Research on the Impact of Digital Technology on Mathematical Creativity Based on Data Science Methods

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Abstract: With digital technology's development and popularization, mathematics education faces new opportunities and challenges. Digital technology can provide strong support for cultivating mathematical creativity and realizing new mathematics education changes. This paper discusses the influence mechanism of digital technology on mathematical creativity from the aspects of the meeting point between digital technology and mathematical creativity, multimodal generation, and intelligent evaluation. It analyzes the challenges of mathematics education brought about by digital technology, such as chaos, prison, and data governance. At the same time, countermeasures such as two-way upgrading, common governance, and value restoration are proposed to provide theoretical reference and practical guidance for the deep integration of digital technology and mathematics education.

1. Introduction

Mathematical creativity is one of the important goals of mathematics education, and it is also a general term for mathematics education. It can be divided into basic mathematical creativity and non-basic mathematical creativity, composed of mathematical discovery, mathematical invention, and mathematical innovation. Mathematics education also entrusts digital technology to develop and evaluate mathematical creativity to cultivate students' creativity. Since the advent of digital technology, mathematical creativity has become the key to mathematics education, and digital technology has become a judging indicator. Different from traditional mathematics education, digital technology puts more emphasis on multimodality, intelligence, and personalization. Therefore, a "win-win" issue of digital technology and mathematical creativity is proposed, and data science provides a new method for digital technology and mathematical creativity.

Data science originates from information science with data as its core. Its methods imply statistics, calculation and reasoning, and it is also a digital technology tool. From the perspective of data science structure, digital technology pursues data-driven and realizes the modernization of mathematics education by combining data collection, data analysis, and data application. However, this is only theoretical. Today, digital technology has practiced a unique path of data science. The comprehensive advancement of data science not only rewrites digital technology and embodies mathematical creativity but also rewrites mathematics education, posing challenges to the quality of education. Therefore, discussing digital technology and mathematical creativity, "win-win" still needs to be worked hard, which requires theoretical support and practical exploration.

Based on the above background analysis, this paper proposes an impact analysis of digital technology on mathematical creativity based on data science methods, aiming to explore how digital technology promotes or inhibits the development of mathematical creativity. The influence mechanism, challenges, and coping strategies are solved through a literature review and case analysis. The main content is the impact mechanism analysis of the meeting point between digital technology and mathematical creativity, multimodal generation, and intelligent evaluation, analysis of the challenges of mathematics education brought about by digital technology, such as chaos, prison, and data governance, suggestions on countermeasures such as two-way upgrades, common governance, and value restoration. It has effectively dealt with the risks and challenges of digital technology and

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has theoretical guidance and practical reference significance.

2. The "Win-win" of Digital Technology and Mathematical Creativity Realizes New Reforms in Mathematics Education

2.1 Digital Transformation of Mathematics Education Content

2.1.1 The Meeting Point of Digital Technology and Mathematical Creativity

Mathematical creativity is a concept developed in parallel with digital technology, which is "soaked" with innovative ideas, highlighting the creative orientation of mathematics education and reflecting the transformation strategy of mathematics education since the digital age. However, it is still difficult to get a consensus when we try to use some objective criteria to construct the definition and nature of mathematical creativity. The connotation and extension of mathematical creativity and its relationship with digital technology are still issues that need to be further explored. This paper believes there are multiple convergence points between digital technology and mathematical creativity, which can be analyzed from three aspects: (1) digital technology can provide rich materials, tools, and environments for mathematical creativity. (2) Digital technology can stimulate and promote various stages and elements of mathematical creativity. (3) Digital technology can demonstrate and disseminate the results and value of mathematical creativity. These coincident points illustrate the mechanism of digital technology's influence on mathematical creativity and provide theoretical and practical guidance for realizing the "win-win" between digital technology and mathematical creativity. The matching model of digital technology and mathematical creativity is shown in Figure 1.

