the performance of digital resource allocation for compulsory education in the Sichuan-Gansu-Qinghai border region. The aim is to design pathways and countermeasures suitable for achieving the equalization of high-quality digital resource allocation in the region's compulsory education. This will provide decision-making support for relevant government departments across the 5 prefectures and 17 counties under the jurisdiction of Sichuan, Gansu, and Qinghai provinces, enabling them to optimize the allocation of high-quality digital resources for compulsory education, enhance the governance capacity of educational informatization, and promote the high-quality development of compulsory education in ethnic minority regions.

3.2.3 Empirical Exploration Objectives

Through field research, to grasp the current level of educational informatization development in compulsory education within the Sichuan-Gansu-Qinghai border region, identify existing problems in the process of optimizing digital educational resource allocation, and understand the key factors contributing to the unequal distribution of high-quality digital resources.

3.3 Research Methodology

3.3.1 Questionnaire Survey Method

This study employs a questionnaire survey to understand and analyze users' attitudes towards the use of digital educational resources. This includes evaluating the quality of digital educational resources, assessing satisfaction with their use, and exploring the internal and external motivations that drive users' sustained engagement. The goal is to identify the key factors and mechanisms affecting satisfaction with digital educational resource quality and users' continued usage, thereby enabling the formulation of targeted strategies to improve resource quality and usage performance. The questionnaire design strictly follows established guidelines from questionnaire design manuals [8]. It also incorporates the specific characteristics of digital educational resources and draws upon relevant, well-regarded questionnaires previously published in the literature. Two questionnaires were developed for this study: the "Survey on User Satisfaction with the Quality of Digital Resources for Compulsory Education in the Sichuan-Gansu-Qinghai Border Region" and the "Survey on Sustained Usage of Digital Resources for Compulsory Education in the Sichuan-Gansu-Qinghai Border Region."

3.3.2 System Dynamics Method

This study aims to construct a system dynamics model to explore the transformation of the digital educational resource allocation model for compulsory education in the Sichuan-Gansu-Qinghai border region. The operational mechanisms of digital educational resource allocation are investigated by adjusting parameters or altering the model's structure. Using causal analysis within the system dynamics framework, the main feedback structures of the "co-construction and sharing" mechanism for digital educational resources are identified. Subsequently, a system dynamics analytical model is built, including flow diagrams and equations that

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link resource quality and user behavior. Following model testing, simulations are conducted using Vensim software, focusing on indicators such as the utilization rate of digital educational resources. These simulations model the internal structure and operational mechanisms of the digital resource allocation system for compulsory education in the border region, leading to proposals for effective implementation pathways.

3.3.3 Mathematical Modeling and Simulation Method

This study develops a dynamic investment strategy model for funding the development of digital educational resources in compulsory education, based on the mathematical modeling process. This includes: a metering model for procuring compulsory education digital resource services based on "user feedback"; a metering model for the "exchange and sharing" of digital educational resources between regions; and a metering model for incentivizing the use of digital educational resources based on users' cumulative points. Concurrently, computer-based stochastic simulation is used to generate data that conforms to realistic scenarios. Analysis of this data aims to determine a dynamic, mutually reinforcing ratio between development costs and usage fees for compulsory education digital resources, thereby introducing greater scientific rigor into funding allocations. The simulations also model the process of how cumulative points for a single digital resource change with user engagement, helping to determine appropriate payment rates for resource procurement and enhance resource quality. Furthermore, they simulate settlement rates for usage imbalances under different inter-regional exchange agreements to expand the sharing scope of high-quality digital resources. Finally, by simulating changes in a single user's cumulative points during resource use, the study seeks to determine an optimal ratio between funding for constructing the digital resource environment and funding for usage incentives. This aims to improve the educational informatization infrastructure in compulsory education schools within the border region and foster an environment conducive to the active use of digital educational resources.

