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Analysis of the Current Status of STEAM Education Research in China in the Past Decade Based on CiteSpace Visualization

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Abstract: In order to understand the current status and future trends of STEAM education research in China, this study employs the visualization analysis software CiteSpace as a research tool. It focuses on 218 journal articles related to STEAM education research retrieved from CNKI database. Through secondary literature review, this paper analyzes and summarizes the current status of STEAM education research in China and identifies related issues. Additionally, it proposes three suggestions for improving STEAM education in China: implementing and practicing core competencies, cultivating professional STEAM educators, and transitioning from "disciplinary" to "interdisciplinary" approaches.

Keywords: STEAM, CiteSpace, key competencies

Introduction

STEAM is a new educational model grounded in solving real-world problems through collaboration and practical application, completing projects to cultivate new-century talents with comprehensive literacy and innovative capabilities[1]. In September 2015, the Ministry of Education's *Guiding Opinions on Comprehensively Promoting the Development of Educational Informatization during the 13th Five-Year Plan* first explicitly proposed STEAM education and considered it as a strategic development direction for future education[2]. STEAM education, which is oriented towards real-world problems, enables students to apply interdisciplinary knowledge comprehensively, use technological tools and engineering thinking, and develop innovative thinking and abilities in the learning process of problem-solving and result presentation. In the past decade, STEAM education has been burgeoning in China's basic education. This study takes the CNKI database as the basis and uses the visualization analysis software CiteSpace as a research tool to analyze the current situation and development trends of STEAM education research in China, in order to provide references for related research on STEAM education.

1. Research methodology

This study utilizes the academic journals indexed in CNKI as the data source. To ensure the quality of the data, only articles from CSSCI were selected. Advanced search functions were employed, with "STEAM" as the search criterion, covering a time span from 2014 to 2023. A total of 218 relevant articles were retrieved. After the removal of duplicate documents, and the exclusion of newspapers, notices, conference proceedings, and invalid literature, 141 valid papers were ultimately identified. These were exported in the RefWorks format and underwent format conversion to obtain raw data suitable for analysis with CiteSpace, which was then imported to create a knowledge map.

2. Data analysis

The keyword network was subjected to cluster analysis using the K-means algorithm, resulting in the identification of 29 clusters.(seen as figure 1)

