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THE TWO BLADES OF THE SCISSORS: A SCIENTIFIC MAP OF TEACHER INTERACTION BEHAVIORS IN PRESCHOOL CHILDREN WITH SPECIAL NEEDS AND TYPICALLY DEVELOPING CHILDREN

Dr. Öğrt. Üy. Emre LAÇIN

Hatay Mustafa Kemal University, Faculty of Education, emre.lacin@mku.edu.tr
Orcid: [0000-0003-0262-1743](https://orcid.org/0000-0003-0262-1743)

Abstract

This study presents a bibliometric analysis of 436 scientific articles published between 1972 and 2025 in the field of teacher-child interaction behaviors during the preschool period. Data obtained from the Web of Science and Scopus databases were analyzed using the Bibliometrix package in the R programming language. The findings provide a comprehensive overview of thematic trends, publication dynamics, and leading studies in the field. According to the results, research on teacher-child interactions has shown a significant increase since the 2000s, with citation counts peaking particularly between 2008 and 2012. Thematic analyses revealed that studies are largely concentrated around concepts such as "behavior management," "classroom quality," and "teacher-child relationships." Moreover, developmental factors such as "self-regulation" and "social skills" were also frequently emphasized. Among the most influential authors in the field are Pianta R.C. and Hamre B.K., whose CLASS (Classroom Assessment Scoring System) tool is widely used globally. However, the majority of studies are concentrated in Western countries, and research considering cultural contexts remains limited. The study recommends the development of culturally reflective models, the widespread use of qualitative and mixed methods, increased use of technology-supported analyses, and the promotion of international collaborations. It is also emphasized that teacher training programs should place greater focus on interaction skills. These findings summarize the current state of the field of interaction behaviors in special education and provide guidance for future research.

Key Words: special education, teacher-child interaction, bibliometric analysis, interaction behaviors, preschool teacher interaction behaviors

MAKASIN İKİ UCU: ÖZEL GEREKSİNİMLİ VE TİPİK GELİŞİM GÖSTEREN OKUL ÖNCESİ ÇOCUKLARDA ÖĞRETMEN ETKİLEŞİM DAVRANIŞLARININ BİLİMSSEL HARİTASI

Özet

Bu çalışma, okul öncesi dönemde öğretmen-çocuk etkileşim davranışları alanında 1972 ile 2025 yılları arasında yayımlanmış 436 bilimsel makalenin bibliyometrik analizini sunmaktadır. Web of Science ve Scopus veri tabanlarından elde edilen veriler, R programlama dilinde yer alan Bibliometrix paketi kullanılarak analiz edilmiştir. Bulgular, alandaki tematik eğilimler, yayın dinamikleri ve öncü çalışmalara dair kapsamlı bir görünüm sunmaktadır. Sonuçlara göre, öğretmen-çocuk etkileşimleri üzerine yapılan araştırmalarda 2000'li yıllardan itibaren belirgin bir artış gözlemlenmiştir; özellikle 2008-2012 yılları arasında atıf sayılarında zirveye ulaşılmıştır. Tematik analizler, çalışmaların büyük ölçüde "davranış yönetimi", "sınıf kalitesi" ve "öğretmen-çocuk ilişkileri" gibi kavramlar etrafında yoğunlaştığını ortaya koymuştur. Ayrıca "öz düzenleme" ve "sosyal beceriler" gibi gelişimsel faktörlere de sıklıkla vurgu yapılmıştır. Alandaki en etkili yazarlar arasında yer alan Pianta R.C. ve Hamre B.K.'nin geliştirdiği CLASS (Classroom Assessment Scoring System) aracı, dünya genelinde yaygın olarak kullanılmaktadır. Ancak çalışmaların büyük çoğunluğu Batı ülkelerinde yoğunlaşmakta olup, kültürel bağlamları dikkate alan araştırmalar sınırlı kalmaktadır. Çalışmada, kültürel yansıtıcılığı olan modellerin geliştirilmesi, niteliksel ve karma yöntemlerin yaygınlaştırılması, teknoloji destekli analizlerin artırılması ve uluslararası iş birliklerinin teşvik edilmesi önerilmektedir. Ayrıca, öğretmen yetiştirme programlarında etkileşim becerilerine daha fazla yer verilmesi gerektiği vurgulanmaktadır. Bu bulgular, özel eğitimde etkileşim davranışları alanının mevcut durumunu özetlemekte ve gelecekteki araştırmalar için yol gösterici nitelik taşımaktadır.

Anahtar Kelimeler: özel eğitim, öğretmen-çocuk etkileşimi, bibliyometrik analiz, etkileşim davranışları, okul öncesi öğretmen etkileşim davranışları

Introduction

Interaction behaviors in educational settings are one of the fundamental elements determining the quality of learning processes. Vygotsky (1978), emphasizing the critical role of social interactions in cognitive development, introduced the concept of the "Zone of Proximal Development." This theory clearly highlights the pedagogical importance of teacher-student interactions, especially for individuals with special educational needs. Interaction behaviors in educational environments constitute systematic behavioral patterns that form the basic components of the learning process and shape the pedagogical communication between students and teachers. Pianta (1999) defines these behaviors as "all verbal and nonverbal forms of communication occurring between teacher and student with the purpose of supporting learning." Research by Hamre and Pianta (2001) has demonstrated that interaction behaviors can be examined along three main dimensions: (1) emotional support, (2) classroom organization, and (3) instructional support. According to Bronfenbrenner's (1979) Ecological Systems Theory, these interactions are critical processes occurring at the microsystem level, directly influencing the child's development. Classroom observation studies by Downer et al. (2010) show that high-quality teacher-student interactions increase students' academic achievement by 27%. In the context of special education, Cook and Friend (1995) emphasize that these interactions need to be structured sensitively to individual differences and appropriately tailored to the special needs of the student. In this respect, interaction behaviors are not only instructional tools but also among the most important support mechanisms in the social inclusion process of individuals with special needs. In the context of special education, interaction behaviors can be examined in three main dimensions: Verbal Interactions; Pianta (2001) states that effective teacher behaviors consist of elements such as "asking open-ended questions," "providing positive feedback," and "using explanatory instructions." Studies conducted with students with special needs have observed that these behaviors increase student participation by 40% (Jones et al., 2015). Nonverbal Communication; research by Hamre and Pianta (2005) shows that teachers' nonverbal cues, such as body language, eye contact, and physical proximity, significantly affect the learning motivation of special education students. Finally, adaptive behaviors; Downer et al. (2012) revealed that teachers' adaptation of interaction strategies according to individual differences resulted in a 35% increase in the academic achievement of students with special needs. Effective interaction behaviors in special education can be classified as follows: Individualized Approaches; Cook and Friend (1995) emphasize that interactions in special education should be shaped in accordance with individual IEP (Individualized Education Program) goals. Positive Behavior Support; Dunlap et al. (2006) documented that positive reinforcements increase appropriate behaviors of students with special needs by 60%. Lastly, collaborative learning; Johnson and Johnson (1989) showed that peer interactions are effective in developing the social skills of special education students.