4. Results and Discussion

4.1 Survey Results and Discussion on the Informatization Level of Compulsory Education Schools in the Sichuan-Gansu-Qinghai Border Region

As early as 2015, research conducted by the Central Committee of the Jiusan Society highlighted the slow development of social undertakings such as education and healthcare in the Sichuan-Gansu-Qinghai border region, coupled with an inadequate public service system. Recommendations were made for coordinated development, focusing on addressing issues like insufficient education funding and a weak teaching workforce. Specific directions proposed included promoting "15-year free education" and strengthening bilingual and vocational education. Concurrently, at the national level, education authorities issued successive special policies to drive progress. In December 2016, the Ministry of Education issued the Guiding Opinions on Promoting Educational Development in the Sichuan-Gansu-Qinghai Border Region, explicitly identifying the improvement of educational informatization as a key task, aiming to expand the coverage of quality education through enhanced infrastructure and digital educational resource development. Subsequently, in its 2017 work priorities and responses to proposals, the Ministry further required Sichuan, Gansu, and Qinghai provinces to formulate special plans to implement preferential policies, including the comprehensive provision of 15-year

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free education, strengthening the development of bilingual teaching staff, and vigorously developing secondary vocational education. It was also confirmed that the region had achieved 3-year free preschool education. Since 2017, relevant counties (cities) have continuously held regional coordination meetings, signing a series of framework agreements that list "science, education, and culture" and "equalization of public services" as core areas of cooperation. Significant progress has been made in the informatization of compulsory education in the border region, with increasingly improved allocation of digital educational resources. However, numerous challenges persist in the construction of educational informatization and the optimal allocation of digital educational resources.

In December 2025, the research team conducted field surveys in one primary school and one junior high school each from County A in Aba Tibetan and Qiang Autonomous Prefecture, County M in Gannan Tibetan Autonomous Prefecture, and County J in Golog Tibetan Autonomous Prefecture, focusing on four key areas. The findings are as follows:

(1) Teachers' and Students' Awareness and Understanding of Digital Resources. Regarding perceived importance, overall recognition among teachers and students is relatively high, but a significant urban-rural disparity exists: the proportion of "strongly agree" responses reached 44.19% in provincial capital cities, compared to only 24.67% in pastoral and agricultural areas. Meanwhile, a notable proportion (15.24%) in pastoral and agricultural areas expressed "uncertainty." In terms of understanding the essence of digital resources, a stepwise improvement is observed from pastoral/agricultural areas (22.0%) to urban areas (56.9%). This gradient difference in awareness and understanding profoundly reflects disparities in the penetration of digital educational resources and the effectiveness of educational outreach between regions. Not only do pastoral/agricultural areas have fewer opportunities to access quality resources, but they may also lack systematic conceptual guidance. Therefore, a combined approach of "concept popularization + case demonstration" should be adopted, specifically targeting teachers and students in compulsory education in pastoral/agricultural areas to promote and interpret the value of digital education, laying an ideological foundation for its practical application.

(2) Construction and Practical Application of Digital Education Facilities. The frequency of using both multimedia equipment and teaching platforms shows a positive correlation with regional development levels. The proportion of "frequent use" of multimedia increased from 22.53% in pastoral/agricultural areas to 32.65% in urban areas. For teaching platforms, this proportion rose from 7.94% in pastoral/agricultural areas to 36.67% in urban areas. Notably, feedback indicating teaching platforms as "inconvenient to use" reached 46.49% in pastoral/agricultural areas, far exceeding other regions. The results indicate that low facility usage rates are intertwined with perceptions of "inconvenience," suggesting that pastoral/agricultural areas face not only "hard gaps" in hardware configuration but, more critically, "soft barriers" related to usability, ease of use, and applicability. Simply increasing equipment investment cannot solve the problem. It is essential to simultaneously optimize platforms, provide continuous technical support, and encourage the development of localized, ethnic-language resources to truly integrate facilities into daily teaching.