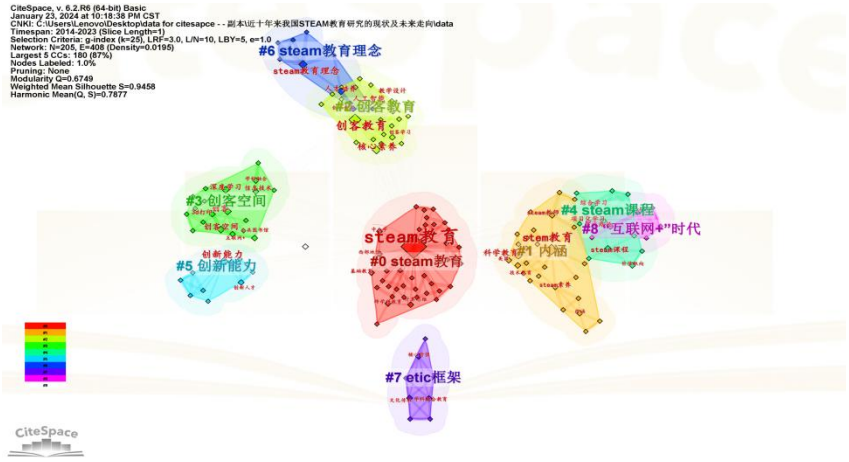

Fig.1 Clustering Analysis of Keywords in STEAM Education Research in China

Among the clusters identified, Cluster #2 (Maker Education) and Cluster #3 (Maker Spaces) are categorized as one major group. The core keywords for this group include "3D printing," "Internet Plus," "artificial intelligence," and "information technology," among others. An analysis of the focus of this cluster reveals an emphasis on integrating the STEAM educational philosophy with a variety of new technologies, aiming to build a bridge between education and informatization. Authors such as Yang Jinyong[3], have initiated a phased construction of a three-dimensional STEAM and maker integrated curriculum starting from elementary school science. Sun Jiangshan[4], and others have extended maker education to the home and society, integrating 3D printing in STEAM maker education. Wu Yonghe[5], and colleagues have conducted maker education from the field of robotics. They have all achieved excellent research results, confirming the strong correlation between maker education and STEAM education. Their closely integrated approach has illuminated the direction for the future development of STEAM education. Furthermore, during the implementation of maker education, researchers have also paid attention to the development of students' abilities. The core keywords of this cluster also include "core literacy" and "innovative ability." Authors such as Wang Tongju[6] have analyzed the ultimate goal of maker education, which is to develop students' interdisciplinary abilities and cultivate their core literacy, with particular emphasis on stimulating innovative spirit and fostering computational thinking.

The remaining clusters, such as Cluster #0 (STEAM Education), Cluster #4 (STEAM Curriculum), and Cluster #6 (STEAM Educational Philosophy), are categorized into a major group with core keywords including project-based learning, interdisciplinary education, and science education. The research within this cluster is characterized by its interdisciplinary and cross-domain nature. It aims to break through traditional subject boundaries[7], construct large units of curriculum teaching, and cultivate the concept of big ideas in knowledge, which has gradually come into public view. Authors such as Yuan Lei[8], after studying foreign project-based STEAM teaching projects, have restructured the content of STEAM curriculum based on the existing subject curriculum system in China through project-based reconstruction, achieving good results with strong replicability. Among a series of subject reconstructions, science education is the most distinctive, as it inherently has an interdisciplinary logical construction as a comprehensive subject. Authors such as Zhang Weida[9], have actively explored the path of science education from division to integration, aiming to cultivate students' core literacy and the ability to solve real-world problems through STEAM teaching.

3. Research results

3.1 Implementation of core literacy

The Ministry of Education first introduced the concept of the "core literacy system" in the "Opinions on Comprehensively Deepening Curriculum Reform to Implement the Fundamental Task of Cultivating Morality and People" issued in 2014[10]. Additionally, the curriculum standards for ordinary high schools and the curriculum standards for the compulsory education stage have also adopted core literacy as an important educational goal. These policies and standards signify the importance of cultivating core literacy. Developing students' core literacy refers to the essential qualities and key abilities that students should possess to adapt to lifelong development and the needs of societal development. It is a comprehensive manifestation of students' knowledge, skills, emotions, attitudes, values, and other multifaceted requirements, which aligns with the STEAM philosophy. Therefore, research on STEAM education based on the cultivation of core literacy is expected to become one of the hot topics in domestic educational research.

3.2 Cultivation of professional STEAM teachers

STEAM education has consistently been a research hotspot in China. The comprehensive nature of STEAM education indeed has the potential to develop students' capabilities, but the extent of its development greatly depends on the capabilities of the teachers. This implies that there is a significant demand for professional STEAM teachers in China's educational sector, and this is an area that is seldom explored. Abroad, there are dedicated undergraduate training pathways for STEM and STEAM, which are almost non-existent in China. Therefore, identifying pathways and evaluation methods for the cultivation of STEAM teachers is a fundamental solution to providing support for the implementation of STEAM education in schools and society.

3.3 Transforming "separate subjects" into "integrated subjects"

The introduction of maker education aims to find a way out for STEAM education. However, due to the disconnection between its form and content, it often fails to achieve the desired effects. Only by achieving interdisciplinary integration in both the content and form of education and teaching can we develop students' lifelong learning abilities through STEAM education. In other words, how to effectively implement STEAM education is a significant research focus for future education. How to enable students to build bridges between various disciplines and form complex and diverse logical chains is a question that educators and researchers need to seriously consider and address.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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