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Bibliometric Trends in Children and Technology Interaction Research

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Abstract
The International Journal of Child-Computer Interaction (IJCCI), published since 2013, has become the primary forum for research focusing on the relationship between children and interactive technology. This study aims to present a comprehensive bibliometric analysis that maps of advancement and research trend of IJCCI publications during the period 2015–2025. A total of 428 documents were analyzed using RStudio, VOSviewer, and Microsoft Excel to evaluate the journal's performance analysis, science mapping, and thematic structure. The results indicates that IJCCI has experienced stable publication growth since 2015, with a significant increase in the period 2019–2023. Keyword analysis revealed themes such as computational thinking, constructivism, and coding. Bibliographic coupling analysis identified four main clusters including design education, computational empowerment, machine learning, and artificial intelligence. These results are an important reference and providing a foundation future study for researchers and practitioners in the field of elementary school and technology implementation.

Keywords:
Digital Interaction; technology for Children; Child-Computer Interaction

A. INTRODUCTION

Research on child–computer interaction has grown rapidly over the past decade, with a significant increase in the number and breadth of publication topics. Studies show that issues such as child-centred design, learning technology, and child-based game interaction have become the main focus of global research (Antle & Hourcade, 2022). Scientific mapping also indicate a diversity of methodological approaches in comprehenssion the mutual between children behaviour and development with the advancement of technology (Giannakos et al., 2020) Increased research on the implementetation of computer technology including tools and digital software in children learning confirms the pivot role of technology in children's learning lives.

Children's interaction with advancement technology has a big impact on their learning process, communication, and social-emotional development. For example, interactive technology increase children's motivation and engagement, especially when designed according to developmental needs (Febliza et al., 2023; Hatzigianni et al., 2023). Despite this utilitations, there is limited meta-scientific research that systematically maps the intellectual development of CCI, particularly the tren and direct research in the International Journal of Child–Computer Interaction (IJCCI). A bibliometric analysis of The International Journal of Child-Computer Interaction (IJCCI) was conducted using Bibliometrix, a state-of-the-art analysis tool based on the R programming language (Aria & Cuccurullo, 2017). This bibliometric approach provides an in-depth understanding of the direction, condition, and performance of a scientific journal, and has been widely applied in various fields of research(Azemi et al., 2024; Durieux & Gevenois, 2010; Karakus et al., 2019; Maral, 2024; Rodrigues et al., 2024). Therefore, the use of this method is relevant to find out the existing and developing trends in this journal.

IJCCI commite to disseminate advanced knowledge in innovation, emerging technologies, scientific discoveries and best practices, tools and techniques, metrics, innovative ways of chindren interaction with digital technology. This is a promising journal that interdisciplinary research perfectly blended toward the field of children learning and advancement of digital technology. The contents of this journal are indexed in EBSCO, EI Compendex, Emerging Sources Citation Index (Clarivate Analytics), ProQuest and ReadCube Discover. As recorded in Scopus, in 2024, IJCCI has the site score of 9.5; scimago journal rank of 1.05, citescoreRank 70/1620 category Education Social Science and 36/186 ini human computer interaction Computer science; and source-normalized Impact per paper of 1.506. Its impact, influence and growing popularity among researchers as the most befitting journal of communication is established beyond any shadow of doubts. This data indicate this journal is priority reference about computer with human interacion focused in children.

Therefore, this study aims to map trends, dominant themes, and directions of CCI development through bibliometric analysis of publications in the International Journal of Child–Computer Interaction. Data is taken from the scopus database to answar the following research question:

1. What are the most significant author, countries,institution, article citation, and country collaboration in IJCCI publication?
2. What are the trend research in IJCCI in last decade?
3. What is the most influence topic area involving interaction bewteen child and digital technology in IJCCI publications?

B. METHODS

Bibliometrics is the application of statistical methods and quantitative tools to systematically analyse bibliographic data (Aria & Cuccurullo, 2017). This study assess scientific productivity, create map the intellectual structure of a field, trace patterns of collaboration and show the evolution of scientific knowledge. Bibliometric analysis applied to analyze publications based on country, institution, journal, author, and specific research field (Alshater et al., 2023; Nandiyanto et al., 2023; Wilson, 2024). Through this study, we identify key contributions, thematic trends, and methodological developments in a scientific domain especially in interaction of children in digital technology (Huang et al., 2020).