(3) Teacher Capacity Development, Training Needs, and Proactiveness in Resource Acquisition. Teachers express a strong demand for training on the integration of information technology into the curriculum, with proportions exceeding 90% for township and county town teachers and reaching 73% in pastoral/agricultural

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areas. Concurrently, the willingness of teachers and students to proactively acquire digital resources strengthens with higher regional administrative levels: the proportion "strongly agreeing" to proactive acquisition is 32.94% in county towns, compared to 17.50% in pastoral/agricultural areas. This contrast between strong training needs and relatively weak proactive acquisition willingness is particularly pronounced in pastoral/agricultural areas. It suggests that while teachers have the desire for change, they may lack action due to insufficient skills, confidence, or inaccessible pathways. Therefore, teacher development support should go beyond mere skill training to build a comprehensive support system, empowering teachers to become proactive designers and creators of quality digital educational resources.

(4) Support Systems and Management Mechanisms. Regarding management mechanisms, the proportion of schools with dedicated personnel responsible for digital resource development increases stepwise from 10.0% in pastoral/agricultural areas to 68.0% in urban areas. In pastoral/agricultural areas, 44.7% of schools have no dedicated management personnel. Furthermore, the survey also examined comprehensive factors affecting resource use and resource sharing mechanisms. The significant disparity in the allocation of dedicated management personnel is an institutional cause of the urban-rural gap in the quality of digital resource development, updating, and maintenance. A sound support system requires not only "dedicated personnel and positions" but also the establishment of closed-loop management processes. Simultaneously, systematic investigation and removal of various obstacles affecting resource use are necessary. By establishing regional resource sharing platforms and incentive mechanisms, the flow of resources between schools and across urban-rural divides can be promoted, thereby enhancing the resilience and efficiency of the entire educational digital ecosystem.

4.2 Results and Discussion on the Construction of the System Dynamics Model

4.2.1 Analysis of the Regional Digital Educational Resource Allocation System Structure

System dynamics posits that a system's behavior is determined by its structure, and it studies the dynamic behavior of complex information feedback systems through "structure-function" analysis. The system of digital educational resource quality and user utilization primarily consists of three modules: resource development and quality improvement, user utilization, and regional education authorities. Furthermore, improvements in resource quality, user incentive measures, and government fund allocation all revolve around the resource utilization rate [9]. The system structure and operational mechanism are illustrated in Figure 1. The dashed box represents the system boundary. Due to the limitations of human knowledge and cognitive capacity, it is often necessary to "close" the model boundary according to research needs, meaning to "know what to include and what to exclude" [10]. This approach, starting from the essence of the problem, treats factors relevant to the modeling objective as endogenous variables within the system, while considering other factors as exogenous or environmental variables, thereby focusing attention squarely on the core issue.

In summary, the education authority, acting as the organizer for regional digital educational resource development and utilization, is primarily responsible for adjusting resource and service pricing, formulating annual funding allocation plans for special educational informatization projects, establishing cloud service platforms for digital educational resource use, and providing scientifically justified incentives based on the performance of users and resources. Software development enterprises, based on user demands for resources and government commissions or customization requirements, leverage their technological and financial strengths to

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produce digital educational resources that meet corresponding technical standards. They also provide ongoing services such as quality improvement and technical support, and sometimes develop new products. Current users selectively utilize high-quality digital educational resources for teaching and learning purposes. Schools are responsible for constructing the informatization environment and encouraging active use by teachers and students. During the usage process, users provide reasonable evaluations and improvement suggestions based on teaching effectiveness and satisfaction, and promptly transmit this feedback to software development enterprises to facilitate resource quality improvement.

