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A Study on the Construction and Evaluation of a Learner-Centered Educational Ecosystem Empowered by Digital and Intelligent Technologies

Haitao Chen, Guihua Lai, Lu Ren, Xinxiu Wang

School of Education, Guizhou Normal University, Guiyang 550025, Guizhou, China

Abstract: The application of digital intelligence technologies is a central issue in educational transformation in the digital and intelligent era. To enhance teachers' practical abilities in using digital and intelligent technologies to build educational ecosystems, this paper focuses on the construction and evaluation of "student-centered" educational ecosystems empowered by digital and intelligent technologies. It elucidates the driving value of digital and intelligent technologies in restructuring educational ecosystems, analyzes the core components of such ecosystems, explores practical pathways for their implementation, and constructs a suitable evaluation system for educational ecosystems. This research can provide theoretical guidance for teachers in the new era to build educational ecosystems using digital and intelligent technologies and enhance their own digital and intelligent literacy, as well as contribute to the development of high-quality education in China.

Keywords: Digital intelligence technologies; Educational ecosystem; Evaluation system

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1. Introduction

Digital and intelligent technologies are the product of the deep integration of digitization and intelligence. Leveraging technical advantages such as dynamic updates and real-time processing, they enable the rapid screening and precise matching of vast amounts of educational resources and have become a key tool driving transformation in modern education [1]. Traditional teaching models tend to be relatively one-dimensional in practice, making it difficult to accommodate students' individualized development needs; this not only hampers the development of students' learning abilities but also poses practical challenges for classroom instruction. With the iterative development of digital and intelligent technologies, educational philosophies have gradually shifted toward a learner-centered approach. The "learner-centered" educational philosophy

emphasizes the learner's central role, prioritizes the cultivation of students' learning abilities and personalized growth, and drives the transformation of classroom teaching paradigms from "teacher-centered" to "learner-centered." This teaching model is gradually being implemented in school educational practices.

At the same time, to thoroughly implement the strategic plan outlined at the 20th National Congress of the Communist Party of China regarding the accelerated development of an education powerhouse, as well as the State Council's "Outline of the Plan for Building an Education Powerhouse (2024–2035)," educators aim to promote the healthy growth and all-round development of students, thoroughly implement quality-oriented education, facilitate students' individualized development, and strengthen their central role in the learning process [2]. A learner-centered teaching model can highlight students' central role and facilitate active learning. At the same time, digital and intelligent technologies, with their powerful data processing, intelligent analysis, and interactive capabilities, provide robust technical support for a learner-centered educational ecosystem while also imposing new requirements on educational assessment. Educational assessment is crucial to the direction of educational development and to the success or failure of building an education powerhouse [3]. By leveraging digital and intelligent technologies, educators can drive reforms in evaluation mechanisms, establish a diversified evaluation system, and facilitate a leap from quantity-based to quality-based assessment. Therefore, in-depth research into the construction and evaluation of a learner-centered educational ecosystem empowered by digital and intelligent technologies is of great significance for promoting the rapid development of education and teaching.

2. Key elements of a learner-centered approach empowered by digital and intelligent technologies

As the central participants in the learning process, students possess diverse personalities and unique interests and aptitudes. Learner-centered instruction requires students to engage deeply in instructional activities and construct their own knowledge through diverse forms of interactive learning. Building a learner-centered educational ecosystem is a key strategy for overcoming the current challenges posed by overly uniform teaching models. It not only promotes the enhancement of teachers' professional competencies, shifts traditional teaching paradigms, and develops their digital and intelligent teaching competencies, but also effectively empowers students to develop their independent learning abilities.

2.1. Transformation of teaching subjects

Hartmut Rosa argues that the subject and the world are not simply isolated entities, but are produced through their mutual connections and interactions [4]. The deep penetration of digital and intelligent technologies into the educational sphere has reshaped the interactive relationship between educational agents and the knowledge system [5]. Under traditional teaching models, students often occupy a passive role in receiving knowledge and find it difficult to truly become active participants in the teaching process. However, within the intelligent learning environments and educational ecosystems constructed by digital and intelligent technologies, students can independently design learning plans tailored to their individual characteristics, actively engage in knowledge construction, participate deeply in the entire teaching process, and fully exercise their subjective initiative in learning. Technology has reshaped teachers' traditional modes of knowledge production and livelihood, giving rise to entirely new forms of teaching and individual practice

models. In a learner-centered educational paradigm, teachers continue to play a vital role in advancing the teaching process; however, the focus of teaching activities should shift toward students, establishing their central role in the progression of instruction.

