The Bibliometric Analysis of Public-Private Partnership in the Field of Education

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Abstract:

This study explores the evolving role of Public-Private Partnerships (PPP) in the education sector, with a focus on their impact on infrastructure development and educational practices. The research aims to identify key trends in PPP-related education research from 2000 to 2023, shedding light on the shift from infrastructure-focused projects to more innovative approaches involving pedagogy, digital inclusion, and educational policy. Previous studies have primarily concentrated on infrastructure development and the financial implications of PPP, while the effects on educational quality and technology integration remain underexplored. This study employs bibliometric analysis using data from the Publish or Perish software to analyze academic articles, citation patterns, and key thematic trends within the field of PPP in education. Findings reveal a significant shift towards discussions on pedagogical innovation, digital inclusion, and the alignment of PPP projects with educational policy. The research emphasizes the growing role of PPP in transforming educational environments through strategic collaboration. These findings provide valuable insights into how future PPP can better support equitable and effective education systems, with implications for policymakers, educators, and stakeholders in education reform.

Keywords: *Bibliometric, Public-Private, Partnership, Education*

Abstrak:

Penelitian ini mengkaji peran yang berkembang dari Kemitraan Publik-Swasta (KPS) di sektor pendidikan, dengan fokus pada dampaknya terhadap pengembangan infrastruktur dan praktik pendidikan. Penelitian ini bertujuan untuk mengidentifikasi tren utama dalam penelitian terkait KPS di bidang pendidikan dari tahun 2000 hingga 2023, dengan menyoroti pergeseran dari proyek yang berfokus pada infrastruktur menuju pendekatan yang lebih inovatif yang melibatkan pedagogi, inklusi digital, dan kebijakan pendidikan. Penelitian sebelumnya sebagian besar berkonsentrasi pada pengembangan infrastruktur dan implikasi finansial KPS, sementara dampaknya terhadap kualitas pendidikan dan integrasi teknologi masih kurang dieksplorasi. Penelitian ini menggunakan analisis bibliometrik dengan data dari perangkat lunak Publish or Perish untuk menganalisis artikel akademik, pola kutipan, dan tren tematik utama dalam bidang KPS di pendidikan. Hasil penelitian menunjukkan adanya pergeseran signifikan menuju diskusi mengenai inovasi pedagogis, inklusi digital, dan keselarasan proyek KPS dengan kebijakan pendidikan. Penelitian ini menekankan peran yang semakin besar dari KPS dalam mengubah lingkungan pendidikan melalui kolaborasi strategis. Temuan ini memberikan wawasan berharga tentang bagaimana KPS di masa depan dapat mendukung sistem pendidikan yang lebih adil dan efektif, dengan implikasi bagi pembuat kebijakan, pendidik, dan pemangku kepentingan dalam reformasi pendidikan.

Kata Kunci: *Bibliometrik, Publik-Swasta, Kemitraan, Pendidikan*

INTRODUCTION

Public-private partnerships (PPP) have become an integral part of addressing infrastructure needs across sectors, including education. The concept emerged as a strategic solution to bridge the financing gap in large-scale infrastructure projects, initially focusing on industries like transport and energy (Jiang, 2023; Khor et al., 2021; Szabó & Jelinek, 2023). Over time, PPP has expanded into education, health, and other vital public sectors, addressing inefficiencies in service delivery and offering innovative solutions for resource allocation (Hjaltalin & Sigurdarson, 2024; Mallat et al., 2021; Shu et al., 2024). Recent global shifts towards digital education and inclusive learning have further reinforced the significance of PPP in the education sector (Kulal et al., 2024; Lennox et al., 2021; Sajida & Kusumasari, 2023). Despite the extensive literature on PPP, the dynamic relationship between education policy, infrastructure, and pedagogy within these partnerships has not been sufficiently explored in academic research, making it a fertile area for investigation (Chan, 2023; Larson & Nelms, 2023; Onu et al., 2024).