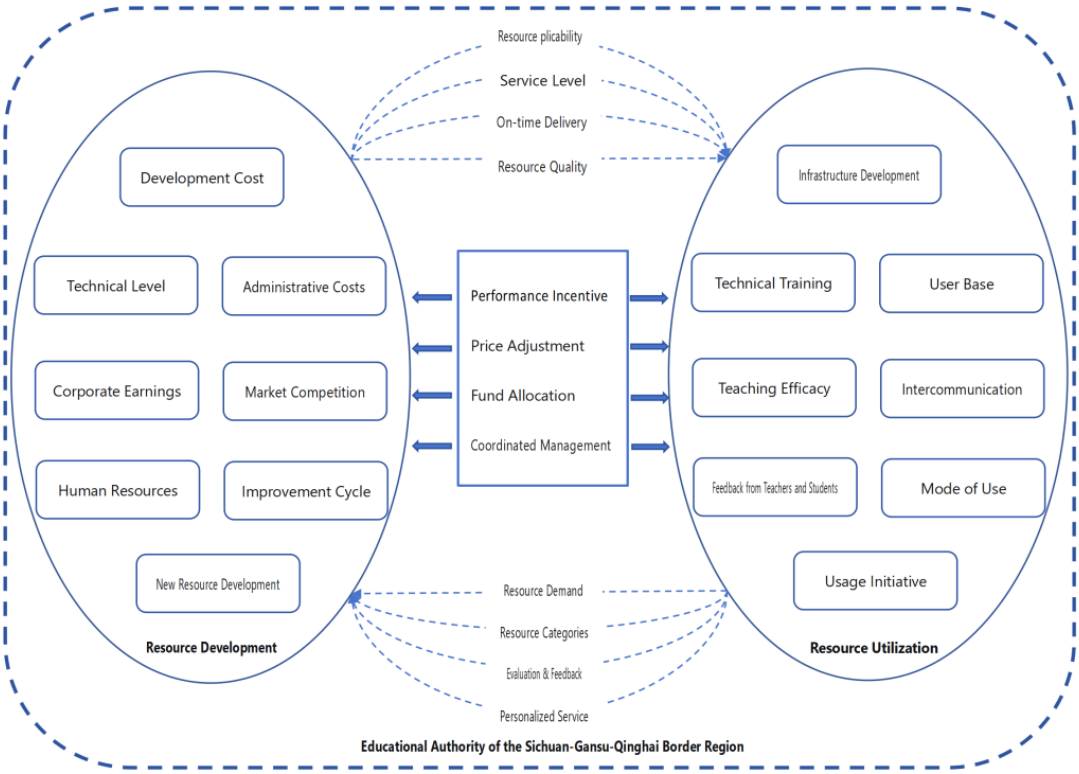


Figure 1. Structure of the Co-construction and Sharing System for Digital Educational Resources

4.2.2 Qualitative Analysis of Causal Feedback in the Digital Educational Resource Allocation Mechanism

The regional (county/city) education administrative department serves as both the main investor and builder of digital educational resources and the organizer of their development and utilization within the region. Its main responsibilities include formulating annual funding allocation plans for digital educational resource projects, establishing co-construction and sharing resource centers and service platforms, providing scientifically justified incentives based on the usage performance of users and resources, and developing strategies for adjusting resource pricing. All school users within the jurisdiction share digital educational resources from the resource center via the service platform. Schools are responsible for building the informatization environment, encouraging active utilization by teachers and students, and soliciting reasonable evaluations and improvement suggestions based on teaching effectiveness and satisfaction during use. Resource development enterprises, responding to user demands and government commissions or customization requirements, lever-

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age their technological and financial strengths to develop digital educational resources that comply with relevant technical standards, and provide services such as post-development quality improvement and technical support [11]. Based on the fundamental structure and operational mechanism of the co-construction and sharing allocation system for basic education digital resources, this study maps the causal relationships among various elements of digital educational resource allocation.