Data was collected from Scopus database using a search method focused on the Search within Source Article option and the keywords computer, child, and interaction. The search was filtered by choosing limited source title to International Journal of Child–Computer Interaction to ensure that the data collected was only from the most relevant journal sources or in advance query we wrote “SRCTITLE (International Journal of Child Computer Interaction) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (EXACTSRCTITLE , "International Journal of Child Computer Interaction"))”. We chose the indexed scopus because it is a reputable database with broad coverage in the fields of social sciences, education, and human technology (Archambault et al., 2009). Even thought IJCCI began publication form 2013, but study specifically focused on the last ten years (2015–2025)(Raman et al., 2022). This time period was chosen because the last decade has seen significant developments and 428 documents were found that satisfied the research criteria.

All documents were then downloaded in RIS format for bibliometric processing. The data were analysed using the R programming language through the RStudio (Posit) application with the Biblioshiny library from the Bibliometrix package (Aria & Cuccurullo, 2017).The data import and loading process was carried out using the bibliometrix function, which accurately reads the metadata structure from the Scopus database.From the metadata extraction results by biblioshiny, data was obtained including abstract, DOI, document type, journal name, language, publication year, article title, total citations (with status: excellent), affiliation, author, cited reference (status: good), and keyword data (status: acceptable). Unfortenatelly, Metadata elements about corresponding authors, keywords plus, and science categories were completely missing.

Data were extracted from Scopus metadata and analysed using VOSviewer software for network mapping and Biblioshiny in RStudio for descriptive analysis. To strength the data, the bibliographic coupling technique was conducted to identify relationships between articles based on similarities in references, while keyword co-occurrence analysis was used to find topic clusters and the evolution of research themes in the field of Child-Computer Interaction.

C. RESULT & DISCUSSION

The International Journal of Child-Computer Interaction (IJCCI) accepts research contributions on the following topics such as new methods for engaging with children in the context of design, evaluation, and research;models that assist designers and researchers in better comprehending children and their relationship with technology; case studies of interaction design featuring technology that is innovative and well conceived for children; studies on how children interact with and use technology; research on the application and design of technology for play, learning, socializing, and communication; literature reviews and theories related to child growth and technology design; studies on gaming and the application of serious games theory to technology for children; and evaluation studies of new and emerging technologies that are designed for children(*Https://Www.Sciencedirect.Com/Journal/International-Journal-of-Child-Computer-Interaction/about/Aims-and-Scope*, 2025).

A database search on IJCCI indicates that there are 428 documents from 2015 to 2025. Types of documents in this journal consist of 245 research articles (88.8%), 18 editorials (6.5%), 8 short notes (2.9%), and 5 review articles (1.8%). In addition, from the perspective of scientific impact, documents from IJCCI has accumulated 2,145 citations with an average of 7.8 citations per document, and this indicating urgency and visibility within the world scientific community in shaping the research landscape of child-computer interaction. A consistent increase in scientific publications in the area of child-computer interaction, with an annual growth rate of 15.3%. A record 1,180 authors have contributed to IJCCI productions, suggesting strong academic collaboration at the global level. Even though there are 29 single-authored documents, the international collaboration rate reaches 18.93% demonstrate cross-national involvement in the studies published in this journal. In extra, there were 1,230 author keywords indicate the diversity of study themes and the breadth of topics covered this journal. Moreover, the average citation per document was 19.45 indicate the publications produce a high scientific impact to other research theme.

Table 1. Publication and Citation Structure of IJCCI

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2015	71.46	13	6.50	11
2016	37.14	7	3.71	10
2017	23.44	27	2.60	9
2018	32.76	38	4.10	8
2019	39.06	31	5.58	7
2020	30.24	21	5.04	6
2021	24.78	51	4.96	5
2022	17.58	85	4.39	4
2023	9.20	49	3.07	3
2024	3.13	52	1.56	2

Table 2. Leading Authors in IJCCI

No.	Authors	Articles	Articles Fractionalized	H-index	Institution
1	Iivari, Netta	14	3.36	29	University of Oulu, Oulu, Finland
2	Giannakos, Michail N.	12	3.71	54	Norwegian University of Science and Technology, Trondheim, Norway
3	Iversen, Ole Sejer	12	2.22	34	Aarhus Universitet, Aarhus, Denmark

