Proceedings of Business and Economic Studies, 2023, Volume 6, Issue 6
http://ojs.bbwpublisher.com/index.php/PBES
Online ISSN: 2209-265X
Print ISSN: 2209-2641

Research on the Spillover Effects of Digital Transformation on the Sustainable Growth of Green Schools

Yiting Qiu[1,2]*, Qiuhua Chen[1], Poh Soon Joseph Ng[3]

[1]Zhejiang Technical Institute of Economics, Hangzhou 3018, Zhejiang Province, China
[2]Innovation and Technology Program, Engineering and Quantity Surveying, INTI International University, Nilai 71800, Negeri Sembilan, Malaysia
[3]Faculty of Data Science and Information Technology, INTI International University, Nilai 71800, Negeri Sembilan, Malaysia

Corresponding author: Yiting Qiu, barbaraqiu@dingtalk.com

Abstract: The development of society and the advancement of science and technology have led to the widespread integration of digital transformation in the field of education. However, the current establishment of green schools faces various challenges, including non-environmental building facilities, high renovation costs, low organizational management efficiency, high energy consumption, outdated office tools, and insufficient environmental awareness among teachers and students. Through thorough research and analysis, it becomes evident that digital technology can play a pivotal role in addressing these challenges and contribute to all aspects of green school establishment. The incorporation of digital thinking concepts is essential for the construction of ecologically civilized campuses and inclusive innovation. The process of digital design and transformation proves instrumental in optimizing both software and hardware facilities within the campus, thereby reducing energy consumption. Simultaneously, comprehensive digital teaching management enhances overall efficiency in management and service delivery. Innovative digital teaching and learning models emerge as transformative tools, providing new avenues to create low-carbon, green classrooms for both teachers and students. By exploring the application of digital transformation in establishing green schools and examining the resulting spillover effects, valuable insights can be gained. These insights, in turn, serve as reference points for building diversified digital technology paths on campus and fostering the creation of green schools.

Keywords: Digital transformation; Green schools; Spillover effect

Online publication: December 22, 2023

1. The research project's importance and the current status of related studies

1.1. Theoretical and practical significance

In recent years, numerous universities have proactively responded to the call of the "double carbon" policy, implementing strategies for energy conservation and emission reduction, and endeavoring to establish green

schools. The opportune establishment of green schools owes much to the flourishing digital technology.

The term "spillover effect," also known as "externalities" [1], is prevalent in both the economy and society. It denotes that when an organization engages in an activity, it produces expected effects that impact people or society beyond the organization. In essence, the development of one aspect drives the development of others. "Externalities" can be classified into two types: positive and negative. Those that benefit other aspects are positive externalities ("external economy"), while those causing losses are negative externalities ("external diseconomy"). This article concentrates on the positive externalities generated by green campus construction within the context of digital transformation.

With the initiation and progression of the "double first-class" construction strategy in Chinese higher education institutions, substantial reforms have unfolded in various facets of college teaching management and campus hardware facilities. Digital technology has permeated all dimensions of social development, revolutionizing higher education's development and reform. Education and teaching, teaching assistant management, and methods of facilities and equipment construction are all undergoing profound changes. Simultaneously, promoting personalized education, fair sharing of education, and lifelong learning has become integral to educational development in the new era.

As higher education institutions fulfill their role in teaching and educating, they concurrently shape ecologically civilized and green campuses, leveraging the benefits of digitalization to drive the modernization of education. This serves as a potent driving force and crucial support for China's progression toward becoming an "educational power." This topic delves into the deep integration of digital technology and education, presenting novel ideas and assumptions for the "double first-class" construction of schools.

1.2. Current status of related domestic and international studies

A review of relevant literature reveals that both domestic and foreign scholars have explored technology spillover effects and knowledge spillover effects, particularly in research on technology spillover effects for enterprises. They delved into the impact of spillover effects on corporate performance, analyzing technology spillover effects on macroeconomic growth and highlighting the role of shared prosperity [2]. Noteworthy studies include domestic scholars Bin Zhang *et al*.'s focus on the construction path of the "double first-class" higher education institutions through the digital transformation of education [3], Zhiyao Li and Mengsi Zhang's discussion on the digital transformation of university governance [4], Yuan Ouyang and Xu Fan's studies on universities' digital transformation from the background of applied undergraduates [5,6], and Chuan Fu's elaboration on the significance and role of digital transformation in higher education institutions regarding education [7].