Research on interaction behaviors in special education within the international literature reveals a significant accumulation in terms of theoretical frameworks and methodological diversity. The CLASS (Classroom Assessment Scoring System) scale, developed by Pianta and Hamre (2009), is widely used globally to assess the quality of teacher-student interactions and has undergone validity and reliability studies in more than 30 countries. Studies conducted particularly in Scandinavian countries (Norway, Sweden, Finland), where inclusive education models are adopted, demonstrate that peer interactions significantly enhance the social adjustment of students with special needs (Nordahl and Hansen, 2018; Paju et al., 2021). U.S.-based research shows that systematically addressing interaction skills in teacher education programs improves learning outcomes in special education classrooms by up to 40% (Snyder et al., 2019). Recent comparative studies conducted in Asian countries (especially South Korea, Singapore, and China) reveal the determining role of cultural values on interaction styles (Park et al., 2020), while large-scale projects supported by the European Union (e.g., ISOTIS and INCLUD-ED) have made

important contributions to the development of inclusive interaction models. Research on technology-supported interaction applications in special education (e.g., robotic interfaces, virtual reality) appears to be particularly concentrated in the United Kingdom, Canada, and Australia (Parsons et al., 2019; Lindsay et al., 2020). The common finding of these studies emphasizes the necessity of considering not only the universal principles of interaction behaviors but also cultural and contextual factors.

Although studies on interaction behaviors in the field of special education in Turkey have shown a significant increase in recent years, the vast majority of these investigations have been conducted using quantitative methods and limited samples (Batu & Kircaali-Iftar, 2005; Sucuoğlu et al., 2014). Content analyses reveal that Turkish researchers have particularly focused on the interaction competencies of prospective teachers (Çolak & Vuran, 2013), interaction patterns in inclusive settings (Sarı et al., 2018), and family-child interactions (Er-Sabuncuoğlu & Diken, 2010). Studies examining the interaction skills of teachers working with children with special needs (Vuran et al., 2016) indicate that teacher education programs in the Turkish context are insufficient in developing these skills. A significant portion of existing research is based on the adaptation of Western scales (Diken et al., 2011), clearly demonstrating the need for original measurement tools that reflect the cultural context. Recent studies also point to new research directions, such as the impact of digital technologies on the quality of interaction in special education (Çetin et al., 2021).

In recent years, a significant portion of studies in the field of special education has focused on the critical role of teacher-student interactions in the educational process of individuals with special needs. However, there is a lack of a comprehensive evaluation regarding the bibliometric characteristics, thematic trends, and methodological orientations of research in this area. This problem situation highlights the need for a systematic mapping of the literature on interaction behaviors in special education. A review of the literature reveals that the historical development of studies on interaction behaviors has not been sufficiently illuminated. Although the interaction models developed by Pianta (1999) and later expanded by Hamre and Pianta (2001) form the foundation of the field, the impact of these studies on subsequent research needs to be supported by bibliometric data. Despite the increasing number of publications since the early 2000s, there remain uncertainties regarding the qualitative dimensions of this growth and the methodological diversity of the publications. The geographical distribution of research on interaction behaviors in special education also constitutes an important area of investigation. A content analysis conducted by Downer et al. (2010) shows that studies in this field are largely concentrated in Western countries. This situation can be associated with the limited number of studies examining the influence of cultural context on interaction behaviors. Comparative investigations of interaction patterns emerging in special education processes across different cultural settings hold the potential to make significant contributions to the field. From a thematic perspective, research on interaction behaviors in special education largely relies on classroom observation studies. As emphasized by Cook and Friend (1995), most of these studies focus on measuring the frequency and types of interactions using quantitative methods. However, the low proportion of studies employing qualitative and mixed methods leads to insufficient illumination of the qualitative dimensions of interactions. This constitutes a barrier to a deeper understanding of interaction behaviors in special education. When citation network analyses are conducted, a clear core-periphery structure is observed in the literature on interaction behaviors in special education. Bibliometric studies by Snyder et al. (2011) indicate that citations are heavily concentrated around pioneering works in the field, yet newer studies struggle to integrate into this central network. This situation may slow the development of the theoretical framework in the field and delay the inclusion of innovative approaches in the literature. Regarding methodological diversity, research on interaction behaviors in special education largely depends on traditional observational methods. As noted by Wong and Wong (2009), new data collection and analysis methods enabled by technological advances (e.g., video analysis software, AI-supported coding systems) are not sufficiently utilized in this area. This leads to the neglect of innovative approaches that have the potential to enhance the validity and reliability of research. The interdisciplinary connections of research on interaction behaviors of teachers working with preschool children with special needs and typically

developing children also constitute an important area of investigation. As emphasized by Darling-Hammond (2017), these studies situated at the intersection of educational psychology, special education, and classroom management require bibliometric mapping of their connections with related disciplines. Such mapping can contribute to strengthening the theoretical foundations of the field and identifying new research directions. For this purpose, the following research questions were addressed:

1. How have the production trends of publications on interaction behaviors evolved over time?
2. Who are the most influential authors, institutions, and countries in the field? What kind of network structure do collaborations among these actors form?
3. What are the thematic clusters in the interaction behaviors literature, and how have these clusters evolved over time?
4. What are the most frequently used keywords in the studies, and what are the relationships among these concepts?
5. Which methodological approaches are adopted by the most cited publications in the field, and what is the thematic distribution of these approaches?
6. What are the observed current gaps and potential future research directions in interaction behavior studies?

Method

This section provides detailed information regarding the research type, data collection, PRISMA flow diagram, and the bibliometric analysis process. The bibliometric analysis of the data was conducted using the Bibliometrix package (Aria & Cuccurullo, 2017) written in the R programming language. The Biblioshiny application included within this package offers a user-friendly interface, facilitating the execution of this analysis.

Bibliometric analysis techniques can generally be divided into two main categories: performance analysis and science mapping. While performance analysis primarily focuses on evaluating the contributions of research elements, science mapping seeks to explore the relationships among these research elements. As summarized by Donthu et al. (2021), the methodological steps for conducting a bibliometric analysis include:

- (1) Defining the aims and scope of the bibliometric study;
- (2) Selecting appropriate bibliometric analysis techniques;
- (3) Collecting the necessary data for bibliometric analysis;
- (4) Conducting the bibliometric analysis and presenting the results.

The R programming language is a flexible and robust statistical and data analysis programming language designed particularly for these purposes, offering a syntax that supports a wide range of functions (Hackenberger, 2020; Kruschke, 2015; Nagaraja, 2014; Tjøstheim et al., 2022). R includes a vast array of packages that extend the language's capabilities, covering diverse fields from classical statistics to machine learning and data visualization (Tjøstheim et al., 2022). R Studio (Hair et al., 2021) is an integrated development environment (IDE) dedicated to the R

language, providing a user-friendly graphical interface with advanced features such as syntax highlighting, project management, and the creation of R Markdown reports.