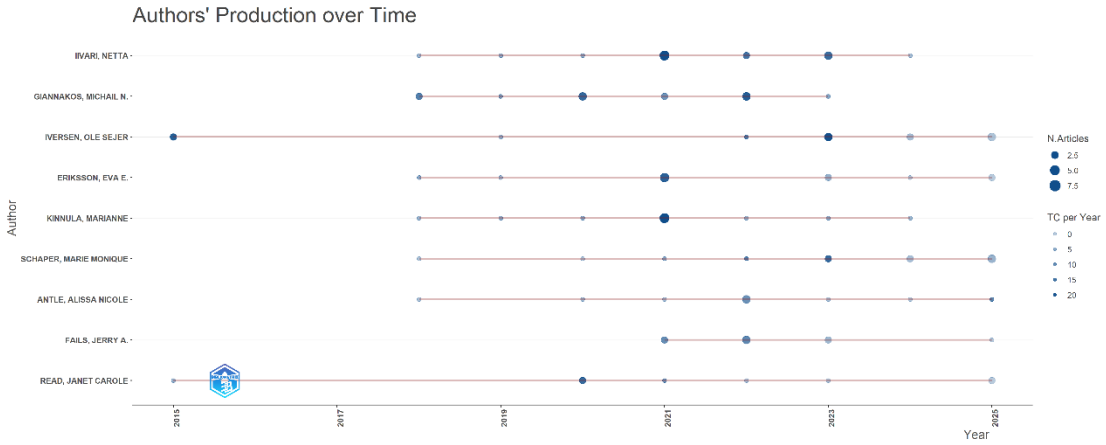

Figure 1. Top Author's Production Overtime (2015-2025)

Table 3. Most Productive Universities

Affiliation	Articles
Aarhus Universitet (Denmark)	75
Interact Research Unit at the University of Oulu (Finland)	46
Norges Teknisk-Naturvitenskapelige Universitet (Norwegia)	37

Table 4. Leading Countries in IJCCI

Country	Freq
United State of America	418
United Kingdom	161
Finland	118

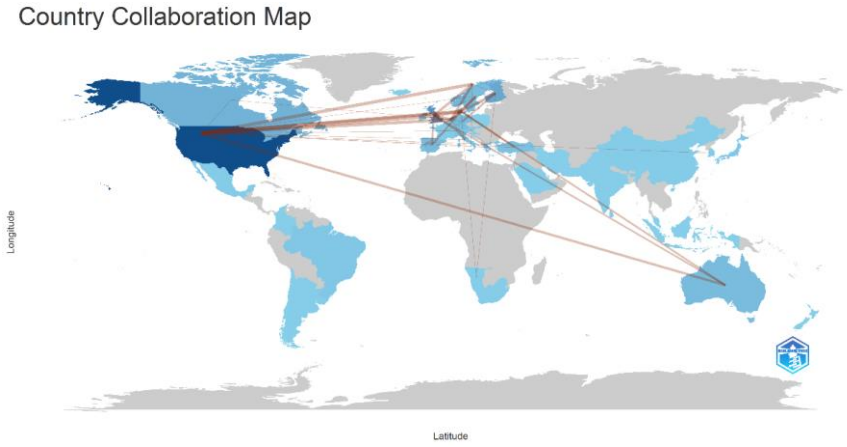

Figure 2. Country Collaboration Map

Table 3 shows the researchers who have published most frequently in the IJJCI over the past decade. This data confirms that collaboration between European countries such as Finland, Denmark,and Norway plays a big role for development of Child-Computer Interaction (CCI) studies in the world. This data aslo support by Table 4 about the most productive instituion, these reflects the consistency from European and North American research institutions in research based on children's educational with interaction on computer technology. Table 5 highlights the important role of developed countries in supporting interactive computer technology-based research for children. The publication pattern in figure 2. also confirms that the main IJCCI research centre are located in North America and Western Europe, while contributions from Asian and Global South countries remain limited.

Table 5. Most Influential Articles of IJCCI

Author	h_index	g_index	m_index	TC	NP	PY_start
Giannakos Michail N. (Norway)	10	12	1.25	408	12	2018
Iivari Netta (Finland)	10	14	1.25	316	14	2018
Kinnula Marianne (Finland)	9	11	1.125	237	11	2018

Table 6. Most Influential Articles of IJCCI, there are two important points that can be concluded. First, the dominance of researchers from Northern Europe is evident, particularly from Finland, Denmark, and Norway. This data feflecting the strong tradition of Child–Computer Interaction research in Scandinavia, which emphasizes participatory design and technology-based learning.

