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Angela Million, Peipei Tang

Spatial Realities in the Digital Age: A Scoping Review and Bibliometric Analysis of Digital Mediatization among Chinese Children and Youth

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Nr. 16

Angela Million, Peipei Tang

Spatial Realities in the Digital Age: A Scoping Review and Bibliometric Analysis of Digital Mediatization among Chinese Children and Youth

Contents

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Abstract

Digital technologies are increasingly shaping how children and adolescents engage with space, challenging traditional distinctions between online and offline environments. This paper examines how digital mediatization influences spatial knowledge among Chinese youth by conducting a scoping review and bibliometric analysis of 389 academic articles published in the China National Knowledge Infrastructure (CNKI) database between 2013 and 2024. The study identifies four key thematic clusters: the role of digital tools in everyday spatial practices, digital parenting, policy and institutional responses, and spatial inequalities in digital access and use. The findings point to the emergence of hybrid spaces as a defining aspect of young people's spatial experiences, underscoring the fluidity between physical and digital realms. Additionally, the analysis highlights the evolving dynamics of digital parenting, the challenges of policy interventions addressing digital risks, and the persistent urban-rural digital divide. By shedding light on these trends, the paper emphasizes the transformative impact of digital technologies on spatial perceptions and practices in the Chinese context, while also recognizing the valuable contributions of Chinese scholarship in this field.

Keywords: *Digital mediatization, Chinese children and youth, Spatial knowledge, Hybrid spaces, Scoping review, Bibliometric analysis, Refiguration of spaces, Digital tools, Spatial practice, Urban Design and Planning*

Zusammenfassung

Digitale Technologien prägen zunehmend die Art und Weise, wie Kinder und Jugendliche mit Raum interagieren, und stellen traditionelle Unterscheidungen zwischen Online- und Offline-Umgebungen infrage. Diese Studie untersucht den Einfluss der digitalen Mediatisierung auf das räumliche Wissen chinesischer Jugendlicher anhand eines Scoping Reviews und einer bibliometrischen Analyse von 389 wissenschaftlichen Artikeln, die zwischen 2013 und 2024 in der China National Knowledge Infrastructure (CNKI)-Datenbank veröffentlicht wurden. Die Untersuchung identifiziert vier zentrale thematische Cluster: die Rolle digitaler Werkzeuge in alltäglichen räumlichen Praktiken, digitales Elternverhalten, politische und institutionelle Reaktionen sowie räumliche Ungleichheiten beim digitalen Zugang und in der Nutzung. Die Ergebnisse weisen auf das Aufkommen hybrider Räume als prägendes Merkmal der räumlichen Erfahrungen junger Menschen und verdeutlichen die zunehmende Verschmelzung physischer und digitaler Welten. Darüber hinaus hebt die Analyse die sich wandelnde Dynamik des digitalen Elternverhaltens, die Herausforderungen politischer Maßnahmen zur Bewältigung digitaler Risiken und die anhaltende digitale Kluft zwischen Stadt und Land hervor. Indem diese Entwicklungen beleuchtet werden, betont die Studie die tiefgreifende Wirkung digitaler Technologien auf räumliche Wahrnehmungen und Praktiken im chinesischen Kontext und würdigt zugleich die wertvollen Beiträge der chinesischen Forschung in diesem Bereich.

Keywords: *Digitale Mediatisierung, Chinesische Kinder und Jugendliche, Räumliches Wissen, Hybride Räume, Scoping Review, Bibliometrische Analyse, Refiguration von Räumen, Digitale Werkzeuge, Räumliche Praxis, Städtebau und Planung*

摘要

数字技术正日益塑造着儿童和青少年与空间的互动方式，对线上和线下环境的传统区分提出了挑战。本文通过对中国知网（CNKI）数据库中 2013 年至 2024 年发表的 389 篇学术文章进行范围综述和文献计量分析，探讨了数字媒介化如何影响中国儿童和青少年的空间认知。研究确定了四个关键主题集群：数字工具在日常空间实践中的作用、数字育儿、政策和机构应对措施以及数字获取和使用的空间不平等。研究结果表明，混合空间的出现是青少年空间体验的一个显著特征，突显了实体空间与数字空间之间的流动性。此外，分析还强调了数字育儿的动态变化、应对数字风险的政策干预所面临的挑战以及持续存在的城乡数字鸿沟。通过揭示这些趋势，该论文强调了数字技术在中国背景下对空间认知和实践的变革性影响，同时也认可了中国学术界在这一领域的宝贵贡献。

关键词：数字媒介化、中国儿童与青少年、空间知识、混合空间、范围综述、文献计量分析、空间重构、数字工具、空间实践、城市设计与规划

1. Introduction: Exploring Chinese Scholarship on Digital Mediatization and Childhood

Digital mediatization is reshaping how children and youth perceive, experience, evaluate, and use space (Castillo Ulloa et al., 2024), fundamentally transforming their spatial knowledge. The societal and scientific discourse often frames virtual spaces as parallel to a "real" world. However, research (de Souza e Silva, 2006; De Souza e Silva, 2023; Tillmann & Hugger, 2014) shows that a dichotomous separation between online spaces and offline realities does not align with the perspective of young people. The online and the offline are mutually interdependent, creating new spatial arrangements— the so-called hybrid or cyber-physical spaces (Castillo Ulloa et al., 2024; Lettkemann & Schulz-Schaeffer, 2021)—in which physical and digital dimensions merge as hybrid spatial knowledge, especially through the use of mobile devices. Consequently, understanding the spatial realities of young people today is nearly impossible without considering hybrid spaces.

Since the late 2010s, and even more so since the COVID-19 pandemic (Choi et al., 2023; Götz et al., 2020; Werling et al., 2021), technologies and applications, such as video and communication platforms for education, leisure, online gaming, and more recently, social media, have become so embedded in society and technology that childhood and adolescence can no longer be described as "internet childhood", but rather as "digital childhood" (Küçükoba, 2023). Children and teenagers globally—assuming they have access to sufficient socio-economic resources—grow up with a wide range of digital devices (from tablets to internet-enabled TVs, smartphones, and smartwatches) (Keya et al., 2020; Panjeti-Madan & Ranganathan, 2023).

In China, as of 2019, approximately 78.5% of surveyed primary school students had access to electronic devices before the age of 10, and around 27.1% already owned a smartphone (Statista, 2019). While "digital poverty" among young people in China is a topic of scholarship and political discussion (e.g. Yuan & Guo, 2021), nearly half of parents of preschool-aged children reported providing them with a smartwatch, possibly as an alternative to a smartphone (Nissen, 2023). Moreover, China was one of the first countries to introduce legal regulations on children and teenagers' use of digital media (Colder Carras et al., 2021). After weekly gaming time for minors was limited in 2019, with further restrictions in 2021 (Goh, 2021), many children and teenagers increasingly turned to watching video game content on various platforms rather than playing themselves (Statista, 2022). These statistics indicate that spatialities of young people, their ways of how they constitute, experience and use space has changed in the past decade.

In this paper, we will shed light on this shift through a scoping review and a bibliometric analysis of papers from 2013 to 2024 that are present in the Chinese National Knowledge Infrastructure (CNKI) Database, to explore Chinese children and teenagers' use of digital tools and the novel spatialities that derive from it. We aim to understand how existing research on young people's use of digital media contributes to a spatial constitutional perspective using the lens of refiguration. By leveraging bibliometric analysis and scoping reviews, we explore how current research contributes to the study of hybrid spatial knowledge (Hatuka & Toch, 2016; Heinrich et. al., 2025), particularly its significance for young people in the Global South (van Blerk, 2019).

China presents a unique case due to the high level of digital mediatization among urban children and youth.

This paper leverages bibliometric analysis and scoping reviews to offer a comprehensive overview of research on the use of digital tools among Chinese children and youth. This work will provide scholars with a comprehensive view on the topic, identifying under-explored issues and hopefully inspiring novel research directions (Donthu et al., 2021). It also provides a unique opportunity to highlight the research of Chinese scholars published in Chinese, showcasing their findings in both local and global perspectives on digital mediatization and the spatialities of young people. Additionally, it serves as a paradigmatic example of the methodology used to study multiple spatialities within international scholarship.