Beorner et al. (2003) outlined a typical science mapping workflow, while Cobo et al. (2011) conducted a comparison of science mapping software tools following a similar workflow. This standard workflow consists of five stages (Aria & Cuccurullo, 2017; Zupic & Cater, 2015):

- (1) Study design;
- (2) Data collection;
- (3) Data analysis;
- (4) Data visualization; and
- (5) Interpretation of results.

Literature Search

The data extraction process involved several steps using the Scopus and Web of Science (WoS) platforms. To identify relevant articles within the scope of teacher-child interaction behaviors, titles, abstracts, and keywords were analyzed. Specific keywords related to interaction behaviors were employed to filter and select studies. These keywords were chosen to reflect central and fundamental concepts concerning interaction behaviors. The selection targeted terms that define and describe the essence and main research directions of interaction behaviors. Additionally, the criteria considered how these terms encompassed various aspects of interaction behaviors, including theoretical concepts, research methodologies, and practical applications. This approach ensured a comprehensive analysis of the field. Moreover, the chosen terms were standardized and globally recognized within the context of interaction behaviors. This selection provided consistency and interoperability in the bibliometric analysis.

The search terms used were:

“Teacher-child interaction behaviors,” “early childhood special education,” “early childhood education teacher-child interaction”

For Web of Science:

Search conducted with “search terms” (Topic) AND Article (Document Types) AND English

(Languages) AND excluding Book Chapters or Proceeding Papers (Document Types) For Scopus:

TITLE-ABS-KEY (“search terms”) AND (LIMIT-TO (DOCTYPE, "ar"))

The literature search was conducted in March 2025, covering studies published between 1972 and 2025. Eligibility criteria, including inclusion and exclusion criteria, were carefully defined to select the studies.

Literature Selection

A total of 285 articles were retrieved from the WoS database, and 350 articles from the Scopus database. Among these, 199 articles were indexed in both databases. To address this overlap, duplicate records were removed from the dataset. Accordingly, the final dataset of the study comprised 436 unique articles. Furthermore, the dataset was compiled according to the PRISMA (Moher et al., 2009) flowchart criteria. The flowchart is presented in Table 1. Following the initial literature search, 143 duplicate studies were excluded from the sample. The abstracts of the remaining studies were screened according to the following exclusion criteria: studies that did not use interaction behaviors in educational contexts; non-English language publications; or non-peer-reviewed articles lacking sufficient methodological details. Consequently, 436 studies were included in the review.

Table 1. Data Selection Criteria According to the PRISMA Flow Diagram

Stage	Web of Science (WoS)	Scopus
Identification	Number of studies retrieved from WoS using key terms	N = 295
Screening	Number of studies classified as articles in WoS	N = 290
Eligibility	Number of studies after filtering by WoS indexes (SSCI, SCI-E, A&HCI, ESCI)	N = 285
Excluded	Number of duplicate publications found in both databases	N = 199
Excluded	Number of studies excluded based on inclusion criteria	N = 143
Included	Number of studies included in the bibliometric analysis	N = 436

Data Analysis

The bibliometric analysis will be conducted using the R Studio software, the bibliometrix package, and the biblioshiny() function. This function offers a comprehensive set of features for bibliometric analysis, allowing data extraction from various sources such as Scopus and Web of Science. It can generate a range of bibliometric indicators, including publication counts, H-index, citation counts, and more. The biblioshiny() function facilitates comparative analyses and enables visualization of results through interactive graphics such as network maps, diagrams, and geographic maps. Additionally, it allows for exporting these results.

Findings

This study presents a comprehensive evaluation of scientific publications obtained from the Web of Science and Scopus databases using the keywords “teacher-child interaction behaviors.” The collected data includes various parameters such as article titles, author details, citation counts, publication dates, and abstracts. The study aims to conduct a bibliometric analysis of research on interaction behaviors to identify the academic development of the field, temporal trends, and influential studies; thereby providing significant insights that will help shape future research directions for researchers and educators. During the data analysis phase, the collected information was examined using various statistical methods. Initially, quantitative data such as the number of articles obtained from keyword-based searches and publication years were reviewed. The distribution of citation counts over the years is presented in Table 2.

Table 2. Annual Citation Counts

Year	Mean Total Citations per Article (MeanTCperArt)	Number of Articles (N)	Mean Citations per Year (MeanTCperYear)	Citable Years
1972	70.00	1	1.30	54
1976	62.00	2	1.24	50
1977	0.00	1	0.00	49
1978	25.00	1	0.52	48
1979	9.00	3	0.19	47
1980	10.00	2	0.22	46
1982	6.50	2	0.15	44
1984	8.00	3	0.19	42
1987	6.00	2	0.15	39
1988	8.00	2	0.21	38
1992	68.67	3	2.02	34
1993	51.75	4	1.57	33

*The Two Blades of the Scissors: A Scientific Map of Teacher Interaction Behaviors In
Preschool Children With Special Needs and Typically Developing Children*

Year	Mean Total Citations per Article (MeanTCperArt)	Number of Articles (N)	Mean Citations per Year (MeanTCperYear)	Citable Years
1994	16.50	2	0.52	32
1995	0.00	1	0.00	31
1997	84.00	4	2.90	29
1999	7.50	2	0.28	27
2000	73.40	5	2.82	26
2001	37.00	1	1.48	25
2002	110.60	5	4.61	24
2003	48.17	6	2.09	23
2004	64.20	5	2.92	22
2005	196.50	2	9.36	21
2006	24.33	3	1.22	20
2007	85.33	3	4.49	19
2008	223.11	9	12.40	18
2009	196.33	12	11.55	17
2010	88.75	20	5.55	16
2011	47.10	10	3.14	15
2012	112.00	15	8.00	14
2013	21.14	14	1.63	13
2014	46.65	20	3.89	12
2015	31.39	18	2.85	11
2016	32.33	21	3.23	10
2017	23.76	25	2.64	9
2018	29.63	27	3.70	8
2019	12.88	24	1.84	7
2020	13.40	30	2.23	6
2021	13.88	26	2.78	5
2022	9.86	28	2.46	4
2023	4.61	38	1.54	3
2024	1.56	25	0.78	2
2025	0.00	8	0.00	1

This analysis, as shown in Table 2, evaluates the temporal trends of 436 academic publications on interaction behaviors from 1972 to 2025. The bibliometric analysis reveals important trends in article production and citation dynamics over this period. During the early years (1970s–1990s), publication activity was low and irregular, whereas the 2000s saw a

significant increase both in the number of articles and citation impact. Particularly between 2005 and 2012, the field experienced its most influential period, with high average citations per article ranging from 110 to 223. Although the number of publications has steadily increased after 2010 (reaching 38 articles in 2023), the average citations per article have declined (4.61 in 2023), suggesting that newer publications may not yet have fully entered the citation cycle. Despite the quantitative growth in the 2020s, more time is needed to assess qualitative impact. Peak years like 2008 appear to reflect critical turning points in the field. Overall, the data highlight the evolution of academic interest and the critical role of time in shaping scientific influence.