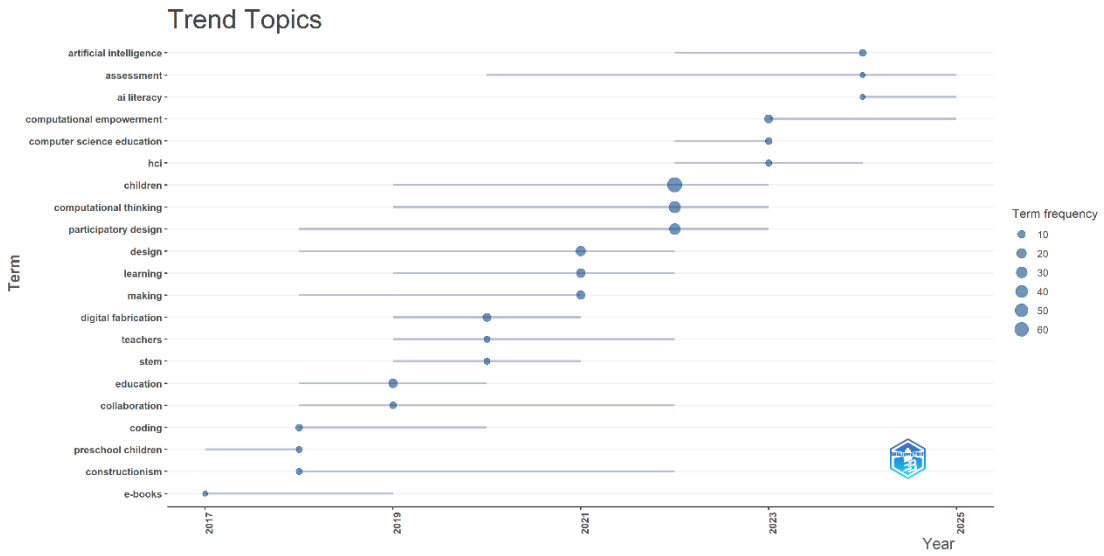

Figure 3. Trend Topics

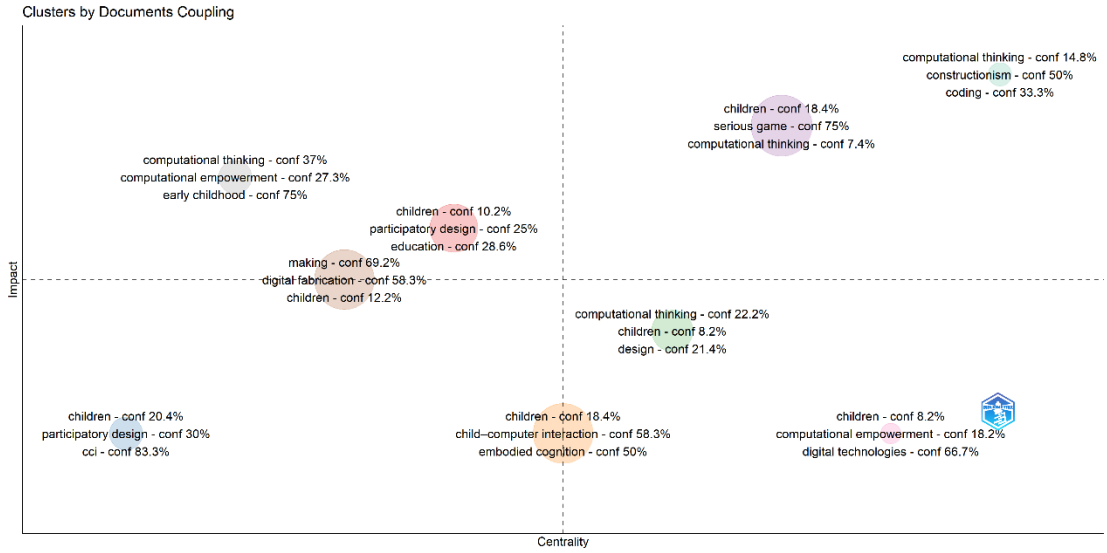

Figure 4. Clustering by Mapping

Conceptual structure analysis conducted on publications in the International Journal of Child-Computer Interaction (IJCCI) enables the identification of key themes and research trends based on keyword relationships (co-word analysis). Through this bibliometric approach, the conceptual map illustrates the dynamics of research focus developments in the field of child and digital technology interaction.

