Developments and cutting-edge themes in the field of education research since the handover of Macau
-- CNKI-based bibliometric analysis

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Abstract. The aim of this study is to provide a comprehensive understanding of education research in Macao since its return to China and offer guidance and foundations for the development and improvement of education in Macao. Utilizing the CNKI database, a literature analysis was conducted to gain a comprehensive understanding of the development trends and cutting-edge themes in education research in Macao. The findings reveal that the research hotspots in Macao education since its return primarily focus on higher education collaboration within the Guangdong-Hong Kong-Macao Greater Bay Area, education policies and the development of the special administrative region, youth education and social impact, as well as education assessment and quality assurance. Moreover, research in Macao education since its return demonstrates interdisciplinary collaboration, international cooperation, an increased importance on policy research, and a growing emphasis on early childhood education and early development. Recommendations for enhancing teacher quality, promoting curriculum reforms, fostering internationalization in education, and optimizing the allocation of educational resources are proposed to stimulate innovation and ensure the sustainable development of education in Macao.

Keywords: Macau; Education; Frontiers; Bibliometrics

1   Introduction

Education is an important field that governments worldwide universally prioritize due to its crucial role in societal progress, prosperity, and sustainable national development. Since the return of Macau in 1999, the education sector has undergone rapid

development and transformation. The Macau SAR government places a high emphasis on education, considering it a vital pillar of social development. It actively allocates resources, increases investment and support in education, and strives to enhance educational quality and promote students' holistic development. The government has formulated and implemented a series of education policies and plans, including teaching management, resource allocation, teaching reforms, and teacher training. Additionally, it emphasizes the coordinated development of preschool education, basic education, vocational education, and higher education to provide diverse educational opportunities and high-quality educational services.

Simultaneously, the central government highly values the education sector in Macau and provides strong support through policy guidance, economic assistance, and talent cultivation. It provides relevant funding and resources to promote cooperation and exchange between Macau's education system and mainland China as well as international educational institutions. Through various exchange programs and training initiatives, it fosters the growth and improvement of educational professionals in Macau. The attention and support from both the central government and the Macau government create a favorable environment and conditions for the development of education in Macau. However, Macau's education still faces challenges and shortcomings, including uneven distribution of educational resources, insufficient development momentum in higher education, limited coverage of teacher training and development, inadequate utilization of educational technology, and prominent student pressures and mental health issues. To further enhance the quality and competitiveness of education in Macau, continuous efforts are needed to strengthen resource allocation, elevate teacher professionalism, promote educational innovation and technological applications, and prioritize students' holistic development and well-being, thereby contributing to a more prosperous and sustainable future for Macau's education.

This study aims to provide a comprehensive understanding and grasp of education research in Macau since its return to academia and educational management. Through in-depth analysis of development trends and cutting-edge topics, it seeks to promote innovation and progress in education research in Macau, facilitate the formulation and improvement of educational policies, and provide scientific evidence and guidance for educational development and quality enhancement.

2   Review of the literature

2.1   Background and characteristics of education in Macau since the handover

Since its return, the Macau Special Administrative Region (SAR) government has attached great importance to educational development and is committed to building a modern, diversified, and internationalized education system (Table 1). In terms of education policies, the government has formulated a series of regulations and policies to promote reform and innovation in the education system. The allocation of educational resources has been optimized, with emphasis placed on the training and enhancement of the teaching workforce. Continuous improvements have been made in the construction of educational facilities, and the application of information technolo-

gy in education is increasingly widespread. Moreover, the Macau SAR government actively promotes education internationalization by engaging in cooperative exchanges with international educational institutions, drawing on advanced educational concepts and experiences to enhance Macau's international competitiveness in education.

   The research aspects related to education in Macau have also become more diversified. First, scholars have focused on policy making and institutional changes in Macau education, exploring topics such as education quality, market-oriented reforms, centralization and localization[1-5] . Second, scholars have also studied the role, teaching practices, and professional development of teachers in Macau education, focusing on teacher identity transformation, the use of technology in assessment, and strategies for working with parents in integrated education, providing empirical research and experience sharing to improve teacher quality and promote student learning.[6-9] . In addition, there are also studies that focus on the impact of social and civic education, English-medium instruction, and language planning on language development and cultural identity in Macau, which provide useful suggestions for developing multilingual policies and language teaching strategies that can help develop students' language proficiency and cross-cultural communication skills[10-11] . There are also scholars in the field of education research who have explored the challenges and directions of development of education in Macau from different perspectives and topics, which provide references for in-depth research on.