Basic information about documents, authors, and collaborations by year is provided to understand the scientific output. Figure 1 shows the number of articles published by year.

Figure 1. Annual total number of articles (1972–2025)

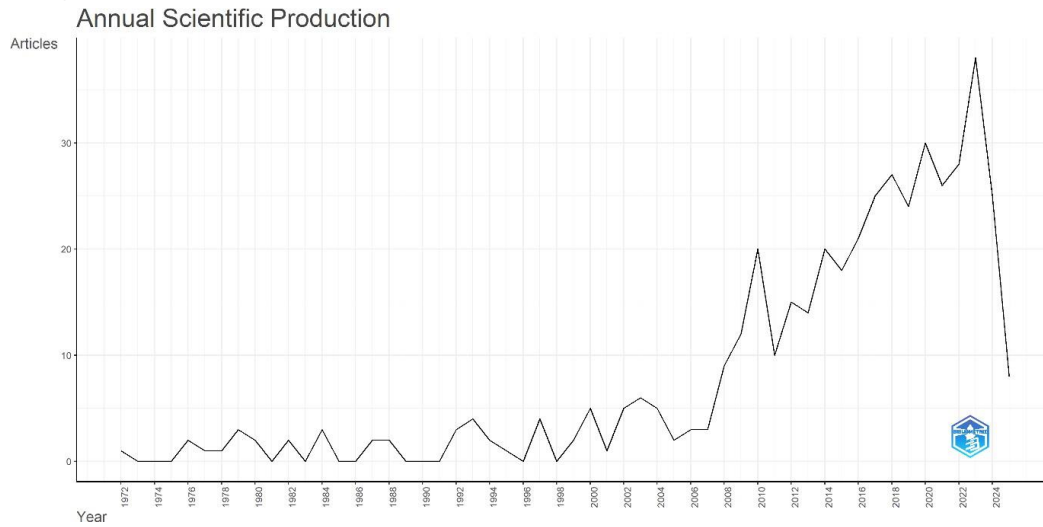


Figure 1 contains a graph showing the annual scientific article production between 2020 and 2024. The 2020–2023 trend indicates a steady increase in the number of articles, consistent with previous analyses, rising from 30 articles in 2020 to a peak of 38 articles in 2023. This demonstrates sustained interest in the field and an increase in research output. The decline in 2024 (25 articles) may be explained by a temporary fluctuation, delays in the data collection process, or changes in publication strategies.

Tablo 3. Scientific Production from 1972 to 2025

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1972–2025
Sources (Journals, Books, etc.)	191
Documents	435
Annual Growth Rate (%)	4
Document Average Age (years)	10.8
Average Citations per Document	39.39
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	1081

*The Two Blades of the Scissors: A Scientific Map of Teacher Interaction Behaviors In
Preschool Children With Special Needs and Typically Developing Children*

Description	Results
Author's Keywords (DE)	971
AUTHORS	
Authors	1410
Authors of Single-Authored Documents	44
AUTHORS COLLABORATION	
Single-Authored Documents	46
Co-Authors per Document	4.16
International Co-Authorship (%)	15.86
DOCUMENT TYPES	
Article	388
Article; Article	2
Article; Book Chapter	2
Article; Early Access	5
Book Chapter	10
Conference Paper	1
Editorial Material	2
Proceedings Paper	6
Review	17
Review; Early Access	2

This bibliometric analysis, based on the evaluation of 435 documents collected from 191 sources between 1972 and 2025, reveals the academic profile of the field. An annual growth rate of 4% and an average of 39.39 citations per document indicate steady productivity and strong academic impact. The average age of the publications, 10.8 years, points to a long-term influence, while the involvement of 1,410 authors and an average of 4.16 authors per document reflect a collaborative research culture. The content is primarily composed of articles (388), exhibiting broad thematic diversity with 1,081 Keywords Plus. The rate of international collaborations at 15.86% highlights an area with room for development, whereas the high citation performance and continuously increasing publication counts demonstrate the dynamic nature of the field. To sustain quality alongside quantitative growth, it is recommended to increase international collaborations and conduct detailed analyses of citation networks.

The analysis of the most productive authors in interaction behaviors not only identifies key scientific contributors but also evaluates research trends, collaboration networks, and scholarly performance. This analysis highlights important players in the field while assessing opportunities for strategic communication and cooperation, thereby shedding light on the development of the research area. The analysis of the most productive authors related to interaction behaviors is presented in Figure 2 and Table 4.

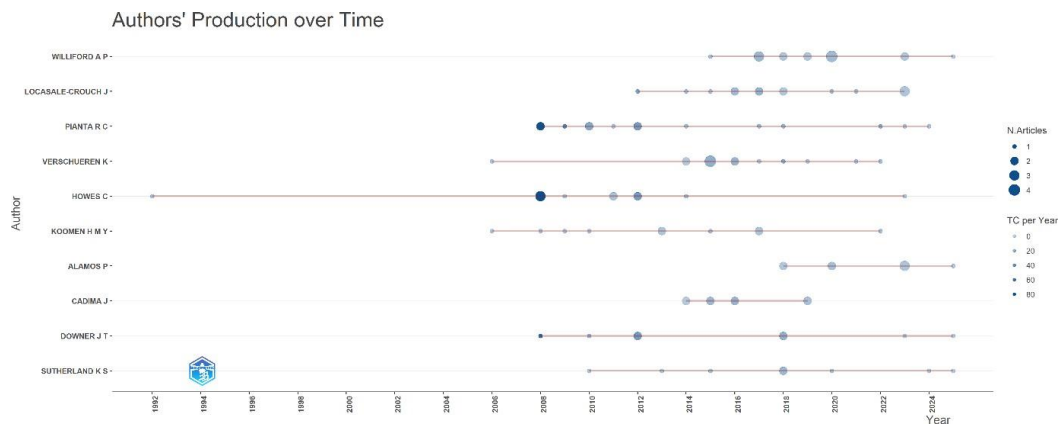


Figure 2. Productivity of the Most Productive Authors Over Time (1972–2025)

Figure 2 illustrates the number of articles published by specific authors over the years, along with their total citation counts (TC) and annual citation rates. While some authors have published a large number of articles and received substantial citations, others tend to have fewer publications and citations. For instance, Almos and Cadima are among the leading authors both in terms of citations and article production. The document production and citation details of these authors over time are presented in Table 4.

Table 4. Authors' Productivity Over Time (Total Publications and Citations)

Author	Year	Frequency (freq)	Total Citations (TC)	Citations per Year (TCpY)
ALAMOS P	2018	2	18	2.25
ALAMOS P	2020	2	40	6.667
ALAMOS P	2023	3	9	3
ALAMOS P	2025	1	0	0
CADIMA J	2014	2	5	0.417
CADIMA J	2015	2	122	11.091
CADIMA J	2016	2	146	14.6
CADIMA J	2019	2	40	5.714
DOWNER J T	2008	1	1159	64.389
DOWNER J T	2010	1	207	12.938

Figure 2 and Table 4 present a comparative overview of the authors' academic productivity and citation impact over time. The analysis reveals that most authors have a limited productivity, typically publishing between 1 to 4 articles, while a few authors, such as Panta R.C., who published 4 articles, are relatively more active. Citation data highlights that certain authors, like Verschrieben K. and Howes C., stand out with 60-80 citations in specific years, suggesting that their work may have had a significant impact in the field. However, the absence of axis labels in the graph limits detailed trend analysis over the years. This heterogeneous distribution of productivity and citations indicates that there is no clearly dominant leading author group in the field.