The trend topic in IJCCI analysis shows the advancement of research concepts from 2015 to 2025, which can be split into three phases of thematic development. In the initial phase (2015–2019), dominating topics in IJCCI such as e-books, coding, preschool children, and constructionist, that reflecting a focal point on fundamental of digital literacy and the application of constructionist approaches in children's learning using computer technology.

During the transition phase (2020–2022), study on children's interactions with computers began to shift towards different areas of trend research, such as computational thinking, participatory online learning design, digital content fabrication, and STEM education. In the COVID-19 crisis, learning process shift to online learning (Cavalcanti et al., 2021)caused a shift in research focus towards 21st-century skills and the engagement of children as design

partners in the digital technology learning process (Dubovi & Adler, 2024; O'Connor Bones et al., 2022). This change has resulted in increased research on distance learning and increased digital content substituting conventional learning content.

The current phase (2023–2025) highlight issues such as the emergence artificial intelligence, artificial intelligence literacy, assessment, computational empowerment, and computer science education. This trend initiated with the proliferation of the latest AI(Yim & Su, 2024), block chain, and web3 technologies(Benny et al., 2025; Yusuf et al., 2024), leading to a shift in research trend focus towards preparing children for the era of artificial intelligence and developing artificial intelligence literacy from an early age. Moreover, the advancement of AI influence the method of assessment to reduce academic dishonesty and trustworthy(Khan et al., 2024; Kooli & Yusuf, 2024; Surahman & Wang, 2022; Zhai & Nehm, 2023). Overall this trend research support children behaviours to adapt with recent technology.

Co-word analysis also indicates two main thematic groups. firstly, research oriented towards developing children's computational abilities and digital pedagogical approaches. secondly, research focused on the application of smart technology in the context of children's learning. It support to bring learning opportunities and foster young children's AI literacy in terms of AI concepts, practices and perspectives (Sperling et al., 2025; Su et al., 2023) .Thus, the conceptual structure of IJCCI shows a significant transition from digital literacy to the empowerment of children in an artificial intelligence-based learning ecosystem.