Table 1. The more significant education-related legal documents issued in Macau after 1999

Category	Name	Year of publication	Published Units	Meaning
Education Laws and Regulations Category	Education Law	1999	Macau Special Administrative Region Government	Establishes the educational system and management system of the MSAR, and establishes the basic principles and objectives of education.
	Basic Law of the Macao Special Administrative Region of the People's Republic of China	1999	Standing Committee of the National People's Congress	It is established that the MSAR enjoys educational autonomy and a high degree of autonomy, and that the educational rights and interests of residents are protected.
	Law of the Macao Special Administrative Region on Higher Education	2016	Macau Special Administrative Region Government	Establishes the organization and management system of higher education in Macao to promote the development of higher education and improve the quality of education.
	Higher Education Act	2018	Standing Committee of the National People's Congress	It provides a legal basis for higher education in the MSAR, emphasizes the autonomy and diversity of higher education, and promotes the internationalization of higher education.

	Macau Special Administrative Region School Management Regulations	2005	Macau Special Administrative Region Government	Provides for the organization, management and operation of schools in the Macao Special Administrative Region to safeguard the normal operation of schools and the quality of education.
Education Policy and Planning Category	Outline of the Education Policy of the Macao Special Administrative Region Government	2002	Macau Special Administrative Region Government	The direction and priorities of the development of education in Macau are planned, including improving the quality of education, strengthening teacher training, and promoting lifelong learning.
	Medium and Long-term Education Development Plan of the Macao Special Administrative Region (2012-2022)	2012	Macau Special Administrative Region Government	The goals and strategies for the development of education in Macau in the next ten years are proposed, including optimizing the structure of education, improving the quality of education, and promoting international education exchanges.
	Outline of the new curriculum reform for primary and secondary schools	2019	Education and Youth Affairs Bureau of the Macao Special Administrative Region	Promote curriculum reform in primary and secondary schools, emphasize the concept of quality education, and pay attention to the overall development and ability development of students.
	Macao Special Administrative Region Pre-school Education Development Plan (2019-2023)	2019	Macau Special Administrative Region Government	Promote the overall development of preschool education in Macao and improve the coverage and quality of preschool education.
	Outline of National Security Education in the Macao Special Administrative Region	2020	Macau Special Administrative Region Government	Establishes the objectives, content and implementation of national security education in the MSAR, emphasizing the cultivation of students' national awareness and the concept of the rule of law.
	Macao Special Administrative Region Vocational Education Development Plan (2021-2025)	2025	Macau Special Administrative Region Government	To promote the development of vocational education in Macau, improve the quality and adaptability of vocational education, and promote the training and employment of talents.
Education Management and Reform Category	Management of teacher training in primary and secondary schools	2015	Education and Youth Affairs Bureau of the Macao Special Administrative Region	Provides for the management system of teacher training for primary and secondary school teachers in Macao to improve their educational level and professional competence.
	Macau Special Administrative	2011	Macau Special Administrative	Establishes the policies and measures for financial assis-

Region Student Financial Assistance Scheme		Region Government	tance for Macao students to promote educational equity and equal opportunities for students.
Reform Program of the Evaluation and Examination System for MSAR Students	2016	Macau Special Administrative Region Government	It aims to reform the evaluation and examination system of Macao students and promote the implementation of comprehensive quality evaluation and diversified evaluation methods.
Degree Authorization and Degree Conferral Methods of the University of Macau Special Administrative Region	2017	Macau Special Administrative Region Government	It stipulates the authorization and conferral system of university degrees in MSAR to guarantee the quality and recognition of the degrees.
Macao Special Administrative Region School Sports Guideline	2018	Education and Youth Affairs Bureau of the Macao Special Administrative Region	Establishes the objectives, content and implementation requirements of physical education in Macao schools to promote the health and overall development of students.
MSAR Quality Assurance System for Higher Education Construction Program	2020	Macau Special Administrative Region Government	It aims to establish and improve the quality assurance system of Macao's higher education and to enhance the quality and international competitiveness of higher education.