Several studies have focused on the evolution of PPP and their impact on various sectors, including education. A study by Hoeft et al. (2021) emphasized the role of technological innovations within PPP, highlighting their potential to drive organizational change and efficiency. This is also supported by research conducted by Jia et al. (2021), which provided an analysis of Building Information Modeling (BIM) in PPP infrastructure projects, showing the growing integration of digital tools in the construction phase. Additionally, studies such as those by Deineko et al. (2022) explored policy strategies for implementing broadband infrastructure through PPP, marking a shift towards addressing the educational digital divide. These studies collectively underline the increasing influence of PPP in education, but they do not fully address how these collaborations are transforming teaching methodologies or advancing digital inclusion in education.

Although existing studies have explored various facets of PPP, there remains a significant gap in understanding how PPP influences educational practices beyond infrastructure development. Specifically, there is limited research on how these partnerships contribute to pedagogical innovation, digital inclusion, and policy development in education systems. This study aims to address this gap by focusing on the evolving role of PPP in the educational sector, analyzing shifts in research topics from infrastructure-focused projects to those exploring educational outcomes, digital equity, and innovative teaching strategies. The significance of this gap lies in its potential to reshape how future PPP can be leveraged to improve education systems, particularly in developing regions facing both infrastructural challenges and the need for educational reform.

This research offers a novel contribution by shifting the focus of PPP analysis in education from infrastructure development to the broader implications on educational quality, equity, and innovation. While prior studies have concentrated on the infrastructural and financial aspects of PPP, this study uniquely integrates a bibliometric analysis to track the evolution of educational themes in PPP research. By using data from 2000 to 2023, this study will provide a

comprehensive view of how academic research related to PPP has developed over time, uncovering emerging trends such as digital inclusion, pedagogical innovations, and policy reform. The study's findings are expected to offer new insights into how PPP can be strategically used to foster a more equitable and effective educational environment.

This research was conducted to explore the evolving role of Public-Private Partnerships (PPP) in education by identifying key trends and developments in academic literature from 2000 to 2023. Using bibliometric analysis, the study will investigate how PPPs have transitioned from infrastructure-focused partnerships to catalysts for pedagogical innovation and digital inclusion. The objective is to provide a comprehensive understanding of how PPP are reshaping education systems, offering new perspectives on policy, technology integration, and the broader educational outcomes that can be achieved through these partnerships. Ultimately, this research seeks to contribute to the development of more effective, inclusive, and sustainable educational strategies in the context of global partnerships.

RESEARCH METHOD

This study focuses on the bibliometric analysis of Public-Private Partnerships (PPP) in education, with the aim of identifying trends and developments in this field from 2000 to 2023. The context for this research is global, as it examines the broader academic community and its publications related to PPP in education. The choice of this context is due to the increasing significance of PPP in improving educational infrastructures, which have been widely implemented across various regions. The research adopts a bibliometric approach, using data from academic databases such as Google Scholar, retrieved through the Publish or Perish application. This approach is inductive, as it seeks to explore emerging trends and patterns in the literature without imposing predefined hypotheses (Naeem et al., 2023; Shrestha et al., 2021; Simsek et al., 2023). Bibliometrics is a suitable method because it allows for the quantitative analysis of academic publications, helping to track the evolution of topics within a particular field (Donthu et al., 2021; Ninkov et al., 2022; Pessin et al., 2022).

Data for this bibliometric study were collected from Google Scholar using the Publish or Perish application, which aggregates scholarly articles and provides citation data. This collection focuses on the primary data from academic articles published from 2000 to 2023, with the keyword search targeting "PPP," "education," and "infrastructure." The data set includes information such as the number of citations, publication year, author affiliations, and the type of publication (e.g., journal articles, conference papers). The combination of primary bibliographic data and citation analysis is particularly relevant for this study because it allows for a comprehensive understanding of the impact and relevance of PPP in education research (Azarian et al., 2023; Hajar & Karakus, 2024; Mehmood et al., 2023). By capturing articles from a wide range of sources, the data collection process ensures diverse perspectives, covering both influential and emerging voices in the field.