2. Theoretical framework: Using the Refiguration Lens of Mediatization, Spatial Knowledge and Multiple Spatialities

In discussing young people's changing spatial knowledge we situate our analysis within the theoretical framework of refiguration. Refiguration refers to the dynamic and tension-filled social transformation of spatial figurations (Knoblauch & Löw, 2020). It also emphasizes processes of refiguration that have intensified since the late 1960s and early 1970s, a time marked by the rapid evolution and the widespread integration of new media, followed later by digital communication technologies and the emergence of knowledge-based societies. This era was also characterized by the transition to post-Fordist economic models, the global expansion of neoliberal frameworks, the rise of emancipation movements, and increasingly intricate networks of transnational connections and circulations.

In this context, (digital) mediatization has been linked to the surfacing of new spatial (including communicative) figurations (Hepp, 2020; Knoblauch, 2021), as mediated communication has transformed social action, for example, "when young people communicate with people at faraway locations or gain knowledge about spaces that they have never, physically, visited" (Castillo et al., 2024, p. 9). Mediatization also encompasses relational and power structures, as well as the sociotechnical infrastructures described in the introduction. While Krotz conceptualizes mediatization as a long-term global ("meta-") process, the specific processes described in this paper are tied to the rapid spread of information and to the communication technologies that impact young people's spatial knowledge. In this paper, spatial knowledge is understood as the (socialized) subjective experience and understanding of space, spatial conceptions, and the emotions and affects associated with space:

> "Subjectified spatial knowledge has to be physically, linguistically, or materially objectified to become the subject of investigation. Similar to the general concept of knowledge, spatial knowledge contains not only explicit and linguistic forms, but also implicit, corporal, and routinized practices. It is shaped by institutionalized stocks of knowledge as they in turn are produced and mediated by institutions such as family, science, school, standard regulatory systems (e.g., building regulations), or art. These

> institutions communicate to the subjects ideas about the spaces in which they live, how these spaces should be arranged, and how to deal with these spaces. These ideas contain, for example, the lifeworld belief about what is considered "far away" and what is "close," the knowledge about the scales of spaces or notions of how the world is spatially refigured, and where individuals are situated within this figuration." (Castillo et al. 2024, p. 12-14 - based definition resulting from debates within Collaborative Research Centre 1265 "Re-Figuration of Spaces," especially among research teams that make use of spatial knowledge to examine distinct forms of refiguration of spaces.)

In our qualitative meta-analysis, "The Evolution of Young People's Spatial Knowledge" (Castillo Ulloa et al., 2024), we identified the refiguration of young people's spatial knowledge by looking at the tendencies, patterns, commonalities, and differences that emerged in 60 empirical-qualitative studies published up until 2019. Conducted in English, German, and Spanish, these studies examined cases of young people from 31 different countries. One key conclusion from the study was that digital media significantly shapes young people's spatial knowledge through virtual spaces, mediated experiences, and altered patterns of interaction with their environments (ibid., pp. 60, 232). This influence extends beyond the virtual realm, affecting their offline experiences and perceptions as well, resulting in a complex and evolving understanding of space, which we conceptualize as hybrid space.

However, our qualitative meta-analysis included only one empirical study on expatriate youth growing up in Shanghai (Sander, 2016). The absence of further studies from China in the meta-analysis is due to our selection criterion, which prioritized research with qualitative methodological approaches and theoretical frameworks, not commonly found in the available Chinese studies.

In line with the concept of multiple spatialities (Knoblauch & Löw, 2021; Knoblauch, 2022), which aims to capture differences, variations, similarities, and connections in the comparative methodological analysis of spaces, this paper focuses on Chinese scholarship on the spatial knowledge of young people. Specifically, it examines who is conducting research on this topic and what findings emerge in the Chinese context. Multiple spatialities can be analyzed on various levels, including knowledge, actions, institutions, and circulation, each tied to specific spatial regimes. In this sense, multiple spatialities, as an overarching concept, also encompass the perspectives of both the actors and researchers, which are interrelated and mutually reflective.

Given the limited representation of Chinese studies in our meta-analysis, a more focused exploration of Chinese scholarship is necessary to uncover how spatial knowledge among young people is studied within this context and to broaden the global discourse on multiple spatialities.

A scoping review and bibliometric analysis is particularly well-suited for this study, as it allows both a quantitatively and qualitatively mapping of who is researching spatial knowledge and how the topic is distributed across disciplines. This method helps identify key contributors, thematic trends, and the extent to which different fields engage with the topic. Given the disciplinary backgrounds of the two authors of this paper (architecture, urban design, and urban planning), assessing the role of spatial sciences in studying young people's spatial knowledge

is a key focus here. This approach also allows for a critical examination of how these disciplines contribute to understanding spatialities and the intersection of digital mediatization with the lived experiences of young people in China. By incorporating a vast body of Chinese research into the debate, this study aims to decenter English-speaking discourses on childhood, digitalization, and space, offering a more globally inclusive perspective.

3. Materials and Methods

3.1 Data Collection (Chinese Database)

To explore the relationship between digital mediatization and spatial knowledge among children and adolescents in China, this study selected the China National Knowledge Infrastructure (CNKI) database as its central literature source. CNKI is the largest comprehensive academic resource database in China, covering a wide range of Chinese academic literature, including journal articles, conference papers, and doctoral and master's theses published in both Chinese and English.

Given that the majority of research on this topic within China is published in Chinese, the search primarily relied on Chinese keywords to ensure the comprehensiveness and relevance of the dataset. Additionally, commonly used English terms and abbreviations in academic discourse, such as "VR," (Virtual Reality) "AR," (Augmented Reality) and "ICT," (Information and Communication Technology) were also incorporated into the search formula. This inclusion of English terminology allowed the study to capture publications that utilized English terms, even within predominantly Chinese-language research. By employing this bilingual approach, the study ensured a more inclusive and accurate retrieval of relevant literature, effectively addressing linguistic diversity in the field.

3.2 Search Strategy and Inclusion Criteria

The search strategy was meticulously formulated to comprise themes pertinent to children, adolescents, digital tools, and spatial knowledge. Terms about children and adolescents, included but were not limited to: "children (儿童)," "adolescents(青少年、少年)," "youth (青少年)," "minors (未成年)," "preschoolers (学龄前)," "primary school students (小学生)," "middle and high school students (中小学、中学生)," "school-age (学龄儿童)," "puberty (青春期)," "high school students (高中生)," and "childhood (童年)." In addition, search terms associated with digital tools such as "ICT," "mobile phones (手机)," "smartwatches (智能手表、电话手表)," "smartphones (智能手机)" "computers (电脑)," "mobile media(移动媒介)," "smart tools(智能工具)," "digital devices(数码设备)," "smart terminals(智能终端)," "tablets(平板电脑)," "smart hardware(智能硬件)," "wearable devices(可穿戴设备)," "virtual reality(虚拟现实)," "VR," "augmented reality(增强现实)," "AR," "mobile devices(移动设备)," "digital media(数字媒介)," "networks(网络)," "internet(互联网)," "social media(社交媒体)," "online platforms(网络平台)," "online learning(在线学习)," "applications(应用程序)," "digital technologies(数字技术)," "screen time(屏幕时间)," and "video games(电子游戏)." Search terms related to spatial knowledge included: "space(空间) ," "place(

场所、地方）" and "geography（地理）." Terms within the same category were logically connected using the operator “OR” (indicated by + in the search formula), while different thematic categories were logically connected using the operator “AND” (indicated by * in the search formula).

The search strategy was designed to capture the intersection of childhood, digitalization, and space, reflecting the core focus of this study. Rather than treating space as an isolated research object, we approached it as an analytical category to examine how digitalization shapes young people's spatial experiences, perceptions, and practices - their spatial knowledge. Our selection of search terms prioritizes children and adolescents in digital contexts, acknowledging that digitalization is a defining factor in their everyday lives, influencing their engagement with both physical and virtual spaces. By incorporating spatial terms such as space (空间), place (场所、地方), and geography (地理), we aimed to trace how digital technologies mediate spatial relations rather than dissolve them. In this framework, the refiguration of spaces is understood not as a loss of spatiality due to digitalization, but rather as a transformation of how spaces are experienced, navigated, and co-constructed through digital means. This perspective aligns with our methodological approach, in which space functions as a structuring lens to analyze empirical findings on digital childhood rather than as the primary research object. Accordingly, we structured our search terms to capture the complexity of digital tools, platforms, and interactions that contribute to shaping young people’s evolving spatialities in the digital age.

The scope of the search was confined to peer-reviewed journal articles and conference papers to ensure comprehensive coverage of the latest developments and trends in the field. The search was conducted on September 27, 2024, yielding an initial total of 1,863 articles. Criteria for inclusion included: relevance to the spatial knowledge of Chinese children and adolescents within the context of digitalization; publication dates from 2013 to 2024; and article types categorized as Chinese journal articles or conference papers.