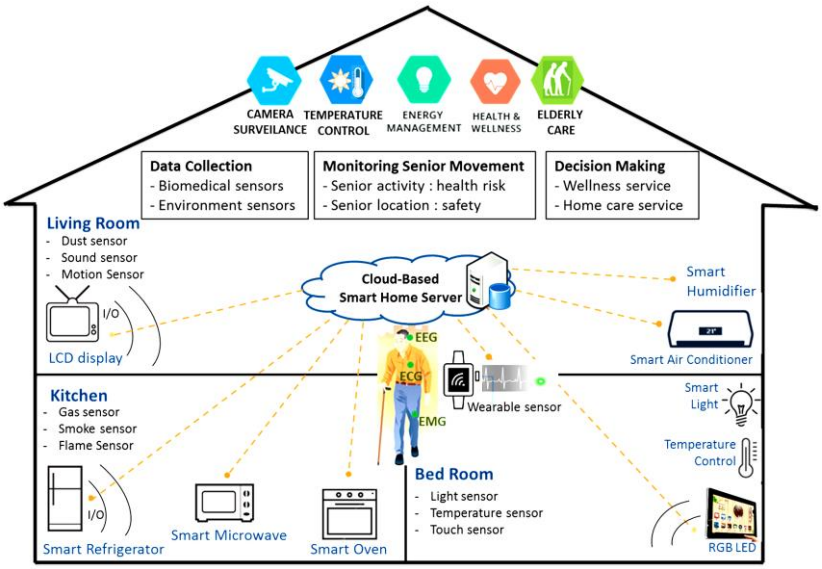

Figure 1 The matching model of digital technology and mathematical creativity

2.1.2 Multimodal Generation of Digital Technologies

The multimodal generation of digital technology is an important standard for digital content generation, and it is a diversified expression of digital content [1]. Multimodality and digital content discuss different definitions of multimodal generation from the perspectives of information, media, perception, etc. Some scholars believe that multimodal generation is the degree of information fusion or interaction. Precisely because the multimodal generation is somehow more creative and belongs to digital science for innovation, the development history of multimodal generation can even be traced back to the 1970s, and its main activities include multimodal interaction, recognition, and synthesis [2]. The concept and method of multimodal generation are closely related to the development of artificial intelligence. Through techniques such as deep learning, pre-trained models, and cross-modal attention, multimodal generation becomes an important responsibility of artificial intelligence. In the deep learning period, the multimodal generation theory's main contribution is the use of neural networks to realize the mapping and conversion between different modalities. Therefore, the concept

of multimodal generation initially focuses primarily on neural network-based modal transformation metrics.

2.1.3 Intelligent Digital Technology and Mathematical Creativity Assessment

Compared with the traditional evaluation of mathematical creativity, the evaluation of intelligent digital technology and mathematical creativity emphasizes the relationship between the process and the result and has the characteristics of dynamic, real-time, and feedback. Although some scholars have questioned that there may be no direct relationship between intelligent digital technology and mathematical creativity, most scholars maintain that intelligent digital technology can rationally evaluate mathematical creativity. Talismans et al. proposed a classic evaluation model for mathematical creativity that includes four elements: fluency, flexibility, originality, and delicacy. Since then, the model has become a typical tool for evaluating mathematical creativity, and the concept of mathematical creativity evaluation based on data science methods has been developed. These scholars believe that mathematical creativity is measurable and is an "observable behavior". Mathematical creativity will appear only when individuals show creative thinking in specific mathematical problem situations. Therefore, mathematical creativity is the behavior result. Some scholars also summarize mathematical creativity as a two-factor model, namely, a product-based evaluation model and a process-based evaluation model [3]. The former focuses on output, and the latter focuses on input, that is, the thinking process. Although the evaluation of mathematical creativity based on data science methods has experienced some practical failures, from the perspective of development, it can overcome the limitations of traditional evaluation methods, and the concept of intelligent digital technology has gradually become the basis for the research and practice of mathematical creativity [4].