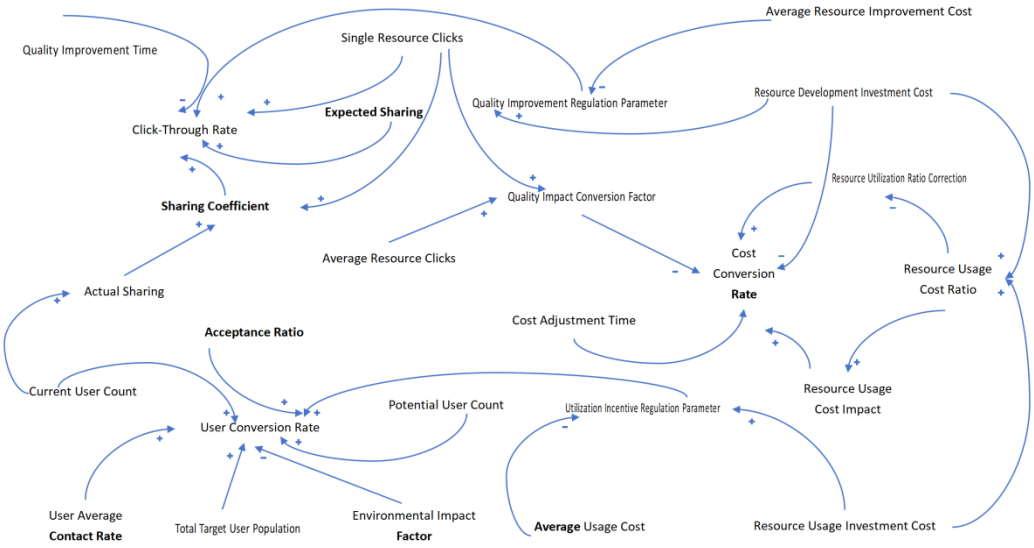


Figure 2. Causal Relationship Diagram of the Operation Mechanism for Co-construction and Sharing of Digital Resources in Compulsory Education in the Sichuan-Gansu-Qinghai Border Region

4.2.3 Analysis of the System Dynamics Model Construction for the Resource Allocation Mechanism

Based on the fundamental principles of system dynamics, this study constructed a system dynamics model to analyze the relationship between resource quality and user utilization behavior. During the modeling process, key consideration was given to core variables such as resource quality, resource utilization rate, user scale, total funding, and its allocation ratios. Concurrently, to simplify the system boundary and highlight the primary driving mechanisms, factors such as government funding sources, corporate competition behavior, internal corporate technological and management levels, and the specific usage processes of teachers and students were treated as secondary conditions. Furthermore, appropriate simplifications were made to aspects like the cost structure of school informatization construction during the compulsory education stage, resource configuration relationships, and government procurement processes for digital resources. The final model comprises a total of 26 variables, specifically including: 5 state variables (single resource click-through volume, current number of users, potential number of users, resource development investment cost, resource usage investment cost), 3 rate variables (click-through rate, user conversion rate, cost conversion rate), 8 auxiliary variables (e.g., actual sharing degree, resource usage ratio correction coefficient, utilization incentive regulation parameter, etc.), and 10 constants (including parameters such as quality improvement cycle, average user contact rate, environmental impact factor, etc.).

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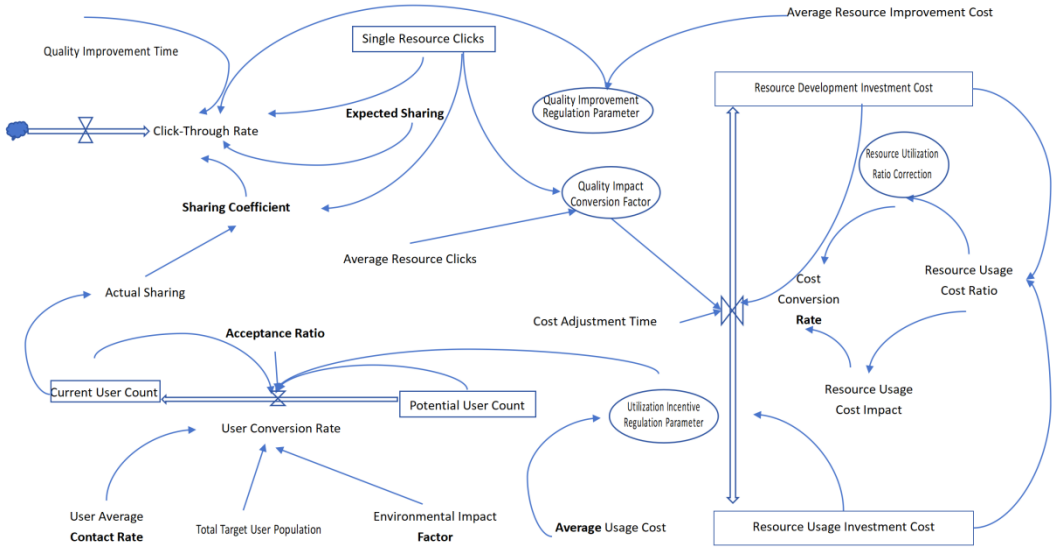