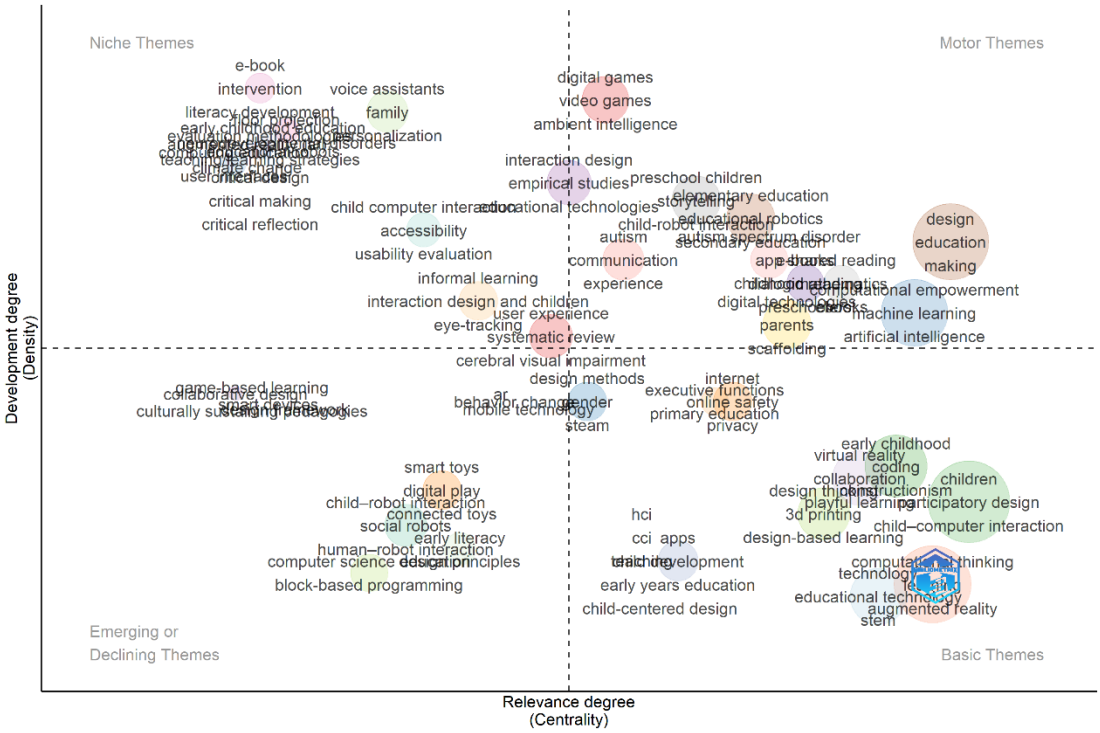

Figure 5. Keyword Thematic Mapping

Figure 5 above depicts a Thematic Map of research topics in the field of Child–Computer Interaction (CCI) based on co-word analysis. This map displays the distribution of themes based on two main dimensions: degree of development (density), which indicates the internal maturity of a theme, and degree of relevance (centrality), which indicates the relevance of a theme to the field of research as a whole(Aria & Cuccurullo, 2017). Motor Themes Quadrant (top right) displays themes with high levels of development and relevance, indicating the main direction and core of CCI's current research. Themes such as design, education, making, machine learning, computational empowerment, and artificial intelligence dominate this area. This means that cutting-edge research focuses heavily on the integration of artificial intelligence and

technology-based learning design for children(Su et al., 2023). These themes are the driving force behind the development of CCI and have the potential for continued growth. The Basic Themes quadrant (bottom right) has high relevance but a moderate level of development. Topics such as children, computational thinking, child–computer interaction, design-based learning, augmented reality (AR), virtual reality(VR), and educational technology form the main foundation of the research. AR/VR not only support positive impact in individual student such as ini achivement, cognitive abilities, learning efficiency, motivation, self efficacy(Alibraheim et al., 2023), cognitive load(Chen & Mokmin, 2024), satisfation, concentration, cooperative ability, and scientific literacy but also support positive impact on learning and teaching processes such as class engagement(Drljević et al., 2024), visualisation, individualize teaching, inquiry learning, active learning, cooperative learning, mainful learning(Flavin et al., 2025), and interaction (Jiang et al., 2025). Unfortunately, VR/AR also poses a several of challenges to students ,teachers, and stakeholder. The challenges teacher encounter include distractions, decreasedefficiency and effectiveness, diminished inquiry and imagination, operational issues,and discomfort. Teachers face strenuous maintaining classroom settings, de-signing activities, acquiring technical competence, and adapting to the new role offacilitating student-centered learning(Singh et al., 2023). Schools face high , inadequate infrastructure, minim of private virtual spaces, and privacy concerns(Egaji et al., 2022). This means that these themes are conceptually and methodologically important as a basis for further research in the solution context of technology-based education for children.

The Niche Themes quadrant (top left) shows themes that are highly developed but less central to the overall field. Topics such as e-books, critical making, voice assistants, accessibility, and usability evaluation reflect specific and in-depth areas of research. These themes are usually addressed by smaller, more applied research communities, for example, for the needs of children with disabilities or specific educational contexts. The Emerging or Declining Themes area (bottom left) contains themes with low relevance and development, indicating fields that are emerging or declining. Themes such as smart toys(Sylla et al., 2022), social robots(Ünlütabak & Erol Barkana, 2025), block-based programming(Lin et al., 2025), and human–robot interaction signify (Esfandbod et al., 2023)current issues directions that are still in the early stages of exploration but have the potential to develop as interactive technology for children advances.

Overall, the results of this thematic mapping show that CCI research is moving towards strengthening the integration of computational thinking, AI literacy, and design-based learning in the context of early childhood and primary education. Technology-based approaches such as augmented reality and virtual learning environments also show potential to become key themes in the coming years.