2.2 Digital Technology, Mathematical Creativity and Mathematical Education

2.2.1 Analysis of User Characteristics of Digital Technology and Users' Mathematical Creativity Needs

Analyzing digital technology user characteristics and user mathematical creativity needs a vital research topic involving the matching degree and adaptability of digital technology and mathematics education. Digital technology user characteristics refer to the characteristics of individuals or groups using digital technology in terms of cognition, emotion, motivation, behavior, etc., which affect users' selection, use, and evaluation of digital technology. The user's demand for mathematical creativity refers to the user's expectations and requirements for mathematical creativity in mathematics learning and application, and it reflects the user's value recognition and development desire for mathematical creativity. Analyzing the relationship between digital technology users' characteristics and mathematical creativity needs can provide helpful references and guidance for integrating digital technology and mathematics education.

2.2.2 Digital Technology Market Moves to Drive Math Education Decisions

The digital technology market trend is the main indicator of the development of digital technology, emphasizing the innovation ability, application scope, and market demand of digital technology and directly reflecting the development status of digital technology and related industries through searching the Internet, analyzing data, and publishing reports. Digital technology market trends have an important impact on the decision-making of mathematics education. It can help education departments, and teachers understand the value and demand of mathematics knowledge and skills in the digital age, formulate adaptive curriculum standards and teaching methods, and cultivate students' mathematics literacy and innovation ability. The research content of the digital technology market trend includes the development trend of digital technology, application fields, market size, competition pattern, consumer behavior, etc. The research methods of digital technology market trends mainly include literature analysis, questionnaires, expert interviews, and case analysis. The research results of digital technology market trends can be presented in reports, articles, charts, etc., providing a reference for decision-making in mathematics education [5]. Graphic art can also display

the research results of digital technology market trends to increase visual effects and appeal. Some elements of the development of the digital technology market are gradually taking shape, and the integration of digital technology and mathematics education has gradually received attention. However, judging from reality, some mathematics teachers' understanding and application of digital technology is still superficial, contrary to the essential characteristics and development mechanism, leading to education quality and fairness issues [6].

3. Mathematics Educational Challenges Brought by Digital Technology and Mathematical Creativity

3.1 Chaos of Mathematics Education: the Over-reliance on Digital Technology Causes the Imbalance of Mathematics Education System

From the perspective of the mathematics education system, the content of mathematics education is the basic link of mathematics education and the core embodiment of mathematics creativity. Therefore, the content of mathematics education takes digital technology as the main generation logic. Digital technology is the main resource of mathematics education and the subject of participation in mathematics education. At this stage, digital technology strengthens the control of mathematics education content from the perspective of market trends. There are three main forms: one is digital transformation. Realize the synergy effect between the design and implementation of digital technology in mathematics education content. The second is standardization construction. Realize the standardized control of mathematics education content by formulating quality and evaluation standards for digital technology and disclosing the use standards of digital technology to mathematics teachers and students to realize the standardized control of mathematics education content. The third is the internal process reengineering of digital technology. In recent years, big data and blockchain have used data science methods to enhance the innovation of mathematics education content and improve the cultivation effect of mathematics creativity. However, compared with the development speed of digital technology, the adaptability of current mathematics education content needs to be further improved.

3.2 Mathematics Education Jail: Educational Operation under the Transcendence of Digital Technology

The fundamental difference between mathematics education and digital technology lies in its essential attributes. The evaluation standards and quality guidelines of mathematics education are aimed at people, and the development of mathematics education mainly reflects humanistic and social values. In the educational framework of mathematics education, accurate understanding, mastery, application, and innovation of mathematical knowledge are the core value and the highest criterion for the development of mathematics education. The diversity of current digital technology types and the differences in functions lead to the diversification of digital technology. Although digital technology can provide convenience and support for mathematics education, it lacks an educational mechanism because it is still imperfect. Therefore, this creates a "short board" of digital technology, which affects mathematics education.