The choice of 2013 as the starting point for the included papers is informed by significant developments in China’s digital landscape, particularly in terms of youth engagement with technology. The early 2010s marked a turning point in smartphone adoption, making mobile internet and digital content more accessible to younger demographics (Fiorello, 2022). This shift was driven by multiple factors, including advancements in mobile communication technology, government infrastructure initiatives, and the increasing affordability of smart devices. A key milestone in this transformation was the launch of WeChat by Tencent in 2011. Initially a messaging platform, WeChat rapidly expanded its functionality to include social networking, gaming, and mobile payments, becoming a central digital hub for Chinese youth. Its rapid adoption set the stage for a new era of mobile-based interactions, making smartphones an indispensable tool in everyday life. The expansion of mobile internet was further reinforced by China’s strategic efforts to develop its digital infrastructure. In August 2013, the Chinese government introduced the “Broadband China” strategy, which aimed to accelerate national informatization and improve broadband network infrastructure. This initiative significantly expanded broadband access, laying the foundation for the rapid growth of mobile internet (State Council of China, 2013). Shortly after, in December 2013, China officially commercialized 4G networks, marking a major milestone in mobile communication. The introduction of 4G

technology provided high-speed internet connectivity, further supporting the widespread use of mobile devices and digital applications (MIIT, 2020).

Alongside these infrastructural advances, the affordability of smart devices played a crucial role in expanding digital access. By 2013, the Chinese smartphone market had undergone a major transformation, with domestic brands Xiaomi and Huawei introducing low-cost, high-performance smartphones. Xiaomi's sub-brand Redmi launched the Redmi 1 in July 2013, priced at just 799 yuan, making smartphones more accessible to ordinary families. Similarly, Huawei's Honor 3C, released in December 2013, directly competed in the sub-1000 yuan segment, rapidly increasing smartphone penetration. The availability of these low-cost yet powerful devices provided the hardware foundation for children and adolescents to engage with mobile technology at an unprecedented scale. At the same time, the growing accessibility of mobile internet and smart devices necessitated new regulatory frameworks to protect minors online. By 2013, discussions on internet safety policies had intensified, reflecting the government's recognition of the emerging challenges of the digital age. The increasing presence of youth in online spaces underscored the need for policies that address digital well-being and security. Taken together, these developments—government infrastructure initiatives, the rollout of 4G networks, the affordability of smart devices, and the growing dominance of multifunctional apps—created the conditions for a fundamental shift in how young people in China engaged with digital technology and warrant using 2013 as a starting point for analyzing youth interactions with mobile internet and digital content.

Exclusion criteria consisted of articles deemed irrelevant to the specified themes as well as duplicate entries. Throughout the screening process, literature that failed to meet the inclusion standards was systematically removed, resulting in a final compilation of 389 articles for this review. These articles collectively provide an extensive overview of research pertaining to the digital media usage and spatial knowledge of Chinese children and adolescents, thereby serving as a robust and insightful data source for this study.

3.3 Methodology: Scoping Review and Bibliometric Analysis

This study employed a combined approach of scoping review and bibliometric analysis (Peters et.al. 2020; Sharifi 2020; Van Winkle et.al. 2022). The scoping review aimed to systematically analyze Chinese academic literature, providing a comprehensive overview of current research in the field of digital mediatization and spatial knowledge among children and adolescents. To better illustrate the developmental dynamics and research trends in this field, we used bibliometric analysis tools to conduct co-word analysis, temporal analysis, and knowledge mapping of the included literature.

3.4 Software and Tools Used

For data anlysis, this study utilized two bibliometric analysis softwares, VOSviewer and CiteSpace. VOSviewer was primarily employed for term co-occurrence analysis and the

subsequent constructions of knowledge network maps that highlighted the relationships between different terms and the main research themes. CiteSpace was used to focus more on the temporal analysis, tracking dynamic changes in the research field and identifying emerging research trends. To ensure the accuracy of the data analysis, the included literature underwent data cleaning, removing meaningless keywords (such as "study"), and merging synonyms and abbreviations, such as "young children (幼儿)" and "early children (幼童)," as well as "Virtual Reality(虚拟现实)" and "VR"). Synonym lists were created according to the format requirements of VOSviewer and CiteSpace to minimize interference from different terminologies, thus ensuring accuracy and consistency in the data analysis.

4. Results

4.1 Publication Trends

4.1.1 Yearly Growth of Publications

During the period under investigation (2013 to 2024), the number of publications related to children's digital mediatization and spatial knowledge grew steadily (see figure 1). From 2013 to 2017, the average annual number of published papers remained relatively low, around 12, but after 2018, the number of publications began to increase significantly. The average annual publication volume was 35 from 2018 to 2020, reflecting a gradual increase in attention to the topic. After 2021, the number of published papers further surged, with the average annual volume exceeding 50. The stable growth in publication numbers is closely linked to advancements in computer technology, the prevalence of smart devices among children, and the application of emerging technologies in children's education, as mentioned in the introduction of the paper. These factors have fueled research interest in the use of digital tools by children, making this field a focal point in academia.

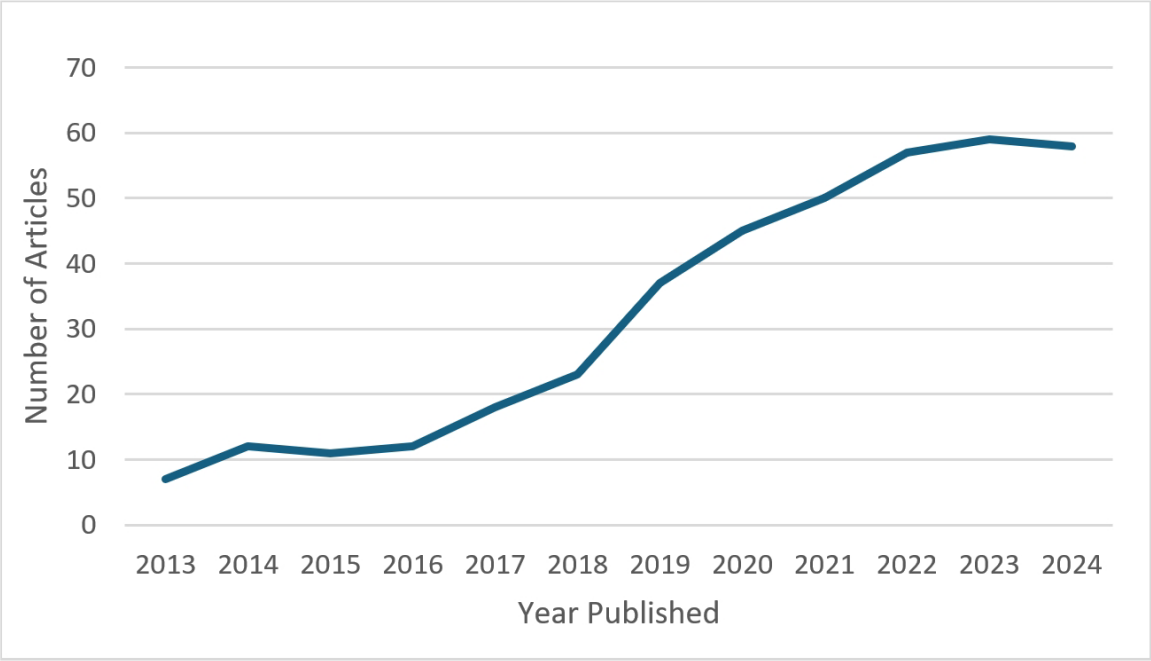

Fig. I: Publication trends for 2013–2024. Note that the number of articles in 2024 is slightly lower than in previous years because the literature search was conducted in September. Overall, the sustained growth trend is expected to continue into 2025.

4.1.2 Prominent Journals and Conferences

The 389 articles included in this review were published in 71 different journals, covering a wide range of topics related to children, adolescents, and digital media. The top 10 journals in the dataset collectively published 92 articles, accounting for 23.7% of all reviewed articles. Among these, four journals primarily focus on children's health, education, and health research, namely the **Chinese Journal of School Health** (17 articles), **Children's Study** (14 articles), **Chinese Journal of Child Health Care** (8 articles), and **Studies in Early Childhood Education** (7 articles). Three other journals focus on research in digital technology, educational informatization, and communication: **China Educational Technology** (9 articles), **e-Education Research** (7 articles), and **Modern Educational Technology** (5 articles). The remaining three journals are related to youth research, namely **China Youth Study** (9 articles), **China New Telecommunications** (7 articles), and **Contemporary Youth Research** (5 articles).