Figure 3. Stock and Flow Diagram of the Digital Educational Resource Quality and User Utilization System

4.3 Policy Simulation Results and Discussion

Based on the Vensim simulation platform, this study constructed a system dynamics model to analyze the impact mechanisms of different policy variables on the utilization rate of digital educational resources. Simulation experiments were conducted primarily from the following two perspectives.

4.3.1 Simulation of the Impact of Environment-User Relationship on Resource Utilization Rate

A sound informatization environment serves as a crucial foundation for promoting the co-construction and sharing of digital educational resources. This environment not only supports users in efficiently obtaining needed resources but also facilitates interaction and dissemination during resource use. The concept of an informatization environment encompasses not only hardware facilities and network conditions but also the requisite digital literacy, awareness of use, and operational skills that resource users must possess. In actual usage scenarios, users often exhibit psychological characteristics such as the desire for knowledge, curiosity, and conformity. When digital educational resources can promptly meet their learning or teaching needs, users are more willing to share their usage experiences, thereby creating a positive diffusion effect that attracts more potential users to try the resources [12].

The simulation results further confirm the promoting effect of user-to-user communication on resource utilization (see Figure 4). As the average user contact rate increases (set at values of 6, 8, and 10 respectively), the speed at which potential users convert into actual users accelerates noticeably, leading to a significant rise in the resource utilization rate during the early simulation phase. Furthermore, the study also indicates that a larger initial user base results in a more rapid increase in the resource utilization rate. However, as the pool of potential users gradually diminishes, the utilization rate shows a declining trend in the later stages of the simulation. Moreover, a higher user contact rate is associated with a faster rate of decline. This dynamic change

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suggests that managers should adopt a forward-thinking planning mindset. On one hand, it is necessary to timely promote the development and updating of new resources to maintain their attractiveness. On the other hand, efforts should be made to actively expand the target user base to prevent insufficient potential users from undermining the long-term utilization efficiency of the resources.

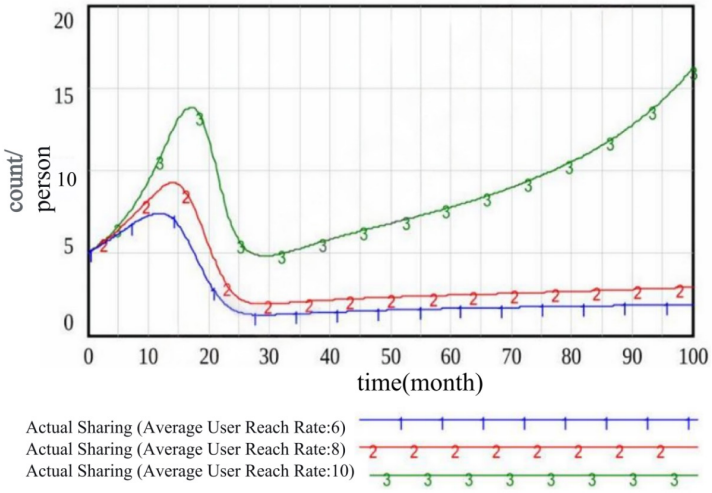


Figure 4. Simulation Results of the Impact of User-to-User Communication on the Utilization Rate of Digital Educational Resources