2.2. Massive learning resources

The application of digital and intelligent technologies has broken through the temporal and spatial boundaries of traditional access to educational resources, providing strong support for the integration and allocation of such resources [1]. With the rapid evolution of information technology, teaching resources have experienced explosive growth, and the capacity to provide learning resources has continued to improve. Cloud computing and big data technologies have generated vast amounts of knowledge resources, while various teaching tools and learning resources are profoundly transforming the landscape of modern education. Online platforms such as MOOCs cover diverse content ranging from foundational knowledge to specialized fields. These vast learning resources span multiple disciplines, educational levels, and diverse teaching formats. Resource types—including courseware, instructional videos, animations, and images—can create multidimensional learning environments, enrich the learning experience, and adapt to varied teaching scenarios and learning needs. Leveraging digital and intelligent technologies, teaching resources can be dynamically updated based on learners' interests, progress, and individual characteristics, thereby maximizing alignment with students' learning needs. Natural language processing technology can also assist teachers in iterating learning resources and optimizing and refining instructional content.

2.3. Optimization of the learning environment

In the late 1960s, China began research on learning environments. Having gone through developmental stages ranging from the formulation of theories and preliminary applications to in-depth exploration, learning environments have evolved from audiovisual learning environments and digital learning environments to smart learning environments and ubiquitous smart learning environments [5]. The learning environment is a key factor influencing the learning process. Since the 1980s, with the widespread adoption of computer labs, multimedia, and other audiovisual educational equipment, the learning environment has gradually evolved through successive iterations, ultimately leading to the smart learning environment—a process of continuous evolution and refinement.

With the help of big data technology, diverse learning spaces can be created based on learners' individual learning characteristics, and remote devices can be used to support teachers in managing and overseeing instruction from a distance. The space management system can flexibly adjust the arrangement of desks and chairs to meet the needs of different teaching activities, creating conditions for classroom discussions and enhancing the flexibility of instruction. Artificial intelligence technology can provide personalized support for online learning; by establishing intelligent tutoring systems, learning content and strategies can be dynamically adjusted based on learners' academic progress. Virtual learning environments built using VR technology allow learners to engage in cognitive perception and practical operations through immersive experiences. These environments can replicate simulated scenarios, such as scientific experiments, thereby enhancing students' learning experiences. Big data further eliminates spatial constraints on learning, enabling ubiquitous, on-demand learning and instant Q&A sessions, accelerating the flow of knowledge, and driving the optimization and upgrading of physical learning spaces on campus. Details are shown in **Figure 1**.