4. Countermeasures for the Sustainable Development of the Mathematics Education Industry under the Challenge of Digital Technology

4.1 Two-way Upgrade: Mathematics Education out of Digital Technology Challenges

From the perspective of the mathematics education industry, digital technology cannot accurately provide the quality assurance required for mathematics education. Mathematics education uses satisfaction evaluation as the main form of digital technology, but digital technology lacks relevant information and feedback mechanisms for education. The core of this problem may be the "black box" feature of digital technology. In mathematics education research, digital technology is often described as a "black box", and its impact on mathematics education directly reflects the plight of

mathematics education. However, most existing research is about digital technology's functions, characteristics, and advantages, and the limitations, risks, and challenges are relatively scarce. Normally, this information is difficult to obtain or measure. The opacity of digital technology and the imperfection of mathematics education directly lead to obstacles in the mathematics education industry.

In order to get rid of the challenges brought by digital technology, the mathematics education industry needs to carry out a two-way upgrade, that is, to improve the quality and adaptability of digital technology and to enhance the innovation and competitiveness of mathematics education. The specific measures for a two-way upgrade include the following aspects: (1) Strengthen digital technology's educational transformation to align with the goals and needs of mathematics education. (2) Enhancing the digital transformation of mathematics education to take advantage of the advantages and opportunities of digital technologies. (3) Strengthen the synergy and interaction between digital technology and mathematics education to form a virtuous circle and symbiotic relationship. (4) Strengthen the evaluation and supervision between digital technology and mathematics education to achieve quality assurance and continuous improvement. Through two-way upgrading, the mathematics education industry can achieve sustainable development and help cultivate and improve mathematical creativity.

4.2 Common Governance: Optimization of Mathematics Education Response System and Digital Technology Governance

From the perspective of mathematics education governance, the rigidity of the system has restricted the innovation ability of mathematics education for a long time. Since the 21st century, mathematics education, which integrates digital technology and mathematical creativity, has reshaped mathematics education through educational reform, but the shortcomings of the traditional education system still restrict mathematics education. The quality and equity of mathematics education have yet to be improved due to the uneven distribution of resources and the influence of stakeholders. Under the premise of the digital age, digital technology is regarded as a direct way to improve mathematics education. However, the actual effect of digitally-focused mathematics education on mathematical creativity is open to debate. At the same time, due to the difficulties in supervision and evaluation, digital technology lacks effective governance. Consequently, digital technologies do not always appear to be meeting the goals of improving the quality and equity of mathematics education. It can be seen that digital technology is not only a technical problem in mathematics education but also faces governance problems.

In order to deal with these problems, mathematics education needs to be governed jointly, establishing multi-party participation, coordination and cooperation, mutual benefit, and win-win governance mechanism to achieve the coordinated development of digital technology and mathematics education. The specific measures of common governance include: (1) Clarify the positioning and role of digital technology in mathematics education and formulate reasonable policies and norms. (2) Strengthen communication and negotiation between digital technology and mathematics education, and establish effective information exchange and feedback channels. (3) Strengthen the supervision and evaluation between digital technology and mathematics education, and establish a scientific quality assurance and continuous improvement system. (4) Strengthen the incentives and constraints between digital technology and mathematics education, and establish a fair benefit distribution and accountability mechanism. Through joint governance, mathematics education can achieve the balance and coordination of digital technology and mathematical creativity and help the innovation and development of mathematics education.

5. Conclusion

Digital technology has played an important role in mathematics education, bringing new challenges and requirements to the theory and practice of mathematics education. Digital technology symbolizes the "modernization" of mathematics education and an important means of mathematics creativity. It is also an urgent need to realize the fairness of mathematics education quality, which

reflects the inherent requirements of mathematics education. Under the guidance of digital technology, data science builds a theoretical analysis framework and practical mechanism for the coordinated development of mathematics education and digital technology. In recent years, modern information technologies such as big data and blockchain have promoted the development of data science. Through data collection, data analysis, data application, etc. to empower mathematics education and improve the accuracy and scientificity of mathematics creativity, its value conforms to the internal logic of mathematics education. Therefore, mathematics education based on data science methods also provides a new path to deal with the challenges of digital technology. In conclusion, the sustainable improvement and development of mathematics education and digital technology will help to better cultivate and enhance mathematical creativity and promote the innovation and progress of mathematics education.

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