2. The alignment of digital transformation with green school establishment

In recent years, the extensive integration of digital technologies, such as artificial intelligence (AI), the Internet of Things (IoT), big data, and cloud computing, has brought disruptive innovations to human life and production. Digital management has played a crucial role in enhancing enterprise quality, efficiency, energy conservation, and emissions reduction. The digitalization wave is transforming both the Internet and industrial sectors, yielding remarkable results. Higher education institutions, with their social functions of talent cultivation and continuing education, are committed to applied teaching and industry-university-research cooperation. Consequently, they are undergoing a digital transformation revolution that aligns with current trends, affecting both organizational culture and software and hardware facilities.

Digital transformation not only directly enhances educational economy activities, such as improving teaching and management efficiency, but also generates diverse spillover effects, such as contributing to the

creation of green schools. It is believed that now is an opportune moment to establish green schools with ecological civilization and sustainable development through digital thinking concepts, digital platform software, digital technology facilities and equipment, and digital shared resources. Therefore, this study focuses on investigating the spillover effects of digital transformation in universities on the creation of green schools, aiming to make academic contributions to related theoretical and practical fields.

The concept of "green schools" was initially introduced in the 1996 "National Environmental Publicity and Education Action Plan." It emphasizes the integration of environmental awareness and action into school management, education, teaching, and construction, guiding teachers and students to address environmental issues. Creating a "green school" inspires teachers, students, families, and communities, becoming a vital vehicle for implementing quality education and an effective method of environmental education in the current context. Scholars such as Yubao Chen and Xinmeng Wan, Cailing Li *et al*., and Xiaoqi Ouyang have contemplated and explored the path of green school construction [8-10].

The digital transformation strategy of higher education institutions aligns with the green school establishment concept, dedicated to improving quality and efficiency, energy conservation, and emission reduction. It serves as an essential "thinking transformation," "technological innovation," and "platform tool" for creating green schools. However, few scholars have investigated specific digital transformation scenarios in creating green schools within higher education institutions, and this study aims to fill that research gap. Starting from the spillover effect (positive externality) of the promotion and application of digital technology in higher education institutions on the establishment of green schools, digital technology can directly or indirectly contribute to the establishment of "green schools."

Therefore, this article's exploration of diversified digital technology paths offers reference ideas for creating green schools. Digital transformation has brought forth multiple positive spillover effects, including enhancing low-carbon awareness among teachers and students, cultivating diversified human capital, innovating industrial ecosystems, stimulating employment, and activating industrial growth. These positive economic externalities underscore the significant role of digital transformation in establishing green schools and provide new insights for achieving sustainable development and environmental responsibility [11].

3. The spillover effects of digital transformation on green school establishment

3.1. Foster low-carbon awareness and instill environmental responsibility

The integration of digital technologies into education, known as digital transformation, has given rise to the concept of green schools, which are educational institutions committed to ecologically conscious practices. Higher education institutions leverage digital technologies to enhance the learning experience, reduce resource consumption, and instill sustainable values among students. The widespread use of digital tools in teaching and management, such as online learning platforms, digital office software, virtual classrooms, and intelligent energy management systems, empowers green schools to optimize resource utilization, curtail carbon emissions, and nurture students' environmental awareness.

Beyond the immediate school environment, the broader environmental impacts and positive spillovers of digital transformation extend to ecological sustainability. Firstly, the application of digital technology in green schools encourages a transition to paperless learning and office work, safeguarding forest resources and mitigating paper waste, which is a significant factor contributing to deforestation and carbon emissions. Additionally, the adoption of intelligent energy management systems based on the IoT ensures automatic regulation of lighting, heating, and cooling based on occupancy patterns. This not only reduces energy consumption but also sets an energy-saving example for the wider community. Therefore, the energy-saving

practices of green schools not only cultivate environmental responsibility but also promote the judicious use of resources, transforming teachers and students into long-term practitioners of low-carbon living.