2.2   History of the development of the education sector in Macau since the handover

Early Stage of Return (1999-2004): In the initial stage of Macau's return to China, the education system faced the significant task of reconstruction and development. The main objectives during this stage were to restore educational infrastructure, improve educational quality, and promote universal basic education. The Macau government invested substantial resources in rebuilding school facilities, enhancing educational conditions, and strengthening teacher training to improve the professionalism of educators. At the same time, educational curricula were adjusted and reformed to adapt to Macau's unique culture and social needs.

  Development Stage (2005-2014): During this stage, Macau's education experienced rapid growth and reform. The government made significant investments in the education sector, promoting systemic reform and innovation to improve educational quality and international competitiveness. Higher education and vocational education became key areas of development, with the introduction of advanced international educational concepts and resources to enhance the internationalization of education. Additionally, Macau actively promoted the development of early childhood educa-

tion, providing more early educational opportunities to ensure children receive a solid educational foundation before entering school.

Transformation and Upgrading Stage (2015-present): Macau's education has entered a phase of transformation and upgrading, focusing on nurturing talent with innovation and practical abilities. The goal during this stage is to cultivate high-quality talents that meet the needs of social development, with an emphasis on enhancing students' innovative thinking and practical application abilities. The education system places importance on the development of science and technology education, innovative education, and information technology education to foster students' scientific literacy and creativity. Furthermore, Macau has strengthened cooperation and exchanges with international educational institutions, promoting the internationalization of education and providing students with broader international perspectives and opportunities.

3   Sources and Methods

3.1   Sources of information

The research data was obtained from the Chinese National Knowledge Infrastructure (CNKI) Academic Journal Full-text Database. The search was conducted using the following criteria: subject terms "Macau AND education," with the search scope limited to journals. The time span for the search was set from December 20, 1999, to June 7, 2023. A total of 1,478 relevant literature articles in the field of Macau education were obtained.

3.2   Research Methodology

Based on bibliometric analysis, this study employed software tools such as VOSviewer to systematically analyze the distribution of research hotspots and the evolution of research trends in Macau education. Visualization maps were generated to depict the findings. VOSviewer is a software tool developed by Professor Ludo Waltman and colleagues from Leiden University, Netherlands, specifically designed for visualizing and analyzing literature. This method provides a direct assessment of research hotspots and related characteristics of the literature.

Use VOSviewer software to analyze the collected data in depth, select "literature coupling" in the analysis type and "keywords" in the analysis module to obtain the corresponding visual graphs and record the specific values of the specific coupling strength; Select "Co-citation" in the analysis type and "Cited literature" in the analysis module to get the co-citation analysis graph and its specific information; select "Co-presence analysis" in the analysis type and "Co-presence analysis" in the analysis module. Select "Co-citation" in the analysis type and "All keywords" in the analysis module to get the network visualization graph of research directions, and continue to select the overlay button to get the trend change graph of research hotspots.

4   Hot spots in the field of educational research and their dynamics since the handover of Macau

4.1   Research hotspots

The hotspots in the field of education research in Macau since the reunification are mainly in the following four areas: First, higher education and the Guangdong-Hong Kong-Macao Greater Bay Area: researchers explore the development of the University of Macau and the Macau University of Science and Technology, higher education policies and reforms, as well as cooperation and exchanges with higher education institutions in Hong Kong and Guangdong. Second, education policy and the development of the Macau Special Administrative Region (MSAR): research in this area focuses on the MSAR government's policy formulation and reform of education. Third, youth education and social influence: researchers focus on research on the educational environment, curriculum, sex education, patriotic education, and other aspects of youth education, as well as the psychological health, value formation, and social adaptation of youth. Fourth, educational assessment and quality assurance: Researchers explore assessment methods and strategies, examine the impact of assessment systems on educational quality, and how to improve the effectiveness of educational assessmen(Figure 1 and Table 2).