The data collected from Publish or Perish were analyzed using a combination of co-citation analysis, co-word analysis, and bibliographic coupling. These techniques allow for a comprehensive examination of how different publications are interconnected, both in terms of shared references (co-citation) and similar terminology (co-word) (Chen et al., 2024; Klarin, 2024; Liu & Hu, 2021). VOSviewer software was employed to visualize the relationships between articles based on keywords, citation patterns, and author collaborations. This tool provides a clear representation of the most cited works and influential authors within the field of PPP in education. The analysis also included the identification of key research trends, author networks, and institutional collaborations. These results were visualized through network maps and keyword relationship diagrams, which helped to reveal the structural and thematic evolution of the field.

RESULT AND DISCUSSION
Result
Metadata Collection and Presentation Using Publish or Perish

The bibliometric data in this study was collected using the Publish or Perish application, which allows the collection of metadata from various scientific articles published in international journals (Goksu, 2021; Kokol et al., 2021; Ullah et al., 2023). The search process was carried out using the keywords "PPP," "School," and "Education" in the period from 2000 to 2023, with a maximum of 500 relevant articles. The data collected includes information such as the number of citations, authors, and year of publication, as well as article type (PDF or HTML), which provides an overview of research related to Public-Private Partnerships (PPP) in the Education sector as shown in Figure 1.

Figure 1. Metadata Search Results Using the Publish or Perish App

Figure 1. Displaying metadata search results from the "Publish or Perish" app using the keywords "PPP," "school," and "education" shows various articles published between 2000 and 2023. The search results table contains information such as the number of citations (citations), average citations per year (per year), article rank (rank), author name, article title, year of publication, journal or conference name, publisher, and article format (PDF or HTML). These search

results provide an overview of the various studies related to public-private partnerships (PPP) in the context of education, compiled based on how often other studies cite the articles. This data provides an overview of the extent to which research related to PPP in education affects this field, as well as showing the most relevant and influential articles in the existing literature.

Analysis of Key Terms in Public-Private Partnership (PPP) Research

The results of the terms collected in the metadata, obtained from a research study on Public-Private Partnerships (PPP) in the education sector during the period 2000 to 2023, are presented systematically in the following table for further analysis. This table includes key terms that frequently appear in the articles analyzed, such as "Public-Private Partnerships" (PPP), "PPP projects," "schools," "infrastructure," and "effectiveness," which indicate the main topics that are widely discussed in the literature. This analysis provides an understanding of how research in the field of PPP in the education sector develops and is in-depth, as well as shows the relationships between relevant terms to understand existing research trends. Table 1 explains the key terms and frequency of their occurrence in public-private partnership research (PPP).

Table 1. Key Terms and Frequency of Their Occurrence in Public-Private Partnership Research

Term	Occurrences	Relevance
Presentation	20	3.80
Production	23	3.68
Skill	18	3.03
PPP method	16	3.01
Student	42	2.82
Practice	32	2.11
Effectiveness	11	1.39
Use	19	0.89
Critical success factor	17	0.73
PPP mode	13	0.71
Ireland	10	0.60
Case Study	13	0.58
Public-private partnership	43	0.57
Role	23	0.57
Education sector	15	0.56
Application	16	0.55
China	30	0.53
Review	22	0.50
Paper	35	0.48
Public-private partnership	147	0.46
Factor	25	0.45
PPP project	113	0.45
Project	25	0.43
Higher education	11	0.42
Infrastructure	38	0.40
Health	21	0.37
PPP model	32	0.35
Risk	28	0.35
Lesson	13	0.30
School	70	0.19

Table 1 shows the results of the analysis using VOSviewer of article metadata collected through Publish or Perish. It shows the key terms that often appear in research related to public-private partnerships (PPP). The term "Public-Private Partnership" (PPP) seems the most frequent, with 147 incidents confirming that this topic is at the centre of much research. Other terms such as "PPP projects" (113 times) and "Schools" (70 times) indicate a strong focus on specific projects and PPP implementation in the education sector.