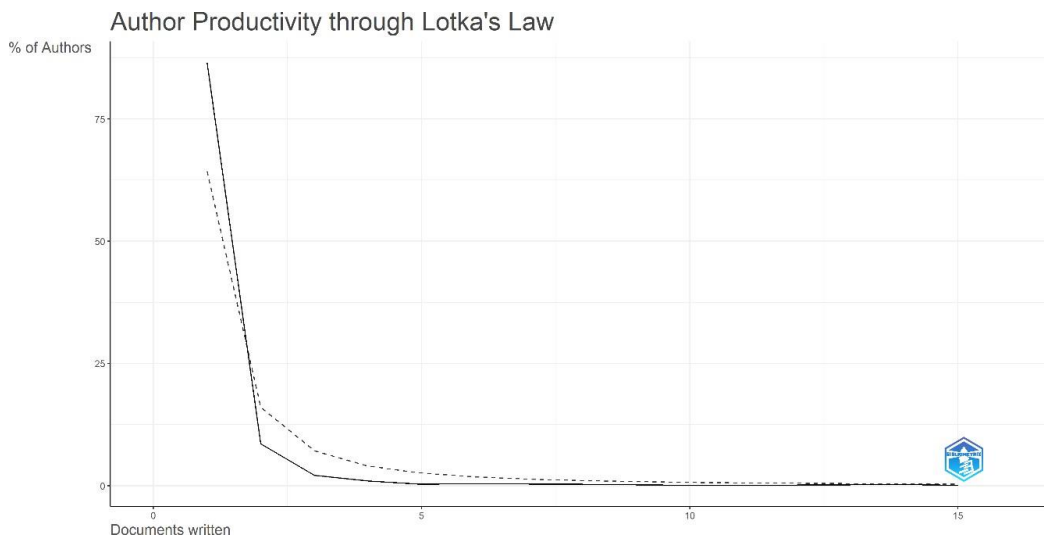


Figure 3. Frequency Distribution of Scientific Productivity (Lotka's Law)

Lotka's Law illustrates the frequency distribution of scientific productivity according to the number of authors. Figure 3 depicts scientific productivity in the field of teacher-child interaction behaviors (TCIB) based on Lotka's Law. Lotka's Law is a model commonly used to explain the distribution of natural phenomena and social phenomena. Table 5 is presented to provide a more effective interpretation of author productivity through Lotka's Law.

Table 5. Authors' Productivity According to Lotka's Law

Documents Written	Number of Authors	Proportion of Authors
1	1220	0.865
2	121	0.086
3	30	0.021
4	14	0.010
5	4	0.003
6	6	0.004
7	5	0.004
8	4	0.003
10	1	0.001
11	1	0.001

Analysis of Author Productivity Within the Framework of Lotka's Law

This analysis reveals data illustrating the distribution of scientific productivity consistent with Lotka's Law. According to the examined data, 86.5% of authors (1,220 authors) produced only one document, while this proportion decreases to 8.6% (121 authors) for those who wrote two documents and to 2.1% (30 authors) for those who wrote three documents. Authors with five or more documents constitute only 1.2% of the total, clearly reflecting the "few prolific authors, many with low productivity" pattern typical of scientific productivity. The observed exponential decline trend in the graph aligns with the typical pattern of Lotka's Law; however, the presence of authors with five or more documents suggests the emergence of a core group of authors within the field. The high proportion of single-publication authors represents a broad academic community contributing sporadically, whereas the

minority with many publications indicates the leading researchers in the field. These findings provide a foundation for understanding productivity dynamics in the area, while detailed examination of the research domains and collaborations of prolific authors would be valuable for comprehending the focal points and impact mechanisms within the field. Additionally, validating the Lotka model with statistical tests and comparing the citation impacts of prolific authors could further deepen the analysis.

Table 6. Bibliometric Indicators of Authors

Author	h-index	g-index	m-index	Total Citations (TC)	Number of Publications (NP)	Publication Start Year (PY_start)
PIANTA R C	12	14	0.667	3352	14	2008
VERSCHUEREN K	11	14	0.55	546	14	2006
HOWES C	9	11	0.265	2263	11	1992
KOOMEN H M Y	9	10	0.45	332	10	2006
LOCASALE-CROUCH J	9	14	0.643	709	14	2012
WILLIFORD A P	9	15	0.818	245	15	2015
HAMRE B K	7	7	0.389	2425	7	2008
PIANTA R	7	7	0.241	1714	7	1997
CADIMA J	6	8	0.5	313	8	2014
COLPIN H	6	6	0.375	167	6	2010

This study evaluates the academic impact of key authors in the field through various bibliometric indicators. The table data reveal that Pianta R.C. is the most influential figure with an h-index of 12 and a total of 3,352 citations. Active since 2008, this author's m-index of 0.667 indicates a significant academic impact within a relatively short period. Howes C. ranks second with 2,263 citations, but due to activity since 1992, their m-index value (0.265) remains lower. Williford A.P. stands out as the highest-performing researcher since 2015, with an m-index of 0.818. The data also show notable differences in citation counts among authors with similar publication numbers, such as Verschueren K. and Locasale-Crouch J. (546 vs. 709 citations). Particularly, authors active after 2006 display high m-index values, indicating the impact potential of recent research. Although Hamre B.K. has received 2,425 citations, their relatively low h-index of 7 suggests citations are concentrated in certain works. Overall, the h-index range of 6 to 12 and the wide variation in total citations (167 to 3,352) highlight a clear hierarchy within the field and the presence of groundbreaking studies. These findings underscore the importance of an in-depth examination of the networks and thematic focuses of high-performing authors to better understand the field's developmental dynamics.