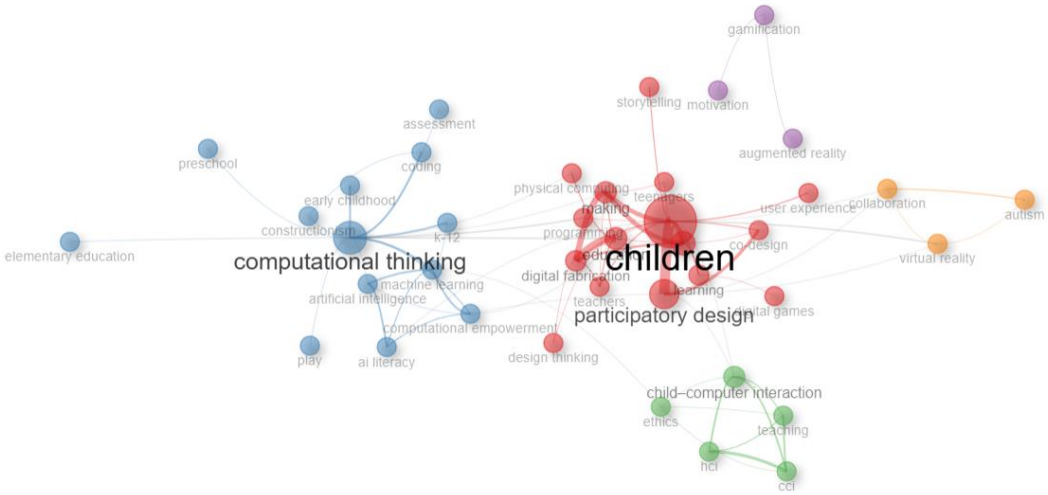

Figure 6. Co-occurance Network

The co-occurrence network map shows the relationships between keywords in publications in the International Journal of Computer-Child Interaction (IJCCI). Larger domains indicate higher frequency of occurrence, whereas connecting lines demonstrate conceptual relationships between the topics. This analysis reveals four main clusters representing the thematic focus of the research. The red cluster centre on children and participatory design, highlighting the dominance of the theme of child involvement in the design of inclusive educational technology. Themes such as digital fabrication, programming, and making emphasize a participatory approach that links pedagogical and social aspects. The blue cluster features the topics of computational thinking and AI literacy, which describe the integration of computational thinking (Bakala et al., 2021)and artificial intelligence in early childhood learning (Sperling et al., 2025). Children gain can benefit from learning tools such as PopBots, while software devices, such as Scratch and Python, which help to develop the computational thinking of AI algorithms, can be introduced to both primary and secondary schools (Yim & Su, 2024). On the other hand, the green cluster focuses on child-computer interaction, Human Computer Interaction, and ethics, highlighting issues of user-centered design and child technology ethics. Two extra groups indicate recent research directions such as the purple group covers gamification, narrative, and augmented reality, that signifying exploration in immersive learning and learning motivation and the orange groups highlights virtual reality (Silva et al., 2022), collaboration (Sharma et al., 2019), and autism(Mora-Guiard et al., 2017), that indicate the implementation of immersive technology for inclusive educations. In general, article researchs IJCCI a big focuses on child-centered design incorporated with strengthening computational thinking,developing AI literacy, and implementing immersive reality-based innovation in learning process.

However, there are several limitations in this study. First, the analysis of author productivity is based only on publications in IJCCI, and does not represent the overall contribution of researchers from another journal with related fields. Second, all citations are treated without in view of the context of the citation, its not always reflect the actual scientific influence. Third, the implementation of the Scopus database limits the scope because not cover all relevant journals. In the further studies, we recommend to combine data from other database such as Web of Science or ERIC for more comprehend results. The data analysed also only included titles, keywords, and abstracts, so full content analysis through text mining in the future could provide more in-depth methodological insights. Nevertheless, this study still makes an important contribution to mapping the main trends, themes, and scientific networks of IJCCI.

D. CONCLUSION

The results of the study show that IJCCI highlights topics including children's themes, participatory design, computational thinking, child-computer interaction, and the application of technologies such as augmented reality, virtual reality, and artificial intelligence in the context of learning for children from kindergarten to primary school.

Intellectual structure analysis shows that research in IJCCI is organized into several main clusters, including topics on child engagement in participatory design, the development of computational thinking skills in primary education, and ethics and human-computer interaction. Meanwhile, social structure analysis indicating international collaboration is dominated by the United States and the United Kingdom and strong influenced by European countries such as the Finland, Denmark, Norway, Canada Netherland, and Spain. Moreover, increasing contributions is also from Asian countries such as China, Japan and South Korea.

Overall, the results of this study show that IJCCI plays a key role in connecting researchers between disciplines and regions to construct a knowledge ecosystem about the relationship between children and digital technology. These findings direct researchers and policymakers in study about future research directions in the field of child-computer interaction for the next time.

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