Fig. 1. Distribution of hot topic terms in the literature of Macau education research

Table 2. Top 50 keywords in the frequency of topical terms in the literature of Macau education research

NO.	keyword	occurrences	total link strength	NO.	keyword	occurrences	total link strength
1	Macau	327	431	21	University Students	12	18
2	Guangdong, Hong Kong, Macao and the Greater Bay Area	162	182	22	Development	12	21
3	Higher Education	64	100	23	Nursing	12	18
4	Hong Kong	30	73	24	Non-tertiary Education	11	20
5	Macau Education	28	30	25	Hong Kong and Macao	11	11
6	Four Regions on Both Sides of the Taiwan Strait	28	32	26	Free Education	11	18
7	One Country, Two Systems	25	68	27	Taiwan	11	33
8	University of Macau	25	22	28	Current Status	11	19
9	Education	24	38	29	Vocational Education	11	17
10	Macau Higher Education	23	31	30	Greater Bay Area	10	16
11	Macau Special Administrative Region Government	23	26	31	Teacher Education	10	17
12	Hong Kong, Macau and Taiwan	21	17	32	Curriculum Reform	10	16
13	Return of Macau to China	20	22	33	Macau Youth	9	15
14	National Identity	20	34	34	University Journal	9	1
15	Macau University of Science and Technology	18	19	35	Library	9	6
16	Comparative Studies	16	21	36	Lifelong Education	9	11
17	Youth	16	24	37	Patriotism and Love for Macau	8	22
18	Lifelong Learning	14	20	38	Patriotism Education	8	5
19	Ministry of Education	13	9	39	Countermeasures	8	13
20	Guangdong-Macau Cooperation	13	17	40	Colleges and Universities	8	11

4.2   Research Posture

The development of educational research in Macau exhibits several distinct trends (Figure 2). Education research increasingly emphasizes interdisciplinary approaches, integrating disciplines such as psychology, sociology, economics, and others, to comprehensively and deeply explore the multidimensionality and complexity of educational issues. The Macau Special Administrative Region actively promotes exchanges and collaborations with international educational institutions and the academic community, engaging in educational projects, academic research, and sharing of experiences with international partners, which facilitates the internationalization and enhancement of educational research. Policy research in education has become a significant focus, examining the implementation, adjustment, and improvement of policies, providing scientific evidence for policy-making, and promoting the optimization and development of the education system. Simultaneously, there is growing attention to early childhood education and early development research, encompassing various aspects of early childhood education policies, educational environments, and children's early development, offering support and guidance for enhancing educational quality and facilitating children's holistic growth. These research directions collective-

ly contribute to the innovation, enhancement, and sustainable development of education in Macau.

Fig. 2. Temporal visualization mapping of keyword overlay in the literature of Macau education research field

5   Recommendations

This study reveals multiple research hotspots and trends in the field of education research in Macau since its return. In terms of hotspots, the research primarily focuses on topics such as higher education and cooperation with the Guangdong-Hong Kong-Macao Greater Bay Area, education policies and the development of the Special Administrative Region, youth education and social influence, and educational evaluation and quality assurance. In terms of trends, education research demonstrates interdisciplinary approaches, international collaboration, an increased emphasis on policy research, and a growing attention to early childhood education and early development. The following recommendations are proposed to promote innovation and sustainable development in the field of education in Macau.

Enhance teacher quality. The key to educational development in Macau lies in cultivating a high-quality teaching workforce. It is recommended to strengthen teacher training and professional development to enhance their subject knowledge and teaching abilities. Additionally, incentive mechanisms should be established to attract and retain outstanding educational talents. Moreover, fostering teachers' research and innovation capabilities and encouraging their participation in educational research

projects and the development of teaching resources would continuously elevate their professional standards and the quality of education.

Advance curriculum reform. Macau's education needs to adapt to the development needs of modern society. Therefore, promoting curriculum reform is recommended. The focus should be on updating and optimizing subject curricula to enhance students' comprehensive qualities and innovative abilities. Introducing modern educational technologies and teaching methods can cultivate students' information technology skills and self-directed learning abilities. Furthermore, strengthening interdisciplinary education can foster students' integrated thinking and problem-solving skills to meet future societal challenges.

Promote educational internationalization. Macau should actively promote educational internationalization. It is advised to establish and expand partnerships with international educational institutions and engage in student and teacher exchange programs. Introducing internationalized educational curricula and advanced teaching concepts can enhance the international influence of Macau's education. Simultaneously, strengthening foreign language education can enhance students' cross-cultural communication abilities and cultivate talents with global competitiveness.

Optimize the allocation of educational resources. To enhance the overall quality of education in Macau, optimizing the allocation of educational resources is recommended. Increasing investments in education and improving the efficiency of educational funding utilization are crucial. Expanding the supply of educational resources and improving school facilities and teaching conditions are necessary steps. Furthermore, optimizing school distribution and equitably allocating educational resources can enhance educational equity, ensuring that every student has access to fair educational opportunities and high-quality educational resources.