Overall, the journals included in the review primarily concentrate on two research areas: children's health and education, and digital media and information dissemination. This shows that this field of research is interdisciplinary by nature, and that it especially revolves around health, education, social development, and digital tool usage among children and adolescents.

Journal	Publication Frequency
Chinese Journal of School Health	17
Children Study	14
China Educational Technology	9
China Youth Study	9
Chinese Journal of Child Health Care	8
e-Education Research	7
Studies in Early Childhood Education	7
China New Telecommunications	7
Contemporary Youth Research	5
Modern Educational Technology	5

Tab. I: Top 10 journals identified based on their frequencies of occurrence in the data set

4.2 Author Affiliation Trend: Geographic and Institutional Distribution

The authors of the 389 articles in this study are affiliated with more than 200 different institutions nationwide, covering fields such as education, digital technology, and health care, showcasing a multidimensional academic focus. The research spans the entire country, with the eastern and central regions as the main contributors. This distribution reflects the emphasis on children's digital media in economically and educationally developed areas. Higher education institutions and research organizations are the primary contributors, demonstrating a collaborative intersection of disciplines such as education, psychology, communication, and digital technology. Additionally, healthcare institutions also contribute to research on children's health and digital lifestyles. Among the most prolific institutions, there are Beijing Normal University, Central China Normal University, and Nanjing Normal University. Their research centers on education, psychology, and digital media highlight the importance of educational informatization and digital media literacy in research on children and adolescents. Overall, the distribution of author institutions is broad, with a primary focus on education, psychology, digital media, and child development, reflecting the interdisciplinary nature of the field and emphasizing the multifaceted impact of digital media on youth education and life.

4.3 Keyword Extraction and Analysis

4.3.1 Key Themes in the Literature

We used VOSviewer to conduct co-occurrence analysis of keywords. Several thematic clusters closely related to research on digital mediatization among Chinese children and adolescents

were identified (see figure 2, 3 and 4). In these visualizations, each node represents a keyword. The size of the node is proportional to the frequency of the keyword, and the thickness of the connecting lines indicates the strength of the association between keywords. Different colors in the figure represent different thematic clusters. In the analysis, the minimum occurrence frequency for keywords was set to five, resulting in a total of 46 keywords forming five thematic clusters of different colors.

- **Red Cluster: Left-behind Children and Digital Device Usage**
  The red cluster has the highest density, mainly revolving around keywords such as “left-behind children,” “mobile addiction,” and “parent-child relationship.” High-frequency keywords include “mobile,” “socialization,” "parent-child relationship," and “media usage,” indicating that the research primarily focuses on how left-behind children interact with mobile devices and the impact of mobile dependency on their socialization and parent-child relationships. This thematic cluster reflects researchers' emphasis on the effects of digital device usage on the social and psychological well-being of left-behind children in the absence of parental companionship. While space is not directly addressed, the geographical separation between left-behind children and their parents, as well as their digital connectivity across spatial distances, suggests a refiguration of family spaces through digital means.
- **Purple Cluster: Adolescents and Online Behavior**
  The purple cluster mainly focuses on keywords such as "adolescents," "internet," "online games," and "cyberbullying." The presence of keywords like "internet," "online games," "adolescents," and "mental health" indicates that this theme primarily explores online activities of adolescents and their impact on mental health. This cluster reveals that research is paying attention to adolescent internet usage behaviors and their potential psychological and behavioral issues. These studies implicitly point to the emergence of hybrid spaces, where adolescents navigate physical environments and digitally mediated spaces, blurring traditional spatial boundaries in their social interactions and daily routines.
- **Yellow Cluster: Students and Educational Environment**
  The yellow cluster mainly revolves around keywords related to students, education, and screen time, presenting research directions connected to educational environments and digital media. Key keywords include “students,” “children,” “preschool children,” and “screen time,” emphasizing the role of digital devices and technology in educational environments, particularly the impact of screen exposure on students and children. This thematic cluster highlights research interest in preschool education and screen time management, reflecting scholars' exploration of the application and impact of digital media in education.
- **Blue Cluster: VR/AR Technology and Education**
  The blue cluster focuses on keywords related to VR, AR, and education, such as "early childhood education," "interaction design," and "human-computer interaction." These keywords indicate research trends on the application of VR and AR technologies in education and explore their impact on early learning and experiences for children.
- **Green Cluster: Behavior and Mental Health**
  The green cluster is related to behavior and mental health, with keywords like “behavior,” “influencing factors,” “time,” and “regression analysis”, reflecting the investigation into the impact of digital device usage on behavior and mental health.

Overall, the co-occurrence analysis of keywords demonstrates the main research directions in the field of digital mediatization among children and adolescents, including mobile usage among left-behind children, and its socialization implications, online behaviors of adolescents, the application of digital media in education, and the potential impact of VR/AR technologies on early education. These themes provide reference directions for further research and indicate that the effects of VR/AR technologies and mental health on digital mediatization warrant deeper exploration. Although space is not a primary theme in these thematic clusters, the findings suggest that digital media reshapes young people's spatial realities by altering their relationships with physical environments, enabling cross-spatial connectivity, and fostering hybrid digital-physical experiences.

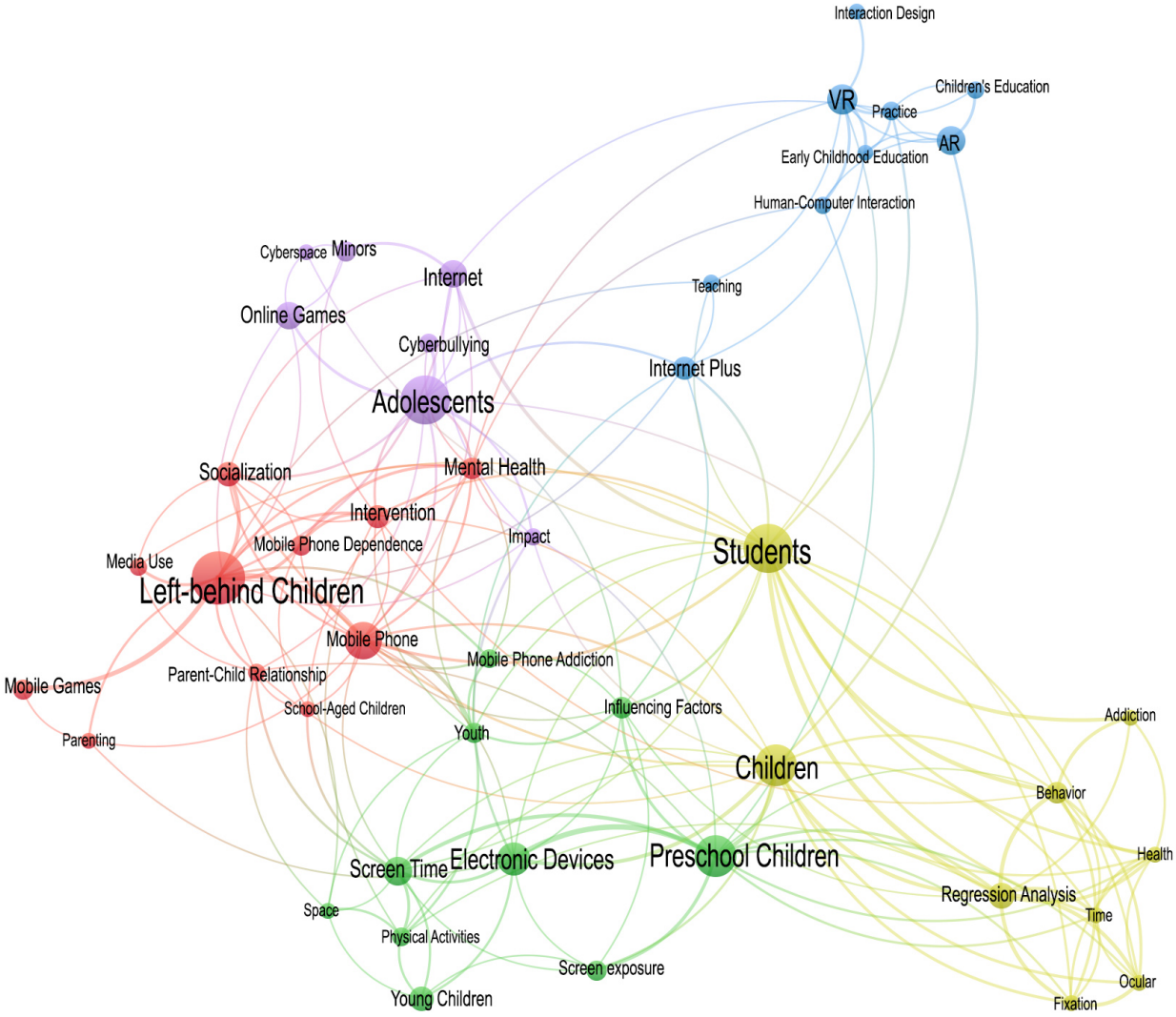

Fig. II: Term co-occurrence map. Node size is proportional to the term frequency, and link thickness indicates link strength. Different colors refer to clusters that co-occur frequently.