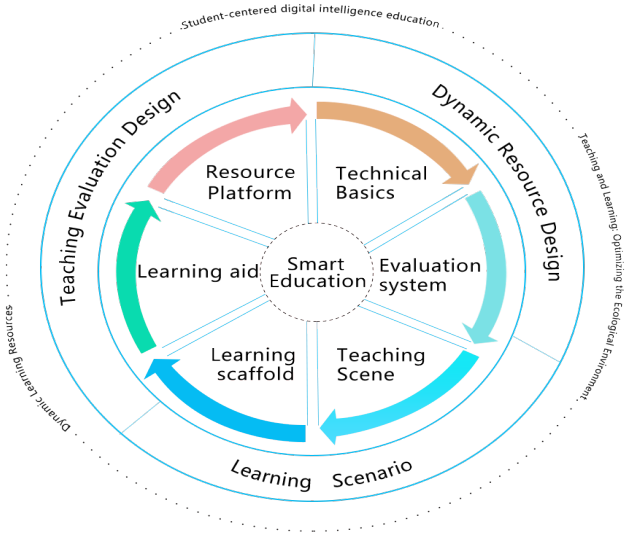

Figure 1. Blueprint for digital-intelligence education construction

3. Pathways to educational ecosystem construction under digital-intelligence technologies

The relationships among educational stakeholders and the construction of educational models are core elements of educational practice. The teacher-student relationship, as the most fundamental of these relationships, defines the roles, functions, and emotional bonds between teachers and students in the teaching process. In traditional teaching, teachers occupy a dominant position as knowledge providers, while students passively receive that knowledge. As educational reforms advance, equal teacher-student relationships are being advocated, while harmonious peer relationships among students are also an indispensable part of the educational ecosystem. The construction of educational models must adhere to a human-centered approach and implement the goal of fostering all-round development in morality, intelligence, physical fitness, aesthetics, and labor. Shanghai's Green Indicators Evaluation Scheme for Compulsory Education Quality embodies this orientation toward the integrated development of these five areas. Building a diverse curriculum and learning ecosystem based on digital and intelligent technologies can cultivate students' comprehensive competencies in all dimensions. These two aspects complement each other and jointly empower students' all-round development. As highlighted in the 2024 National Education Technology Plan released by OECD member countries, the focus is on bridging the digital divide and ensuring that all students have access to transformative learning experiences enabled by digital and intelligent technologies [6]. Based on this, to realize the use of digital and intelligent technologies to empower students' learning and development, it is necessary to establish a corresponding system, as shown in **Figure 2**.

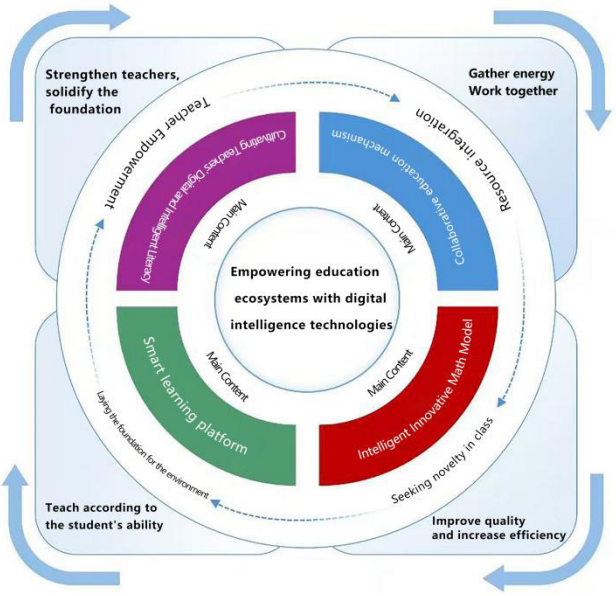

Figure 2. Building an educational ecosystem empowered by digital and intelligent technologies

3.1. Intelligent learning platforms

Intelligent learning environments have emerged as a result of intelligent technologies, effectively driving the optimization and reform of educational settings. Their educational value lies in providing learners with intelligent learning, intelligent communication, intelligent problem-solving, and intelligent analysis services to meet their personalized learning needs. Their functions and characteristics are reflected in the following ways.

3.1.1. Personalized learning support

The philosophical roots of personalized learning stem from Confucius's educational philosophy of "teaching according to individual aptitude" [7]. In the process of contemporary educational reform, personalized learning has become a key direction for development. As a teaching paradigm that combines value orientation with practical application, personalized learning aims to enhance the quality of learning and promote students' all-around development. It focuses on stimulating learners' intrinsic motivation and facilitating the construction of deep knowledge. In traditional teaching settings, personalized learning requires teachers to assess students' learning situations, plan tailored learning schedules, identify learning gaps, and dynamically adjust instructional content and structures. However, due to constraints on human resources and class size, it is difficult to fully implement this approach. Digital and intelligent technologies, leveraging big data analytics of student learning profiles, can automatically generate personalized learning pathways and precisely deliver differentiated learning resources, thereby providing viable technical support for the effective implementation of personalized learning and meeting students' diverse developmental needs.

3.1.2. Construction of diversified scenarios

Creating diverse learning scenarios not only enriches the learning process but is also a core teaching competency that educators should possess in the digital and intelligent era. The creation of diverse teaching scenarios helps improve the learning ecosystem, stimulates learners' motivation, and facilitates the effective

achievement of instructional goals. With the help of digital and intelligent technologies such as VR and AR, immersive learning scenarios can be dynamically constructed. Creating tailored virtual scenarios for different disciplines: In information technology classes, students can use VR devices to immerse themselves in spatial environments generated by artificial intelligence; in biology lab instruction, AR technology can simulate dynamic experimental procedures, allowing students to perform experimental operations and observe phenomena intuitively under safe conditions. At the same time, building online collaborative learning communities through digital technology can break down geographical barriers, allowing learners from different regions to form learning communities and engage in cross-regional, interdisciplinary collaborative inquiry. Taking the "Dynamic Website Development" course as an example, learners divide tasks such as data collection, data analysis, and solution design among themselves, thereby fostering the coordinated development of teamwork skills and comprehensive competencies.