3.2. Promote talent cultivation and enhance human capital

The digital transformation of higher education institutions has yielded significant positive economic externalities by enhancing human capital in the establishment of green schools. Through digital technology, green schools can create a more flexible learning environment, encouraging students to engage in in-depth learning and independent exploration while experiencing the engaging teaching brought about by digital technology. Digital resources, such as personalized learning plans, virtual laboratories, and online collaboration tools, not only provide students with diverse learning paths but also cultivate their abilities in information acquisition, analysis, and application. This training helps students better adapt to changing workplace demands, thereby improving the overall quality of the labor market. In addition, digital education transcends traditional constraints of time and space, enabling students to cross national borders and access global knowledge and culture, further advancing the globalization of human capital.

3.3. Promote an innovation ecosystem and enhance educational development feedback

Digital transformation has ignited a vibrant innovation ecosystem, representing another spillover effect of establishing green schools. The establishment of digital green schools has fueled growth in the education technology industry, spanning various fields such as software and hardware development, AI, and educational data analysis [12]. This innovative ecology not only offers schools advanced technical support but also generates fresh business opportunities for entrepreneurs. For instance, the empowerment of data technology has led to the continuous emergence of innovative educational applications and intelligent learning tools, propelling ongoing innovation in digital educational content and platforms. Additionally, digital transformation has accelerated progress in educational research, including the application of educational data analysis and the advancement of educational psychology, further fostering innovation and progress in education.

3.4. Stimulate employment and activate multifaceted industrial growth effects

The emergence of digital green schools has triggered various effects on employment and industrial growth at the economic level, constituting a crucial component of positive externalities in the economy. With the widespread adoption of digital education, educational technology companies have become pivotal partners for green schools. This collaboration is alleviating pressure on the job market by creating new employment opportunities for diverse professions, including architectural designers, software engineers, education experts, content creators, and more. Simultaneously, the successful business model of green schools provides reference experiences for other educational institutions, stimulating the overall development of the education industry. This healthy cycle of competition and cooperation fosters diversified and innovative growth in the education sector, thereby strengthening the spillover effect of creating digital green schools.

4. Difficulties in establishing green schools and their root causes

4.1. Non-environmental friendly infrastructure and funding constraints

Establishing green schools necessitates investment in environmentally friendly building designs, energy-efficient equipment, and sustainable water treatment systems. Many schools' existing structures and infrastructure fall short of environmental standards, exhibiting low energy efficiency, thereby impeding efforts towards energy conservation and environmental protection. However, the adoption of these environmental

measures often comes with substantial costs, exerting significant pressure on school finances. Moreover, large-scale infrastructure improvements may demand substantial modifications to existing campuses, disrupting regular school operations and compounding the challenges. Consequently, the complex issues of construction conditions, funding availability, and technical support for updating and transforming the original infrastructure present formidable obstacles.

4.2. Inefficiencies in school organization and management and resource management shortfalls

In the pursuit of green schools, the prevailing teaching management model can give rise to various issues, particularly concerning resource waste and environmental awareness. Concerns over paper resources and consumable wastage are particularly noteworthy. Traditional teaching models heavily rely on paper resources, such as textbooks and exercise books, contributing to resource depletion and exacerbating environmental problems such as deforestation. Additionally, the use of disposable consumables such as plastic stationery and packaging materials contributes to environmental pollution.

During visits and surveys, three "soft power" deficiencies in fostering a green organizational atmosphere were identified in universities compared to advanced enterprises. Firstly, there is a technological and tools gap: some faculty members may lag in adopting updated office software and technical tools, leading to low management efficiency and hindering digital transformation and green office initiatives. Secondly, there are multiple and complex organizational processes: The layered approval processes within schools may impede decision-making speed and innovation, hindering the swift advancement of environmental advocacy and green development. Lastly, there is a deficiency in resource management: the absence of a modern resource management system may result in the inefficient use of energy, water resources, etc., limiting the implementation of sustainable development and resource conservation.

4.3. Inadequate environmental awareness and low-carbon lifestyle concepts among teachers and students

This deficiency may be linked to certain limitations of the traditional education model. Traditional education tends to prioritize the impartation of knowledge and the development of subject-specific skills, often neglecting the comprehensive cultivation of students' environmental awareness and sustainable lifestyles. Consequently, students may lack a profound understanding of low-carbon, environmentally friendly values, and struggle to integrate these values into their daily lives as they grow up. Another factor contributing to this shortfall is potential shortcomings in the education system's teacher training. Without a thorough understanding of the importance of low-carbon and environmental awareness and behavior, teachers may find it challenging to effectively convey these values during the teaching process. Thus, it is imperative to train teachers, providing them with adequate environmental protection knowledge and advocacy skills as a prerequisite for nurturing students' relevant awareness and behaviors.