6   Summary

In this study, Advanced Computers and information technologies were extensively applied to conduct the bibliometric analysis. Specifically, automated data scraping tools were employed for the efficient collection of large datasets from the CNKI database. The raw data were then meticulously processed and cleaned using advanced data processing algorithms, ensuring accuracy and reliability. The core of the analysis was carried out through VOSviewer software, which is known for its sophisticated analytical capabilities in network and visual analysis. This software facilitated the generation of highly-interactive visualizations and maps, allowing for an in-depth understanding of the complex relationships and patterns among the key themes and trends in Macau's educational research. Additionally, statistical software was utilized for performing rigorous quantitative analysis, which included trend analysis and correlation studies. The integration of computer and information technologies in this study not only enhanced the efficiency and depth of the analysis but also ensured the empirical robustness of the research, providing valuable insights and recommendations for the education sector in Macau.

The innovation of this study lies in its in-depth exploration and comprehensive analysis of the development trends and cutting-edge topics in the field of education research in Macau since its return. Through comprehensive organization and systematic summarization of relevant literature, this study will reveal the hotspots and trends in Macau's education research, showcasing the interdisciplinary and international collaboration characteristics of educational research, as well as the focus on areas such as education policy, early childhood education, and educational evaluation. Furthermore, this study provides suggestions and recommendations for future cutting-edge topics and research directions in education research in Macau, aiming to contribute to the advancement of education research in Macau and promote the enhancement and progress of the Macau education system.

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References

1. Bray M. Colonialism, scale, and politics: Divergence and convergence of educational development in Hong Kong and Macau[J]. Comparative Education Review, 1992,36(3):322-342.https://doi.org/10.1086/447129
2. Bray M, Koo R. Education and society in Hong Kong and Macao: Comparative perspectives on continuity and change[M]. Springer Science & Business Media, 2006.https://doi.org/10.1007/1-4020-4449-6
3. Chou B K. The paradox of educational quality and education policy in Hong Kong and Macau: A postcolonial perspective[J]. Chinese Education & Society, 2012,45(2):96-110.https://doi.org/10.2753/ced1061-1932450206
4. Tang, Hei F, Joan, et al. When marketisation does not improve schooling: The case of Macau[J]. Compare: A Journal of Comparative and International Education, 1998,28(3):245-262.https://doi.org/10.1080/0305792980280303
5. De Robertis C, Morrison K. Catholic schooling, identity and social justice in Macau[J]. International Studies in Catholic Education, 2009,1(2):152-169. https://doi.org/10.1080/19422530903138044
6. Tse K C. Society and citizenship education in transition: The case of Macau[J]. International Journal of Educational Development, 2001,21(4):305-314. https://doi.org/10.1016/s0738-0593(00)00004-3
7. Vong S, Wu X. An examination of language planning and policy: Implications for language and literacy education in the Macau education system[J]. English literacy instruction for Chinese speakers, 2019:349-366. https://doi.org/10.1007/978-981-13-6653-6_21
8. Horta H, Li H. Nothing but publishing: the overriding goal of PhD students in mainland China, Hong Kong, and Macau[J]. Studies in Higher Education, 2022:1-20. https://doi.org/10.1080/03075079.2022.2131764
9. Lau C M D, Yuen P K. The globalisation of public higher education in Macau[J]. The Asia-Pacific Education Researcher, 2014,23:117-124.https://doi.org/10.1007/s40299-013-0093-x

10. Müller U, Hancock D R, Stricker T, et al. Implementing ESD in schools: Perspectives of principals in Germany, Macau, and the USA[J]. Sustainability, 2021,13(17):9823. https://doi.org/10.3390/su13179823
11. Zhu G. A prism of the educational utopia: the East Asian Educational Model, reference society, and reciprocal learning: Comparing high-performing education systems: understanding Singapore, Shanghai, and Hong Kong, by Charlene Tan, Oxon, Routledge, 2018, 270 pp., $12.60 (paperback), ISBN 978-0815375920[J]. Discourse: Studies in the Cultural Politics of Education, 2021,42(6):943-957.https://doi.org/10.4324/9781351238724-5