3.2. Innovative teaching models

The deep integration of digital and intelligent technologies into the knowledge-generation process has endowed knowledge production in the new era with the characteristic features of accelerated iteration, cross-disciplinary convergence, and dynamic uncertainty [8]. Traditional teaching models are no longer sufficient to meet the demands of educational development in this new era. With the rapid advancement of China's education and science and technology sectors, educators must confront the challenges of their time, adapt to future trends, and embrace innovative educational philosophies. Innovative teaching models, grounded in the needs of educational development in this new era and gradually established through the continuous reform and optimization of traditional teaching models, are better suited to meet the demands of modern education.

Currently, typical innovative teaching models include project-based learning, the flipped classroom, and VR virtual classrooms. Different models are suited to different teaching scenarios, requiring teachers to flexibly adapt and apply them based on the realities of the classroom. Among these, project-based learning uses real-world projects as a vehicle, focusing on cultivating students' investigative skills and teamwork competencies; the flipped classroom restructures the teaching process by relying on a format that combines pre-class online self-directed learning with in-class discussion and collaboration, thereby expanding students' opportunities for independent learning and promoting the development of higher-order thinking; and VR virtual classrooms utilize immersive technology to create simulated learning environments, enabling students to participate in the learning process in an intuitive and in-depth manner.

3.3. Cultivation of teachers' digital-intelligence literacy

Teachers' digital and intelligent literacy refers to their comprehensive ability to use digital technologies and intelligent tools for teaching, management, and professional development in the digital and intelligent era. Its cultivation must be systematically advanced across multiple dimensions—including knowledge, skills, thinking, and ethics—in alignment with the needs of educational contexts. Training in teachers' digital and intelligent literacy reflects the fundamental essence of literacy in both practice and theory. Literacy refers to the set of actions people undertake based on certain social norms and patterns, imbuing these behaviors with specific cultural meanings; it is acquired through the application of knowledge and skills mastered by individuals in their work and daily lives [9]. In 2019, the International Society for Technology in Education (ISTE) released the "ISTE Standards for Coaches" for teacher trainers, systematically outlining for the first time the fundamental elements of teacher trainer competence in the digital and intelligent era [10]. Therefore,

in the digital and intelligent era, teachers' digital literacy should be cultivated from multiple perspectives, including the comprehensive application of knowledge, skills, and emotional attitudes and perspectives. Specifically, this cultivation includes the following three aspects:

First, technical Training. Through training, participants will learn to utilize teaching tools enabled by digital and intelligent technologies and to design interactive platforms based on these technologies. They will learn to use smart platform systems, Seewo Whiteboard, MOOCs, Chaoxing Learning Platform, and other technologies to significantly enhance teachers' technical capabilities and improve teaching efficiency. Second, teaching Competence. Leveraging digital and intelligent technology equipment, explore the varying outcomes of different teaching models, design approaches such as project-based learning and the flipped classroom, and implement targeted instruction to fully empower students as active participants in the learning process. Third, raise awareness of digital and intelligent education. Strengthen the study of cybersecurity knowledge and gain an understanding of national policies and guidelines regarding the digitalization, digitization, and intelligent transformation of education. Continuously learn new digital and intelligent teaching models. Through training in digital and intelligent literacy for teachers, enhance their teaching capabilities, improve classroom instruction, promote students' all-around development, and better reflect students' central role in the learning process.

3.4. Establishing a collaborative education mechanism

Collaborative education is a vital practical approach to fulfilling the fundamental mission of fostering virtue and nurturing talent. To implement collaborative education, educators must ground their efforts in the practical needs of teaching, anchor their educational goals, and establish actionable teaching directions guided by the promotion of students' all-round development. By dynamically coordinating various educational resources, educators can build a practical platform for collaborative education. In the educational process, educators must, on the one hand, promote regular communication and collaboration among teachers, parents, and students; and on the other hand, foster in-depth collaboration between schools, educational communities, and industry enterprises to expand diverse learning and practical scenarios.

The collaborative education curriculum system is a key vehicle for ensuring the effectiveness of education. The development of this curriculum system should involve the dynamic allocation of teaching resources, the coordinated integration of on-campus courses with off-campus social resources, and the development of locally distinctive courses tailored to specific regional contexts. Curriculum development must balance adaptability with continuity, adhere to a learner-centered approach, and rely on scientifically sound and standardized curriculum design to fully leverage the comprehensive effectiveness of collaborative education.