5. Research on digital technology paths for green school establishment

5.1. Application of digital design and transformation to optimize green campus software and hardware facilities

Efficient utilization of existing campus structures and cost-saving measures are imperative in the establishment of green schools. Exploring lightweight facility renovation and optimization, coupled with resource recycling strategies through diversified digital technologies, is essential.

Firstly, digital modeling facilitates the transformation or construction of campus buildings and facilities. Designers conceptualize, analyze, and optimize architectural designs in a virtual environment. For instance, they simulate the effects of various energy efficiency measures, such as wall insulation materials or solar photovoltaic panels on teaching building roofs. By comparing the energy efficiency performance of different solutions, designers can select the most economical option.

Secondly, energy management systems monitor energy consumption in school buildings, ensuring efficient energy utilization. Digital technology integrates building equipment with energy management systems, enabling real-time data collection and analysis. The system identifies peak energy consumption hours and areas of waste, adjusting equipment operating modes automatically to curtail energy consumption.

Thirdly, intelligent monitoring technology, using sensors and data analysis, provides real-time monitoring of parameters such as temperature, humidity, and lighting within buildings. This data helps administrators detect abnormalities promptly, adjust equipment status, and predict equipment failures in advance, reducing maintenance costs.

5.2. Comprehensive digital teaching management for cost-effective and efficient green campuses

Digital transformation facilitates collaborative office work, reduces operating costs, elevates management service levels, and enhances the soft power of green school establishment. Diverse digital technologies enable teachers and students to transition to cloud services, visualizing and tracing work processes. Various departmental data platforms foster data sharing through "appointment and supervision" channels. School-enterprise collaboration creates digital platforms for personalized campus services, emphasizing a people-oriented, high-quality development concept.

Several universities have spearheaded digital reforms with impressive outcomes. For instance, Zhejiang University's "Zhejiang University Ding" offers multi-module functions for paperless learning and campus office life. The Zhejiang Technical Institute of Economics has introduced a "one-step completion" function, streamlining all major and minor tasks for teachers and students, significantly enhancing campus management efficiency and overall satisfaction. In another example, students at Zhejiang Gongshang University utilized Real Intelligence Company's RPA software platform to develop software robot automation processes suitable for campus management and industrial applications.

Simultaneously, the establishment of green schools necessitates a reevaluation of curriculum design and resource management approaches. Digital technology can promote electronic textbooks, online learning platforms, and other measures to reduce paper resource usage. Schools can implement resource conservation policies, encouraging the use of sustainable materials and reducing disposable consumables. Management can establish a resource usage monitoring mechanism, regularly evaluating and optimizing resource usage to minimize waste.

5.3. Innovating digital teaching and learning models for low-carbon green classrooms

The creation of low-carbon green classrooms for teachers and students stands as a prominent trend in educational development. The application of digital technology innovates the digital teaching and learning model, providing a more efficient and convenient learning method for teachers and students, effectively enhancing teaching outcomes, and saving teaching costs. Digital teaching technology is predominantly employed in the following aspects.

5.3.1. Establishing a digital teaching platform for hybrid teaching

Leveraging digital technology supports functions such as sharing classroom content, integrating teaching resources, and collaborating on teaching activities. This provides teachers and students with richer and more diverse learning resources and experiences. The Internet facilitates the sharing of low-cost global educational resources, allowing students to remotely participate in open courses from renowned universities worldwide through video conferencing, broadening their horizons. Simultaneously, online learning platforms enable students to study anytime and anywhere, breaking free from the constraints of time and location.

5.3.2. Developing virtual laboratories and educational games

Virtual laboratories, a vital application of digital technology in education, offer a cost-effective and flexible alternative to physical laboratories. By simulating experimental scenarios, students can experience a safer and more convenient experimental environment, fostering the improvement of their experimental and innovative abilities. Encouraging teachers to design and develop educational games using digital technology introduces gamification elements into the teaching process, enhancing student interest and enthusiasm, and consequently, improving learning outcomes.