4.3.2 Simulation of the Impact of Digital Educational Resource Costs on the Resource Utilization Rate

This study adopts a co-construction and sharing model characterized by "government leadership, enterprise development, and school application" to advance the construction of digital educational resources. This model relies on market mechanisms to balance the benefits for resource producers and the needs of users. The pricing is predicted and assessed based on the characteristic indicators that information goods exhibit in the market and is dynamically adjusted according to the economic benefits generated through practical application. Simulation analysis indicates (Figure 5) that as resource development technology matures, development and improvement costs decrease correspondingly. This expands the profit margin for digital educational resource providers, thereby incentivizing them to continuously optimize resource quality. The stable supply of high-quality resources effectively promotes the actual utilization level of the resources. Simultaneously, the simulation results also suggest that when initially launching a digital educational resource product, significant emphasis must be placed on its initial quality. Prematurely releasing immature resources for short-term gains not only increases subsequent improvement costs but will also, in the long run, significantly hinder the growth of the user base, leading to a substantial decline in the resource utilization rate. This finding also explains why teachers often exhibit cautious or even resistant attitudes when faced with digital educational resources of varying quality.

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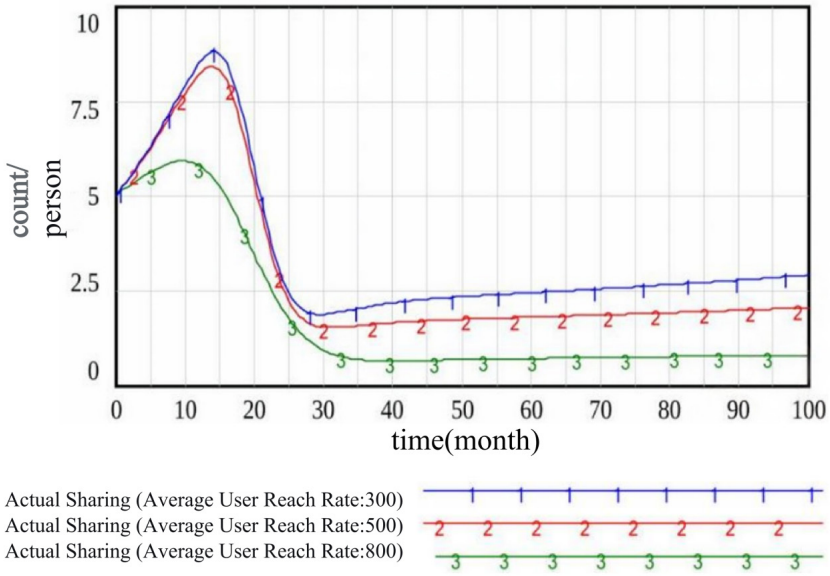


Figure 5. Simulation Results of the Impact of Digital Educational Resource Improvement Costs on the Utilization Rate

5. Conclusions and Recommendations

5.1 The Significant Application Value of System Dynamics in Research on High-Quality Digital Resource Allocation for Compulsory Education

System dynamics, as an interdisciplinary field that integrates systems science theory with computer simulation, excels at revealing the feedback structures and dynamic behaviors of systems through modeling and simulation. It is particularly well-suited for analyzing the complexity, dynamism, and information feedback characteristics inherent in the co-construction and sharing mechanisms of digital educational resources. This method offers unique advantages when investigating nonlinear issues such as resource quality enhancement, user incentive strategies, rational fund allocation, and long-term development planning. Applying system dynamics to study digital educational resource allocation can not only expand the theoretical application of systems science in the field of educational informatization but also provide a basis for predicting regional trends in educational informatization development.

Following system dynamics modeling conventions, this study identified key feedback structures within digital educational resource allocation through causal analysis. It constructed system flow diagrams and equations linking resource quality and user utilization. After model testing, simulation analyses were conducted focusing on the resource utilization rate. Based on these findings, the study proposes establishing a comprehensive incentive mechanism for resource development and use, coordinating market-based and government-led allocation methods, building information feedback platforms between producers and consumers, and fostering a favorable environment for user interaction and informatization. By introducing measures such as price adjustments and tiered resource point systems, resource utilization efficiency can be effectively enhanced. This promotes the continuous evolution of resource quality through a competitive mechanism of

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"survival of the fittest," gradually achieving optimized allocation [13].