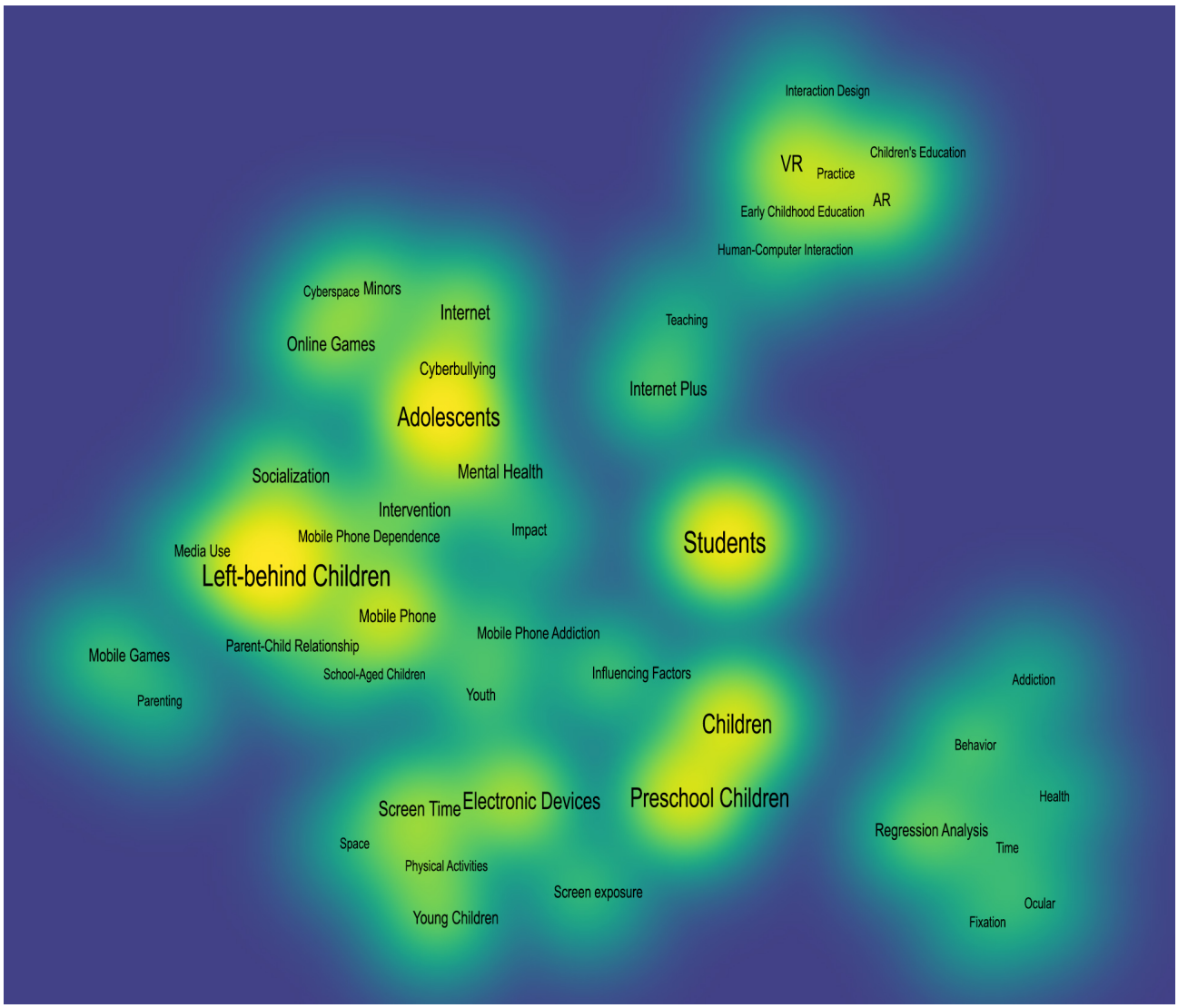

Fig. III: Term co-occurrence map-density

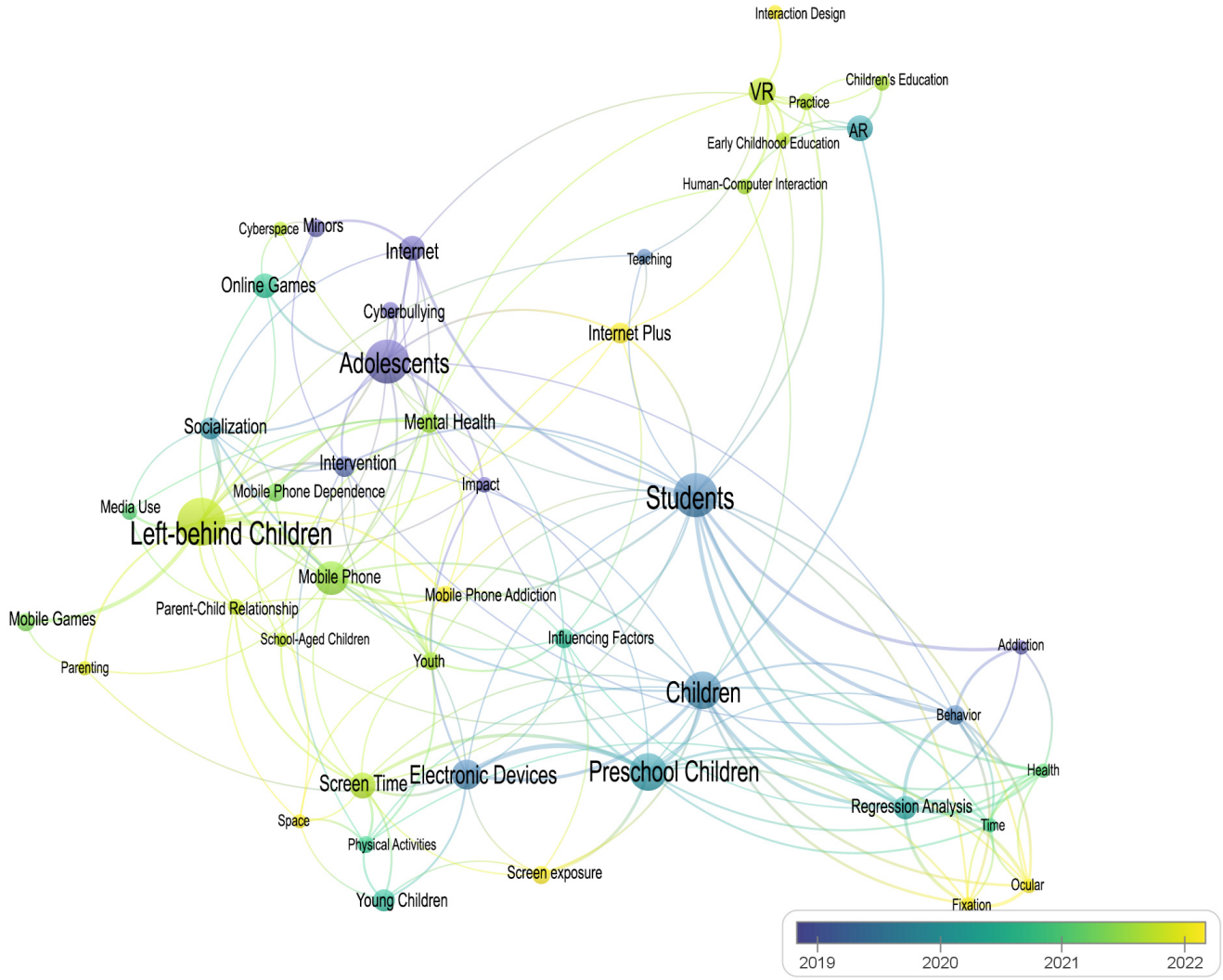

Fig. IV: Term co-occurrence map-overlay

4.3.2 Co-occurrence of Keywords and Emerging Topics

The analysis of the keyword co-occurrence timeline reveals the main themes and their evolution in the digital mediatization process among Chinese children and adolescents (see figure 5, 6). The keywords in the figure, such as “augmented reality,” “adolescents,” “left-behind children,” and “screen time,” show how these themes are interconnected and have developed over time. The emergence of “augmented reality” as an emerging theme highlights the profound impact of technological advancement on children's cognitive and social behaviors.