5.3.3. Cloud-based learning data and progress tracking

Digital technology contributes to intelligent management, elevating the quality of education and teaching. The student information management system allows tracking and evaluating students' learning status, enabling prompt identification and resolution of issues. Furthermore, it advocates for transcending the confines of purely subject-based cramming education. The construction of digital green schools emphasizes curriculum design that integrates content related to environmental protection. This approach ensures students comprehend the limitations of ecosystems, resources, and personal impact. The lifelong benefit education concept of a low-carbon lifestyle and environmentally friendly behavior habits is integrated into all-encompassing educational aspects such as "labor education," "cultural education," and "ideological and political education." This effort strives to enrich the connotation and scope of green school construction [13].

6. Conclusion

While the creation of green schools encounters challenges, achieving campus ecological civilization is possible through multidimensional digital technology paths. This study reveals that digital transformation and green campus construction are not just individual pursuits; they complement each other. Digitalization significantly aids in establishing and constructing green schools, while ecologically civilized campus construction amplifies the impact of digital reform.

The integration of green schools within the context of digital transformation yields positive externalities across various economic facets. This includes the establishment of low-carbon lifestyles and long-term environmental protection concepts for teachers and students, the promotion of talent training and enhancement of human capital, the innovation of the educational technology ecological industry chain, and the stimulation of employment and activation of multiple spillover effects such as industrial growth. These positive economic externalities underscore the pivotal role of digital transformation in the creation of green schools and offer fresh insights for achieving sustainable development and environmental responsibility.

Funding

2022 School-Level Topic "Research on the Spillover Effects of Digital Transformation of Universities on Establishing Green Schools" (No. X2022094)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Li Y, Peng J, Luo T, 2022, Digitalization, Spillover Effects, and Corporate Performance. Industrial Technology and Economics, 41(3): 25–33.

[2] Ouyang R, 2022, The Logic, Mechanism, and Path of Digital Economy Promoting Shared Prosperity. Journal of Chang'an University (Social Science Edition), 24(1): 1–15.

[3] Zhang B, Wen Z, Lu Y, et al., 2022, Research on the Digital Transformation of Education to Empower Universities to Build "Double First-Class." China Informatization, 2022(5): 97–98.

[4] Li Z, Zhang M, 2022, Exploration and Practice of Digital Transformation of University Governance. Office Business, 2022(7): 56–58 + 73.

[5] Ouyang Y, 2022, Exploration of the Digital Transformation of Teaching in Applied Undergraduate Universities. Journal of Liaoning University of Science and Technology, 24(1): 66–68.

[6] Fan X, 2020, Discussion on Digital Transformation Approaches for Application-Oriented Undergraduate Universities. China Educational Technology and Equipment, 2020(10): 56–59.

[7] Fu C, 2021, Digital Transformation of Universities and Educational Brain. China Education Network, 2021(5): 43–44.

[8] Chen Y, Wan X, 2022, Research on the Path of Green School Construction in Higher education institutions Under the Background of the New Era. Science and Education Wenhui, 2022(9): 24–26. https://doi.org/10.16871/j.cnki.kjwh.2022.09.007

[9] Li C, Cheng W, Bai G, et al., 2022, Exploration and Reflection on the Practice of Green School Construction – Taking Beijing Agricultural Vocational College as an Example. Journal of Beijing Agricultural Vocational College, 36(1): 71–76. https://doi.org/10.19444/j.cnki.1671-7252.2022.01.011

[10] Ouyang X, 2021, Research on Green School Construction in Higher education institutions. Popular Standardization, 2021(14): 34–36.

[11] El Hilali W, El Manouar A, 2019, NISS '19: Proceedings of the 2nd International Conference on Networking, Information Systems & Security, March 27–29, 2019: Towards a Sustainable World Through a SMART Digital Transformation, Rabat, 32, 1–8. https://doi.org/10.1145/3320326.3320364

[12] Wang Z, 2021, Judgment of the Ten Major Trends in the Development of Digital Economy. Communications Enterprise Management, 2021(11): 6–10.

[13] Li C, 2022, Analysis of Similarities and Differences Between the "Green Schools" Created in Higher Vocational Colleges and Other Schools. Environmental Education, 2022(Z1): 64–66.