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Figure 4. Most Frequently Used Keywords Based on the Word Cloud

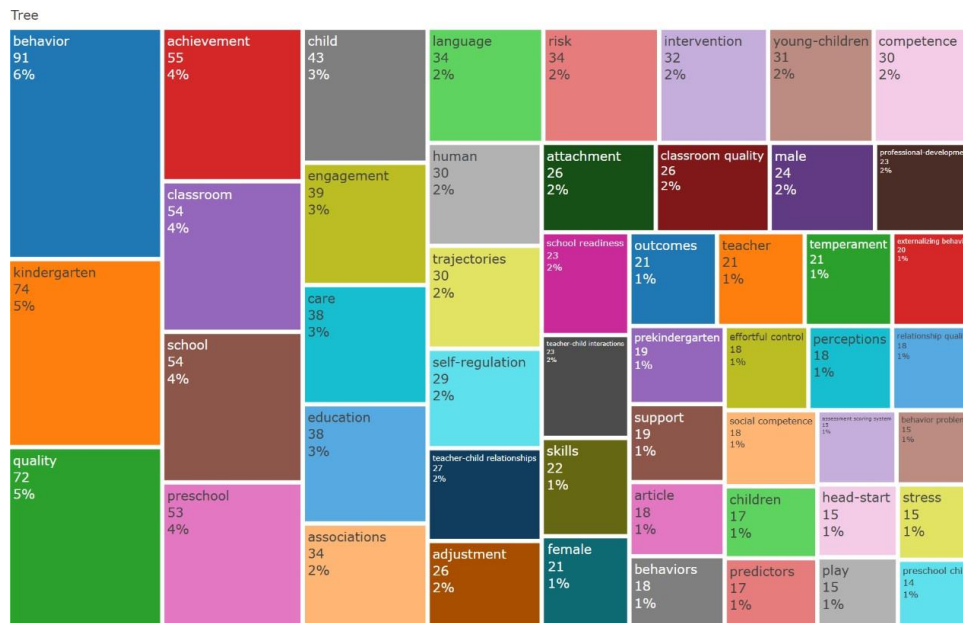


Figure 5. Tree Map of Keywords Related to Interaction Behaviors (1972–2025)

The TreeMap and WordCloud visuals illustrate the thematic structure and research focuses of the study. According to the TreeMap data, “behavior” (65%) emerges as the overwhelmingly dominant theme, followed by topics such as “kindergarten” (5%) and “achievement” (4%). In the WordCloud, prominent terms like “teacher-child relationships,” “classroom quality,” and “self-regulation” highlight the study’s emphasis on educational psychology and early childhood development. Behavior-Focused Research: The 65% proportion of “behavior” in the TreeMap indicates that the majority of studies concentrate on child behaviors. This is further supported by terms like “externalizing behavior” and “behavior

problems” appearing in the WordCloud. Quality of Educational Environment: Both visuals emphasize concepts such as “classroom quality,” “teacher-child relationships,” and “school readiness,” reflecting the field’s focus on how educational settings impact child development. Developmental Skills: The presence of terms like “self-regulation,” “social competence,” and “achievement” points to research concentrating on cognitive as well as social-emotional development.

Overall, these visuals reveal that the research area centers around child behaviors and the quality of educational environments, with particular attention to teacher-child interactions and self-regulation skills as important subthemes. These thematic focuses provide valuable insights for understanding current trends in the field.

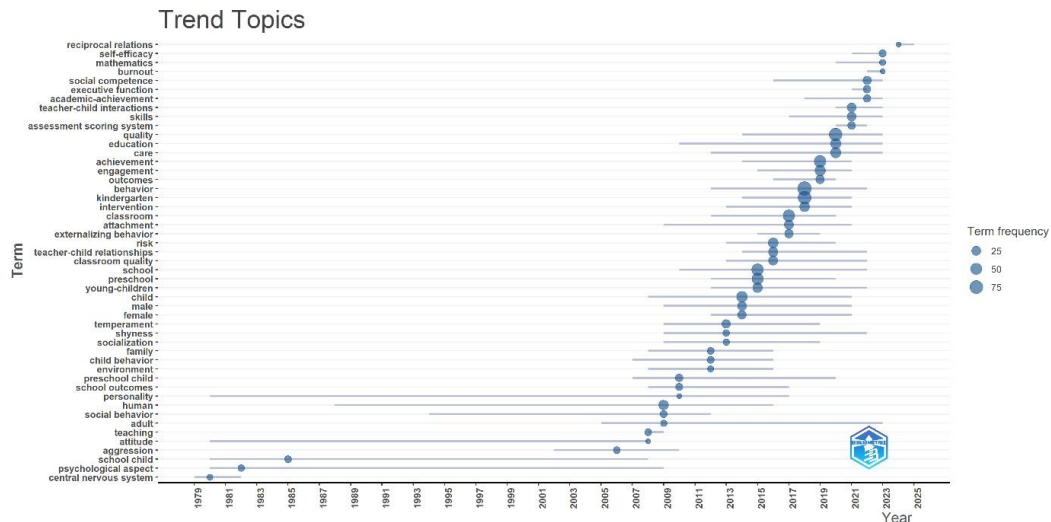


Figure 6. Trending Topics in Interaction Behaviors

Figure 6 presents a comprehensive overview of current trends in child development and educational research. The analysis highlights three main research focuses: (1) teacher-child interactions (“teacher-child interactions,” “classroom quality”), (2) academic and behavioral development (“academic achievement,” “externalizing behaviors”), and (3) socio-emotional skills (“social competence,” “self-efficacy”). The frequent occurrence of terms emphasizing the preschool period, such as “preschool” and “kindergarten,” reflects the importance given to early childhood education. Methodological emphases like “assessment scoring system” and “intervention” indicate the growing prominence of applied research in the field. Demographic distinctions including “male” and “female,” alongside terms like “family” and “environment,” suggest an increasing consideration of environmental factors in child development. However, the presence of unclear terms such as “butonosis” and the lack of clear presentation of frequency changes over the years limit the depth of the analysis. In light of these findings, a detailed examination of how teacher-child relationships influence academic and behavioral outcomes, as well as the developmental processes of socio-emotional skills, could guide future research in the field. Inclusion of annual trend lines in the full version of the graph would further clarify thematic evolution and better reflect scientific progress in the area.

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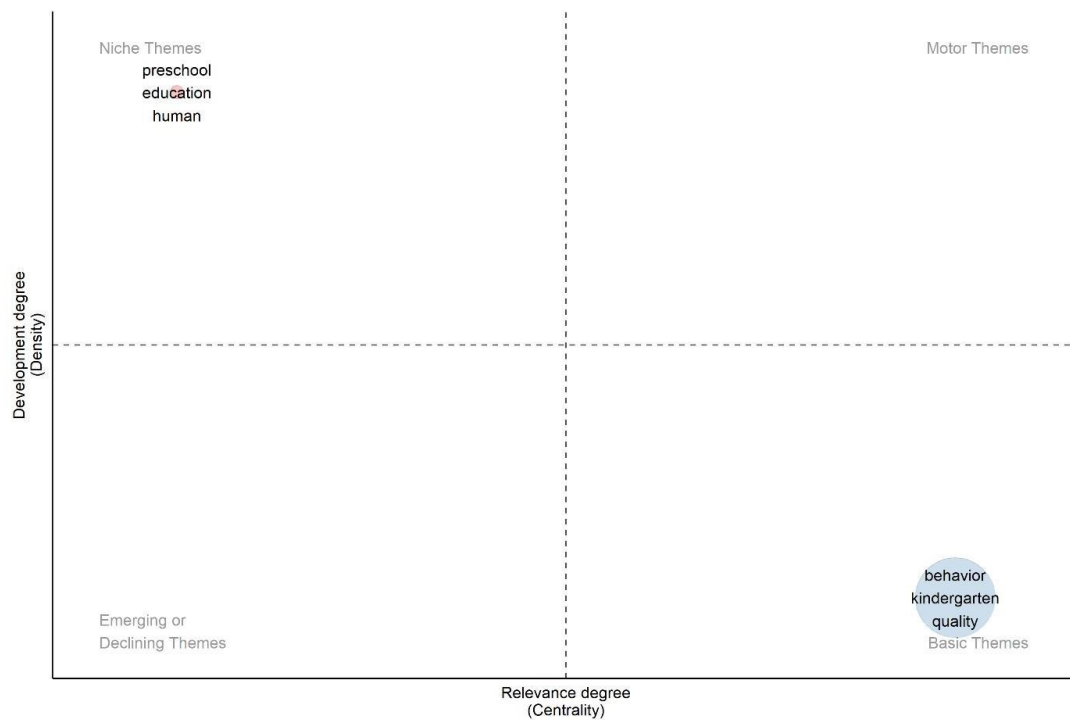