“Left-behind children” is also a key research theme, with a citation strength of 3.21, underscoring its importance in social changes and the digital environment. The vulnerability of this group in terms of family structure and social support makes it a focal point for the study of the influence of digital technology. Additionally, the rising trends of keywords such as “adolescents,” “mobile dependency,” and “virtual reality” emphasize the critical role of technology in shaping children's social behaviors and learning patterns. The growth of terms like “influence” and “screen exposure” also indicates a rising academic concern about the potential effects of the digital environment on children's mental health and social development.

By analyzing keywords like “electronic devices,” “regression analysis,” and “social capital,” researchers can explore how children construct their social identities and interpersonal relationships in the digital age. Moreover, the emphasis on “countermeasures” shows the need for strategies to protect the physical and mental health of this vulnerable group in both research and practice. These findings offer new perspectives to understand the complex role of digital media in the lives of children and adolescents and can lay the groundwork for future research and policy development.

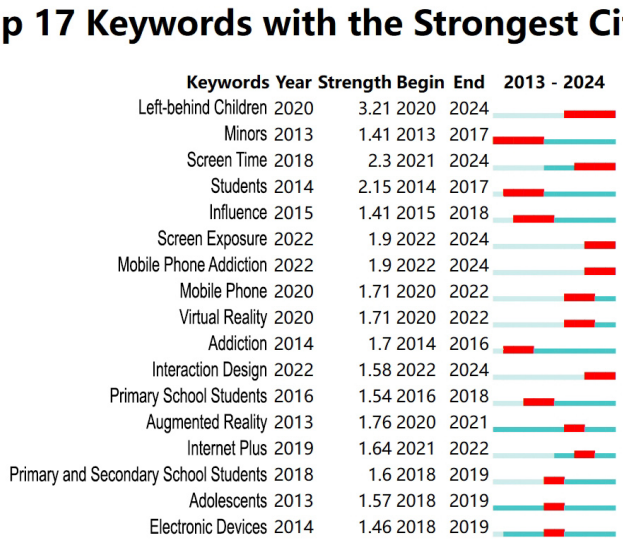

Fig. V: Top 17 keywords with the strongest citation bursts

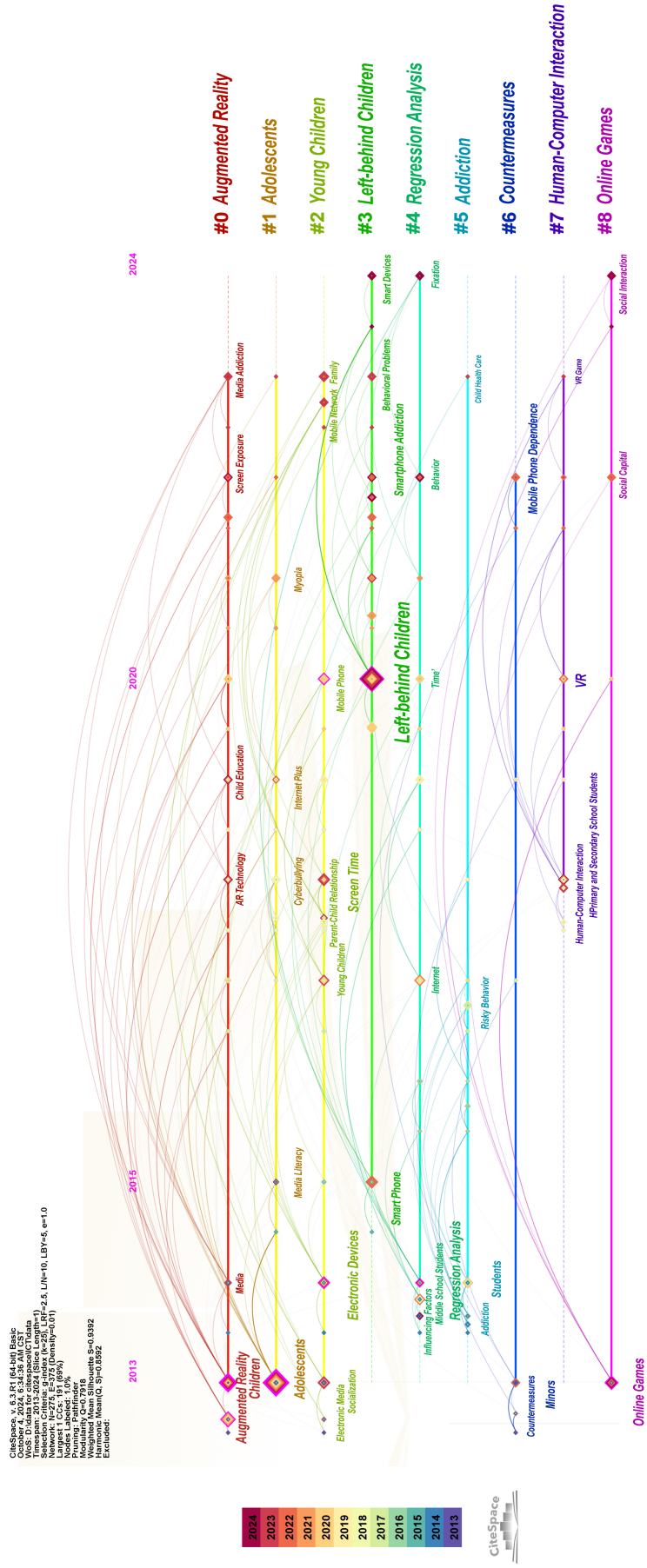
#0 Augmented Reality
#1 Adolescents
#2 Young Children
#3 Left-behind Children
#4 Regression Analysis
#5 Addiction
#6 Countermeasures
#7 Human-Computer Interaction
#8 Online Games
2024
2020
2015
2013
Augmented Reality
Children
Media
Adolescents
Electronic Media
Socialization
Electronic Devices
Media Literacy
Smart Phone
Influencing Factors
Middle School Students
Regression Analysis
Addiction
Students
Countermeasures
Minors
Online Games
Left-behind Children
Media Addiction
Screen Exposure
Child Education
AR Technology
Internet Plus
Cyberbullying
Parent-Child Relationship
Young Children
Screen Time
Mobile Phone
Myopia
Mobile Network
Family
Behavioral Problems
Smartphone Addiction
Smart Devices
Fixation
Behavior
Time'
Internet
Risky Behavior
Child Health Care
Mobile Phone Dependence
Human-Computer Interaction
HPrimary and Secondary School Students
VR
VR Game
Social Capital
Social Interaction
2024
2023
2022
2021
2020
2019
2018
2017
2016
2015
2014
2013
CiteSpace

Fig. VI1: Research topic timeline view

5. Thematic Analysis - Digital Mediatization of Children and Adolescents
5.1 Digital Tool Usage in Everyday Spatial Practices

In their everyday spatial practices, children and teenagers engage with digital tools across diverse settings, where these routinized interactions are understood as integral forms of spatial knowledge. The home remains the primary location for young people's digital media usage (Li et al., 2016; Liu & Liu, 2015; Zhang et al., 2023), especially in private spaces such as bedrooms (An & Wang, 2024; Qin & Wang, 2022). Screen time for children is significantly higher at home compared to school and public spaces (Liu et al., 2024). Research shows that the number of media devices in the household and the placement of electronic screens directly impact children's screen time (Shi et al., 2022; Xie & Chen, 2022; Xiong et al., 2019). Furthermore, adolescents frequently use digital tools in public spaces, such as roads, subways, restaurants, and schools (Chen, 2019; Liu & Liu, 2015). Despite widespread bans on bringing mobile phones into schools, some students still manage to secretly bring their phones to school, using them in private areas such as restrooms (Kuang & Zheng, 2024).