4. Educational ecology evaluation system under digital and intelligent technologies

4.1. Reform of evaluation through digital and intelligent technologies

Educational ecosystem evaluation serves as a strategic fulcrum that underpins educational evaluation practices and guides the direction of educational development; it is a key cornerstone for promoting high-quality educational development and building a country with a strong educational system [11]. The rapid and ever-evolving development of digital and intelligent technologies has brought numerous opportunities to education while also driving transformations in the educational ecosystem. On October 13, 2020, the Central

Committee of the Communist Party of China and the State Council officially issued the "Overall Plan for Deepening Educational Evaluation Reform in the New Era," emphasizing that during the implementation process, evaluation tools should be innovated and digital and intelligent technologies utilized to explore the conduct of longitudinal evaluations covering the entire learning process for students in all grade levels, as well as horizontal evaluations encompassing all elements of moral, intellectual, physical, aesthetic, and labor education [12]. Educational evaluation is a crucial component of educational work. In line with national education policies, integrating digital and intelligent technologies and the educational ecosystem into the educational evaluation system has become an inevitable trend. Empowering educational evaluation reform through scientific digital and intelligent technologies has significantly enhanced the teaching process.

4.2. Reshaping the educational ecology evaluation system through digital and intelligent technologies

Digital and intelligent technologies have effectively enriched the scope and implementation tools of educational assessment, driving the evolution and innovation of teacher evaluation concepts. Traditional educational evaluation models tend to be relatively one-dimensional and rigid, relying excessively on test scores as the core criterion for assessment, which makes it difficult to comprehensively measure students' overall level of development. In contrast, educational evaluation systems empowered by digital and intelligent technologies are driving a shift toward a "student-centered" approach. Grounded in the principle of fostering all-round development through the five aspects of education—moral, intellectual, physical, aesthetic, and labor education—these systems focus on students' holistic development across all dimensions, thereby achieving a comprehensive evaluation of their educational growth.

At the level of evaluation metrics, digital and intelligent technologies have broken free from the limitations of a single-dimensional, score-based evaluation system and established a diversified, multidimensional evaluation framework. Evaluation criteria are no longer confined to academic performance but have expanded to include a wide range of areas such as students' digital and intelligent literacy, comprehensive competencies, and practical skills. This has completely reversed the shortcomings of traditional exam-oriented evaluation and guided teachers toward adopting a multidimensional approach to educational assessment.

At the level of assessment methods, by leveraging big data and artificial intelligence algorithms, it is possible to collect and analyze data on students' learning processes and outcomes from all dimensions, thereby enabling precise and objective assessments and ensuring fairness and impartiality in educational evaluation. At the same time, this technology can review the entire teaching and learning process, accurately identify key learning points, difficult areas, and individual challenges, and provide data support for optimizing personalized learning.

At the level of evaluation subjects and objects, digital and intelligent technologies have reshaped the landscape of diverse, collaborative assessment. The evaluation model has shifted from a single-teacher assessment to a multi-stakeholder approach involving teachers, parents, peers, and student self-assessment, helping students reflect on their learning and address developmental gaps. At the same time, the scope of evaluation has expanded in both directions: students can draw on their own learning experiences to provide feedback on teachers' instructional abilities, classroom design, and the development of teaching platforms, thereby driving the optimization of teaching practices and the iterative upgrading of educational software. Overall, digital and intelligent technologies are propelling educational evaluation toward greater intelligence,

precision, and human-centeredness, effectively enhancing educational equity and the quality of education, and helping to build a modern educational evaluation system that aligns with the fundamental mission of fostering virtue and nurturing talent and is suited to the development of the new era.

5. Conclusion

Exploring the impact of digital and intelligent technologies on the evaluation of the educational ecosystem has become a hot topic of analysis today. These technologies have broken down the traditional boundaries of the educational ecosystem and driven the shift in modern education from a teacher-centered approach to a learner-centered one. This reflects the principle that the entire teaching process should be built around the students. To enable teachers to play a more effective role in the classroom, it is necessary to enhance teaching effectiveness through digital and intelligent technologies. Through digital and intelligent technologies, educators can achieve the dynamic allocation of learning resources, the creation of learning environments, and the construction of a full-chain educational ecosystem. This enables teaching to take place within a cyclical framework. Leveraging these technologies also facilitates the development of a diversified assessment system, moving beyond an era dominated solely by test scores, where students become active participants in their own learning evaluations. In future teaching practices, digital and intelligent technologies will drive the rapid development of education, ultimately leading to the creation of a harmonious and ideal educational ecosystem.

Disclosure statement

The authors declare no conflict of interest.

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