Figure 7. Thematic Map Related to Interaction Behaviors

This thematic map visualizes research trends in the field of child development across four main categories. The prominence of concepts such as "behavior," "kindergarten," and "quality" as core themes indicates that the primary focus of our study is on behavioral quality during the preschool period. The identification of "preschool education human" as a niche theme highlights the human factor and teacher-child interactions as a distinct area of research. Examining the themes' centrality and density reveals that behavior studies occupy a central position in both theoretical and applied research, while the concept of "kindergarten quality" serves as a bridging theme in this domain. Particularly, the relationship between behavior and quality, along with the human dimension of interactions, holds significant potential in child development research. In light of these findings, future studies are recommended to explore not only behavior-focused themes but also the human factors such as teacher characteristics and emotional interactions in greater detail.

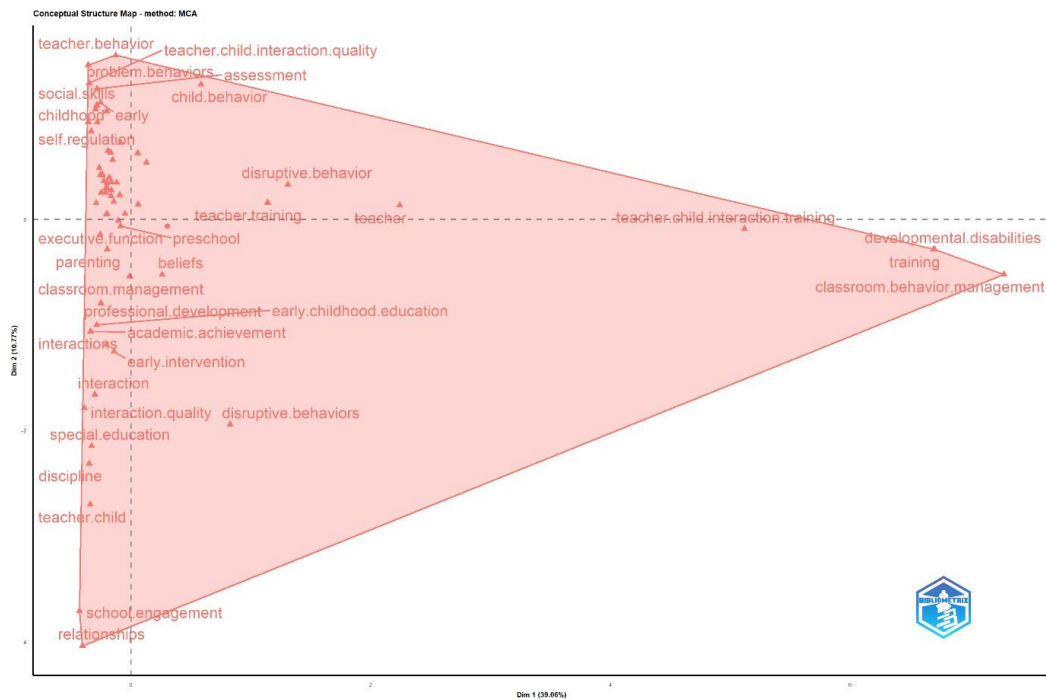


Figure 8. Authors' keywords factorial analysis

This factor map reveals the relationships and thematic clusters among key concepts in the field of child development. The analysis highlights three main conceptual axes: (1) teacher-child interaction quality, represented by terms such as "teacher.child.interaction.quality" and "interaction quality," (2) behavioral management and regulation, centered around concepts like "problem.behaviors" and "classroom.behavior_management," and (3) the domain of academic and social skills, formed by terms such as "academic.achievement" and "social.skills." The close connections between these clusters are notable; particularly, the strong link between teacher training ("teacher.training") and classroom management ("classroom management") underscores the critical role of professional development in effective behavior management. Additionally, the proximity of cognitive processes like "self-regulation" and "executive.function" to the behavioral management cluster reflects growing interest in the neurocognitive mechanisms underlying behavioral issues. The central position of "early.intervention" and "special.education" highlights the importance of early intervention programs on both behavioral and academic outcomes. In light of these findings, interventions aimed at improving the quality of teacher-child interactions are predicted to have multifaceted positive effects on behavior management strategies and the development of academic and social skills. Future phases of this study should experimentally investigate the causal relationships among these conceptual structures, which will provide significant contributions to the field.

Discussion

This study presents a bibliometric analysis of the scientific literature on teacher-child interaction behaviors within the context of special education, covering the period from 1972 to 2025. It aims to systematically map the historical development, thematic trends, and prominent scientific actors in the field. The findings offer important insights into both general trends in the literature and research clusters shaped around specific authors, countries, and key concepts. In

this section, the results are discussed within the context of national and international literature, addressing current trends, gaps, and recommendations in the field.

Publication Trends Over Time and Increasing Scientific Interest

The data indicate a significant increase in research on teacher-child interaction behaviors since the early 2000s, with citation counts peaking between 2008 and 2012. This trend may be attributed to the growing empirical evidence on the impact of interaction behaviors on student achievement, as noted in classroom observations by Downer et al. (2010). Particularly, the global acceptance and use of the Classroom Assessment Scoring System (CLASS) developed by Pianta and Hamre (2009) points to an elevation in methodological standards within this research area. While the number of publications has continued to rise quantitatively post-2020, a notable decline in citations per article has been observed. This suggests that recent studies require more time to generate scientific impact and raises discussions about publication quality. The long-term academic effects of research conducted in the last five years are likely to be assessed only through advanced bibliometric analyses (Zupic & Čater, 2015).

Thematic Concentrations and Behavioral Focus

Thematic mapping and keyword analyses reveal that research predominantly clusters around concepts such as “behavior,” “classroom quality,” and “teacher-child relationships.” These findings support the centrality of interaction behaviors to both theoretical and applied studies concerning the quality of learning environments (Pianta, 1999; Hamre & Pianta, 2005). The frequent use of terms like “self-regulation” and “social competence” reflects an increasing emphasis on the importance of socio-emotional skills in child development. Accordingly, the need to develop teacher competencies in the three key dimensions of emotional support, classroom organization, and instructional support is clearly highlighted (Hamre & Pianta, 2001). Furthermore, the predominant focus on early childhood (preschool, kindergarten) corresponds with literature emphasizing the critical developmental opportunities of this period (Bronfenbrenner, 1979).