The use of digital tools is also prevalent in educational and learning environments (Huang, 2021; Li, 2024; Li & Li, 2018; Zhang et al., 2020). Through online self-study, adolescents integrate the physical spaces of dormitories, libraries, and homes with virtual study environments, creating a "collaborative self-study" model (Han, 2018; Zhao, 2024). The rapid growth of online education during the pandemic, within informal learning spaces such as homes, internet cafes, and tutoring centers, has reshaped the educational landscape (Xie et al., 2022). Moreover, digital reading has disrupted the traditional private reading space of "book and reader," transforming the act of reading often into a group interaction, reshaping the domain of children's literature (Li & Peng, 2024). The application of virtual reality (VR) technology has not only broken through the spatial and temporal limitations of classroom teaching, significantly enhancing students' spatial perception and skills (Jiang, 2024; Li, 2024; Liu et al., 2022), but it has also allowed for participatory and interactive experiences away from traditional physical spaces and in new ones, such as immersive educational settings in museums (Xu et al., 2024; Ye & Xu, 2024).

Additionally, the process of mediation has reshaped children"s play spaces. Digital games have relocated some forms of play from natural physical settings to virtual worlds, enabling play to occur anytime and anywhere rather than being confined to specific locations (Chang & Zhang, 2020). This has reduced children's dependence on physical spaces while increasing their dependence on virtual spaces.

Digital tools have also expanded children's social spaces. Smart devices, such as smartwatches, enable children to continue communicating with peers after school, thereby overcoming temporal and spatial limitations associated with after-school times (Yang, 2020; Zhang & Xu, 2022). Online games further dissolve the physical limitations of adolescents' social interactions, promoting a shift from offline to online socialization (Tao & Zhai, 2021). This phenomenon is particularly evident in rural areas (Zhou & Guo, 2023), where the proliferation of mobile phones

allows children to transcend traditional geographical boundaries, shifting from geographic proximity for social interaction to establishing mediated cross-village social networks (Zheng, 2023).

However, while digital tools enrich children's lives, they also weaken their interactions with physical spaces, resulting in reduced outdoor activities and social interactions (Huang et al., 2023; Liang & Tang, 2017; Min, 2024). This issue is particularly acute among rural left-behind children and urban migrant children (Wang & Zheng, 2023). To mitigate these potential negative impacts, scholars have been exploring ways to effectively reduce sedentary behavior and screen time among children and adolescents in different settings—such as homes, schools, and communities—to counteract the adverse effects of digital tools (He et al., 2022). Additionally, the use of location-based services (LBS) has provided insights into children's spatial practices, revealing that primary school students tend to make more frequent and longer stops in informal activity spaces after school—such as community streets near their homes—, demonstrating the potential of digital tools to research children's spatial behavior (Zhu & Zhang, 2019).

5.2 Digital Parenting

With the widespread use of digital tools such as smartphones and smartwatches, a "remote caregiving" model of digital parenting has gradually emerged (Liu & Long, 2023). These devices break the limitations of physical space by enabling a sense of "virtual presence" through digital interactions (Wang & Zheng, 2022). For rural left-behind children, in particular, digital devices help mitigate physical distance, allowing them to maintain emotional contact with parents working away from home (Zheng & Gao, 2021). The tracking and location history functions of children's smartwatches allow parents to monitor their child's whereabouts in real-time (Hu, 2020). By setting safety zones, these devices offer children greater freedom of movement while providing parents with a sense of security, thereby transforming children's spatial behavior and altering their traditional modes of travel.

However, the integration of digital tools has also reshaped spatial relationships within the household. The living room, traditionally a communal family space, now faces a "presence-absence" paradox due to the usage of digital devices (Yan & You, 2023). Children often retreat to their bedrooms to escape direct parental supervision, while parents use mobile devices for a "mediated presence" to remotely manage and regulate their child's behavior, thereby altering interactions within the family. While digital tools provide convenience in the form of "virtual presence," their compensatory capacity is limited. They cannot fully replace face-to-face emotional communication, and can impede the growth of strong emotional bonds between parents and children (Wang & Zheng, 2022). Children may prefer using digital devices for interaction with peers, creating a personal, entertainment-focused digital network, rather than engaging deeply with their parents (Kuang & Zheng, 2024), which further complicates family dynamics. Moreover, parents' use of digital tools for monitoring may extend beyond the household and interfere with other spaces, such as school classrooms (Mo et al., 2021). This form

of digital surveillance, which transcends the physical boundaries of the home, highlights the profound impact of digital tools on spatial knowledge.

5.3 Policies and Institutional Reaction in regard to Digital Tool Usage

As of 2022, internet penetration among Chinese minors reached nearly 100%, with smartphones becoming the most common device for internet access (Li, 2023). However, alongside increased connectivity, children and adolescents are increasingly vulnerable to risks such as privacy breaches, exposure to harmful content, addiction to digital games, cyberbullying, and even cybercrime— all issues that have raised widespread societal concerns (Zhang, 2023).

To address these risks, China's approach to managing the use of digital tools by children and adolescents has shifted from early restrictive regulations targeting internet service locations to comprehensive governance addressing content risks, consumer behavior, and the prevention of addiction associated with digital games (Ma, 2024). In the early stages, the government aimed to control the negative impacts of digital games on children's academic performance and mental health through spatial isolation of gaming venues, service restrictions, and environmental regulation. For instance, strict regulations prohibited arcade gaming venues within a 200-meter radius of schools, limiting opportunities for children to access such games.

With the widespread adoption of mobile devices, the use of digital tools by minors has become less confined to specific physical locations, rendering traditional measures (e.g., regulations targeting family and internet cafes) less effective (Zhang, 2023). This shift has led to an increased emphasis on technological measures to manage digital risks, promoting collaboration between various actors—including government bodies, families, schools, and private enterprises (Han & Xu, 2021). In particular, schools have introduced strict controls on the use of electronic devices, including banning students from bringing mobile phones and other smart devices to school. These policies are intended to reduce dependence on such devices during school hours and ensure a focused and secure learning environment (Tian et al., 2024; Zhao, 2019).

Furthermore, adolescent cybercrime and cyberbullying have become critical concerns in digital risk management. Juvenile cybercrime is highly concealed and can transcend physical boundaries, allowing perpetrators to operate with less restriction in terms of location or time (Hu, 2022). Studies examining the spatiotemporal aspects of adolescent cyberbullying reveal that these offenses often occur in private offline spaces such as homes, hotel rooms, or secluded areas, in conjunction with digital spaces like WeChat and QQ, forming an integrated online-offline cycle of violence (Lü & Mao, 2024; Yang, 2024). With increased access to the internet, juvenile cybercrime has gradually spread from urban centers to rural areas, affecting left-behind children who are particularly vulnerable due to insufficient parental care and ineffective supervision (Hu, 2022). However, managing juvenile cyberbullying presents several challenges, including difficulties in regulating, collecting evidence, and holding offenders accountable—

especially given the relatively lenient penalties for online violence. These challenges demonstrate the need for improved regulatory frameworks and more stringent policies.

5.4 Spatial Inequalities in Digital Access and Usage

With the rapid development of information technology, regional disparities in children's use of digital tools have become increasingly evident (Zhang et al., 2018). This digital divide primarily manifests itself in three areas: accessibility to digital devices; usage behaviors; and difference in media literacy levels (Li, 2019; Zhang & Fang, 2022). Firstly, there are significant rural-urban differences in children's media exposure and usage habits. Children in towns and rural areas start using computers later than their urban counterparts. Urban children have a higher rate of exposure to devices such as tablets, computers, and magazines, while rural children are more reliant on television, books, and radio (Wang et al., 2018). There is little difference between urban and rural children in terms of the use of mobile phones. Specifically, children in developed cities such as Shanghai are more likely to have access to mobile devices, while children in other regions, such as Zhengzhou, Huangshan, and Guangshan, use tablets and e-readers at significantly lower rates (Jiang & Wang, 2019). Even within the same city ownership and usage of digital devices varies. Students in urban Shanghai, for example, show significantly higher rates of ownership and use of smart media compared to suburban students (Li & Zheng, 2018).