5.2 The "Co-Construction, Sharing, and Exchange" Collaborative Allocation Model Promotes the Equalization of High-Quality Digital Resources in Compulsory Education within the Sichuan-Gansu-Qinghai Border Region

This study proposes and constructs a regional "co-construction, sharing, and exchange" collaborative allocation model for digital educational resources in basic education [14]. This model helps expand the beneficiary scope of high-quality resources and promotes the equalization of public services for digital educational resources across a large-scale region. The traditional practice of "each school building its own repository" suffers from multiple limitations, including dispersed funding for resource development, a lack of economies of scale, prominent low-level redundant construction, insufficient regional sharing mechanisms, significant regional disparities in high-quality resources, inadequate sharing, and limited benefit coverage.

To address these issues, this study breaks through the closed concept of "educational resources being solely self-built by the education system." Following the development logic of "application-driven, government-led, enterprise-developed, and proactive service," it designs a new paradigm for the equalization of digital educational resource services in basic education under an informatized environment: the "intra-regional co-construction and sharing" configuration model. This model shifts the concept of optimal resource allocation from being closed, static, and singular to being open, dynamic, and pluralistic. It redefines the roles and positioning of the government, enterprises, schools, and users within the allocation process, enabling them to form an organically collaborative whole. By placing resource quality and usage efficiency at its core and paying greater attention to the returns on capital investment, this model facilitates the leap of digital educational resource services from "equality within schools" to "equality within the region," effectively alleviating the imbalance of resource allocation among schools.

Furthermore, the "inter-regional exchange and sharing" mechanism promotes the complementary advantages and dynamic equilibrium of high-quality digital educational resources among different regions. By establishing a cross-regional resource exchange system and a coordinated development mechanism, the overall quality and scale of resource development can be significantly enhanced, and the integrative effect of regionally characteristic resources can be strengthened. Based on the principles of "whoever invests, benefits" and rights protection, this mechanism achieves effective sharing of resources between regions through methods such as negotiated purchasing/billing and balance settlement, thereby promoting the equal allocation of high-quality digital educational resource services across an even broader scope.

5.3 Introducing Service Outsourcing and Market Mechanisms to Promote the Commercial Operation of High-Quality Digital Resources in Compulsory Education in the Sichuan-Gansu-Qinghai Border Region

As the marketization of public services becomes a significant direction for transforming government functions, the means of resource allocation are gradually extending from government leadership to market regulation. Drawing on New Public Management theory and under the premise of fostering a strong sense of community for the Chinese nation, this study introduces market mechanisms and service outsourcing into the

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allocation of high-quality digital resources for compulsory education in the Sichuan-Gansu-Qinghai border region. It leverages social forces and corporate resources to enhance the efficiency and quality of public service provision.

The endogenous drivers for promoting service outsourcing primarily include leveraging external professional resources to reduce development costs, enabling various entities to focus on their core functions, and improving management efficiency and resource quality. External factors involve advancements in information technology, the diversification of user needs, and the formation of a competitive market environment. Building on this, the study proposes that the supply of digital educational resources for basic education should follow a "one-leading, multi-participatory" model. This model insists on government leadership while encouraging the joint participation of enterprises and social organizations to form a collaborative supply framework. In this process, the government primarily assumes the responsibilities of providing resource development funds and offering policy guidance, rather than directly producing the resources. Actual production can be entrusted to public sectors, non-profit organizations, or private institutions. This arrangement aims to separate funding from production and decision-making from execution, thereby fully responding to user needs, granting autonomous choice, and relying on the technical advantages of third parties to ultimately enhance the supply efficiency of digital educational resources.

At the operational mechanism level, using public service outsourcing as a practical entry point, this study explores the establishment of a new resource development mechanism characterized by "competitive enterprise provision, government evaluation for access/qualification, and school autonomous selection." Based on theories of comparative advantage, economies of scale, and value chain, a digital educational resource service outsourcing supply model is constructed, which is "demand-driven, government-led, enterprise-undertaken, and service-oriented."

Funding

This project is supported by the 2025 project of the Aba Prefecture Philosophy and Social Sciences Key Research Base—Basic Education Development Research Center of the Sichuan-Gansu-Qinghai Border Region(No. ABKT-CGQ2025-10).

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