Interdisciplinary Approaches and Conceptual Coherence

Conceptual structure analysis reveals strong relationships between teacher-child interactions, behavioral management, and academic-social skills clusters. The reciprocal reinforcement of concepts such as “teacher training” and “classroom management” indicates that interaction behaviors entail not only pedagogical but also managerial dimensions (Darling-Hammond, 2017). These results suggest that teacher-child interaction behaviors in special education should be addressed not only at the classroom observation level but also at structural levels such as teacher training program design, policies, and professional development. The central positioning of “early intervention” and “special education” in the conceptual map emphasizes the importance of researching the long-term effects of early interventions (Downer et al., 2012).

Author and Country Distributions: Core-Periphery Dynamics

Bibliometric analyses reveal that pioneering authors in the field (e.g., Pianta R.C., Hamre B.K., Howes C.) are predominantly based in the United States, indicating a Western-centric research hegemony as highlighted by Downer et al. (2010). The high h-index and citation counts of these authors suggest that theoretical models and measurement instruments largely originate from these regions. Lotka’s law analysis showed that 86% of authors contributed only a single publication, indicating that the bulk of output is carried by a small number of productive researchers. This structure reveals a delicate balance between “core researchers” and “peripheral contributors.”

These findings imply that researchers in developing countries need more incentives, and expanding collaborative networks could contribute to diversifying the literature. In the Turkish context, most studies have employed scales adapted from Western contexts with limited samples (Batu & Kırcaali-İftar, 2005; Sucuoğlu et al., 2014), underscoring the need for culturally relevant models reflecting local contexts.

Methodological Orientations and Technological Advancements

Another important finding is that most studies on interaction behaviors in special education rely heavily on traditional observational methods. As emphasized by Wong and Wong (2009), data collection processes in the field lack diversity and underutilize technological opportunities. However, video analysis systems, AI-supported coding software, and virtual observation tools can provide higher validity and reliability, especially in special education settings requiring individualized instruction (Parsons et al., 2019). Thus, in countries like Turkey, the widespread adoption of technology-supported interaction analyses, integration of these technological tools into teacher education curricula, and systematic development of instructional materials are strongly recommended.

Directions for Future Research

Although this study offers a comprehensive map of the literature on interaction behaviors in special education, several gaps are evident, highlighting the need for future research in the following areas:

1. **Cultural Context Studies:** Comparative research exploring how interaction behaviors vary across cultural variables remains limited. The pioneering work of Park et al. (2020) calls for broader analyses in this regard.
2. **Increase in Qualitative and Mixed Methods:** While quantitative data on interaction frequency and types dominate the current literature, the qualitative aspects of experiences are underexplored. In-depth interviews, case studies, and ethnographic methods could fill this gap.
3. **Longitudinal Research:** There is a continuing need for longitudinal data on the long-term effects of teacher-child interactions, such as on academic achievement, social adjustment, and self-regulation.
4. **Policy Impact and Implementation:** Concrete application models should be developed to integrate scientific findings into educational policies. Inclusive education policies, teacher training, and curriculum development are strategically important in this context.

Conclusion and Recommendations

Conclusion

This study comprehensively examined the scientific literature on teacher-child interaction behaviors in special education using bibliometric methods, revealing thematic concentrations, methodological trends, and key scientific actors. Based on the analysis of 436 academic publications from 1972 to 2025, the findings show that interaction behaviors have gained increasing importance in special education, with academic interest particularly intensifying since the early 2000s. Highly cited works cluster around theoretical models emphasizing the impact of teacher-student interactions on learning outcomes (e.g., Pianta, 1999; Hamre & Pianta, 2001) and measurement tools such as CLASS.

Thematic analyses demonstrate that research predominantly revolves around core concepts like “behavioral management,” “interaction quality,” and “classroom environment.” The prominence of “self-regulation,” “academic achievement,” and “social skills” reflects the developmental implications of interaction behaviors beyond pedagogical concerns. Methodologically,

observation-based quantitative studies dominate, while qualitative and technological methods remain underutilized.

These findings suggest that teacher-child interactions in special education must be addressed not only at the individual level but also within systemic and policy frameworks. Interaction behaviors have the potential to influence multi-dimensional outcomes including classroom success, social inclusion, self-efficacy, self-regulation, and lifelong learning.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **Development of Culturally Localized Models:** In developing countries like Turkey, interaction behaviors are mostly examined through adapted Western models, risking neglect of local cultural dynamics. Therefore, culturally sensitive measurement tools should be developed to better understand contextual interaction patterns (Diken et al., 2011).
2. **Promotion of Qualitative and Mixed Methods:** To gain deeper insight into the quality of teacher-child interactions, the use of qualitative approaches such as observation-based qualitative studies, video analyses, and content analyses of teacher and student interviews should be increased. These methods provide comprehensive understanding beyond numerical data (Wong & Wong, 2009).
3. **Integration of Technology-Supported Applications:** Innovative methods including virtual classrooms, AI-supported analytic tools, and mobile data collection systems should be widely adopted for observing and evaluating teacher-child interactions. Studies like those of Parsons et al. (2019) on robotic interaction systems are particularly inspiring.
4. **Encouragement of International Collaborations:** The dominance of single-author and short-lived publications reveals a lack of continuity and insufficient collaboration among researchers. International projects and co-publications can enhance diversity and scientific impact (Snyder et al., 2019).
5. **Revision of Teacher Education Programs:** Effective interaction behaviors require systematic training of teacher candidates. However, studies in Turkey indicate inadequacies in such training (Vuran et al., 2016). Therefore, teacher education curricula should integrate interaction models like CLASS and Positive Behavioral Interventions and Supports (PBIS).
6. **Increased Investment in Early Intervention Programs:** The significant impact of interaction behaviors in early childhood necessitates designing early intervention programs aimed at improving interaction quality and strengthening teacher capacities in this area (Downer et al., 2012).
7. **Deepening Scientific Impact Analyses:** Evaluations should extend beyond publication counts to include performance metrics such as h-index, m-index, and g-index, examining how influential studies shape the field. Detailed analyses of thematic contributions from emerging researchers with high m-index values are recommended.
8. **Strengthening the Link Between Policy Documents and Practice:** The translation of effective interaction behaviors into classroom practice is possible only when educational policies align with teacher training, resource allocation, and assessment systems.

National policy documents should be reinforced with interaction-focused pedagogical principles.

In conclusion, this study sheds light on the scientific development dynamics of teacher-child interaction behaviors in special education, providing a comprehensive roadmap for academics and practitioners alike. The bibliometric evaluation of accumulated knowledge emphasizes the necessity of more holistic, culturally contextualized, and interdisciplinary approaches. Future research following these directions will contribute to building more effective, inclusive, and sustainable learning environments for individuals with special needs.

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