Urban and rural children's preferences differ also in terms of media practices. Urban children are more inclined towards watching videos and chatting online, while rural children prefer online gaming and shopping (Hu et al., 2024). Moreover, significant differences exist in screen time. Urban children have longer screen times and higher rates of myopia than rural children (Liu et al., 2024; Yuan et al., 2022). Children living in urban suburbs spend more time on screens compared to those in urban areas (Chai et al., 2020). There are also notable differences in the duration of digital device usage: Urban children use tablets and other devices for longer periods, whereas rural children watch television for longer (Wang et al., 2018). These differences not only reflect disparities in digital resources between urban and rural areas but also reveal the different characteristics of children's daily lives and family environments. Some studies have also analyzed the spatial distribution of compliance with the World Health Organization (WHO) recommended levels of moderate-to-vigorous physical activity (MVPA) and screen time for children under 5 years old in China, finding that the regions with higher compliance rates for these health behaviors are concentrated in northern China, while lower compliance rates are found mainly in economically developed areas in southern coastal and Yangtze River regions, further highlighting regional differences in digital device usage (Wang et al., 2023).

There are significant urban-rural and regional differences also regarding mobile phone use and addiction. Children and adolescents in suburban and rural districts are more likely to experience mobile phone addiction compared to those in urban areas. In addition, the spatial differences between provinces also affect children's likelihood of mobile addiction, with children in coastal provinces showing lower rates of mobile addiction compared to those in municipalities (Zhou et

al., 2022). This highlights the impact of socioeconomic conditions on children's media usage behaviors.

Significant regional differences also exist in knowledge acquisition and internet literacy (Ji & Wang, 2023). Minors in rural families generally have lower levels of internet safety knowledge and less risk response skills compared to those in urban families. Rural children have a higher probability of facing online risks such as cyberbullying, exposure to harmful content, fraud, and privacy breaches than urban children, with rural areas showing significantly higher rates of cyberbullying (Wu, 2024). This disparity is closely related to imbalances in educational resources and internet education opportunities between urban and rural areas. Furthermore, differences in knowledge levels and knowledge gaps among rural children in different regions are also significant. It has been found that television and computers slightly widen the knowledge gap, while newspapers and mobile phones do not narrow the gap (Yi et al., 2020).

Overall, spatial disparities and digital divide in children's use of digital tools pose greater challenges for rural children in the communication society. Therefore, it is necessary to address this imbalance with policy and educational interventions, especially in terms of narrowing the accessibility gap to digital resources and enhancing internet literacy, thereby promoting digital equity and educational equity (Chen et al., 2018; Zhang et al., 2018).

6. Conclusion - Spatial Realities in a Digital Age

This paper has explored the intersection of digital mediatization and spatial knowledge among Chinese children and adolescents, shedding light on the profound changes brought about by digital technologies in their everyday lives. Through a combined bibliometric and scoping review, we have identified key trends, research gaps, and thematic clusters that define this interdisciplinary field. The findings reveal the significance of hybrid spatial knowledge, the nuanced dynamics of digital parenting, the policy responses to digital risks, and the persistent spatial inequalities in digital access and usage. The results highlight the emergence of hybrid spaces—a blend of physical and digital dimensions—as a defining characteristic of children's spatial realities. This phenomenon challenges traditional notions of spatiality and calls for innovative approaches to studying and understanding children's experiences. The analysis also underscores the growing reliance on digital tools for communication, learning, and play, with their benefits counterbalanced by potential risks such as reduced physical activity, limited social interactions, and dependency on hybrid spaces.

Digital parenting has emerged as a key theme, demonstrating how digital tools enable new forms of caregiving, particularly among rural left-behind children. However, these tools also reshape family dynamics, often creating tensions between digital surveillance and emotional connection. The analysis further emphasizes the importance of policy interventions in mitigating risks associated with digital tool usage. China's regulatory measures, while addressing immediate concerns such as cyberbullying and gaming addiction, highlight the challenges of managing a highly mediatized childhood in a rapidly evolving digital landscape. The spatial

inequalities in digital access and usage remain a critical issue, particularly between urban and rural areas. The disparities in media exposure, usage behaviors, and internet literacy underscore the need for targeted interventions to bridge the digital divide. Addressing these inequalities is essential not only for ensuring equitable access to digital resources but also for fostering broader social and educational equity.

This paper emphasizes the perspectives of Chinese scholars and local contexts, contributing to a nuanced understanding of the digital mediatization of children and youth through the perspective of multiple spatialities. The perspective of multiple spatialities enriches research on children, digitalization, and space by emphasizing context-specific dynamics, revealing hybrid spaces, analyzing spatial inequalities, informing policy and practice, and decolonizing research. This approach highlights the significance of local contexts and cultural specificities, enabling a deeper understanding of how children interact with digital media and spaces, and informs targeted interventions. By prioritizing scholarship published in China and in the Chinese language, this work provides an in-depth view of research conducted within China's socio-cultural and academic frameworks. This localized focus highlights the spatial specificity of scientific knowledge production, demonstrating how research is shaped by the particular historical, cultural, and institutional dynamics of its environment. This influence can be seen in China's approach to managing children's and adolescents' use of digital tools. Regarding historical dynamics, China's approach initially involved restrictive regulations targeting internet service locations to curb the negative impacts of digital games on academic performance and mental health. This was achieved through spatial isolation, such as prohibiting arcade gaming venues within 200 meters of schools. As mobile devices became more widespread, the focus shifted to more comprehensive governance, addressing content risks, consumer behavior, and addiction associated with digital games. This cultural shift reflects a broader cultural concern for the well-being and development of children in a rapidly digitalizing society. Institutionally, schools serve as a prominent example. They introduced strict controls over electronic devices, including prohibitions on bringing mobile phones and smart devices to foster a more focused and secure learning environment. This demonstrates an institutional response shaped by China's specific educational priorities and challenges.

However, as this paper focuses on Chinese scholarship, it inherently excludes studies conducted by international scholars or published in global academic journals and books, which may offer complementary or contrasting perspectives to those presented in this paper. While this certainly introduces a contextual bias, it also provides a unique opportunity to examine how research conducted within the Chinese context aligns with or diverges from broader international narratives. This localized focus underscores the richness of Chinese scholarship while leaving room for future comparative analyses that integrate global perspectives to provide a more holistic understanding of digital mediatization.

Notably, while this study draws on a wide range of Chinese scholarship, the disciplines of urban planning, urban design, landscape planning, and architecture are underrepresented. Only two of the reviewed references were authored by scholars from these fields, indicating a need for more research contributions from spatial research disciplines to better understand the spatial implications of digital media usage and so draw conclusions for practice. The limited presence

of this approach also suggests an opportunity for future studies to consider how built environments shape digital media use and vice versa.

Based on our review, the findings underscore the need for a deeper exploration of hybrid spatial knowledge and its impact on children's well-being, particularly in contexts of rapid digital transformation. Digital technologies do not merely dissolve spatial relations but actively mediate and reshape them, influencing how young people perceive, navigate, and interact with their environments. The emergence of hybrid spaces—where digital and physical dimensions intersect—calls for theoretical and empirical approaches that capture the complexity of these evolving spatial dynamics. The concept of refiguration of spaces provides a valuable framework for understanding these shifts, particularly in relation to children and adolescents. Moving beyond traditional dichotomies of online and offline spaces, this perspective highlights the fluid interplay between virtual and physical realms, recognizing how mediated experiences shape spatial awareness and behaviors. Future research should also examine how emerging technologies such as augmented reality (AR) and virtual reality (VR) further redefine young people's spatial experiences, introducing new modes of interaction that blend physical and digital spaces in unprecedented ways. Additionally, comparative studies between regions and countries can provide insights into the global and localized dynamics of digital mediatization, offering a more nuanced understanding of how different socio-cultural and infrastructural contexts shape spatial experiences.

At the same time, the emergence of hybrid spaces challenges conventional frameworks in spatial studies, calling for approaches that account for the interconnectedness of physical and digital environments. Traditional notions of spatiality are increasingly insufficient in capturing the complexities of young people's experiences in mediatized spaces. Future research should focus on how digital tools reshape spatial behaviors and perceptions across different contexts, particularly in urban and rural settings, where access to digital infrastructures and socio-cultural conditions create varied spatial experiences. Understanding these transformations requires analytical frameworks that explore how digital technologies mediate spatial relations, influencing the way young people construct, navigate, and experience space. Beyond theoretical considerations, integrating Chinese scholarship into these discussions broadens the scope of research by decentering dominant English-speaking discourses on childhood, digitalization, and space. Recognizing the contributions of research conducted within different socio-cultural and academic contexts enriches the debate and offers a more globally inclusive perspective on the spatial implications of digital media use.

For practitioners in urban planning, urban design, landscape planning, and architecture, this study underscores the rising importance of designing spaces that accommodate the hybridity of young people's physical and digital interactions. By aligning spatial design with the realities of hybrid spaces, professionals can create environments that foster meaningful and balanced engagement across both dimensions.

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