Several other high-frequency terms, including "Infrastructure" (38 times) and "China" (30 times), indicate significant interest in specific infrastructure and regional contexts in PPP implementation. The Relevance Levels listed in the table measure the importance of the term in the context of the study; for example, "Presentation" and "Production" have high relevance, which shows that the delivery and development aspects play an essential role in research on public-private partnerships. Overall, this table provides an overview of the dominant themes in PPP research, including the projects undertaken, the sectors involved, and the success factors that are often the focus of the study.

Visualization of the Network of Relationships Between Key Terms in PPP Research

Next, researchers analyze the relationships between terms to identify key patterns, trends, and associations in the study. This analysis provides insight into the thematic structure and conceptual links in the metadata. These findings highlight the significant relationship between the terms, as presented in Figure 2.
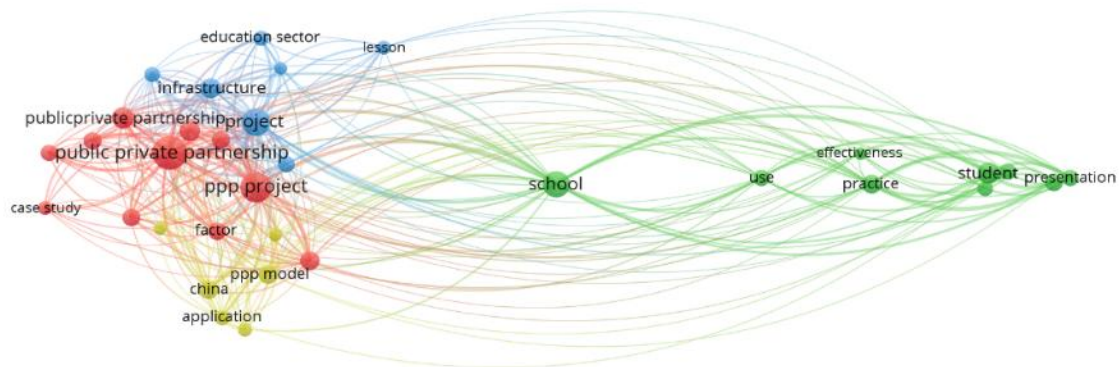

Figure 2. Network Visualization of Relationships Between Key Terms

Figure 2 presents a network visualization of the results of the analysis using VOSviewer, illustrating the relationship between key terms in research on public-private partnerships (PPP) in education. Nodes represent a specific term or theme while connecting lines indicate associations based on the frequency of co-occurrence. The size of each node reflects the frequency of the term, while the colour of the cluster signifies a group of thematically related concepts. The red cluster includes terms such as "public-private partnerships," "PPP projects," and "PPP models," which indicate a strong focus on PPP models and projects, which often appear together in the scientific literature. The green cluster includes terms such as "school," "student," "us," and "effectiveness," highlighting research on the application of PPP in educational settings, particularly regarding student

engagement and effectiveness assessments. The blue cluster contains terms such as "infrastructure," "education sector," and "lessons," which emphasize the importance of infrastructure in supporting education development through PPP initiatives.

The interconnection between groups, represented by connecting lines, further illustrates thematic relationships. For example, the relationship between "schools" in green clusters and "PPP projects" in red clusters suggests that schools often serve as focal points for PPP initiatives. This visualization underscores the integration of various aspects, including models, infrastructure, and implementation, in the broader academic discourse on public-private partnerships in education.

Relationship Between Terms in Public-Private Partnership Research

To understand the key terms in Public-Private Partnership (PPP) research, we created a network visualization that illustrates the relationships between terms that often appear in the research metadata. This visualization helps identify interrelated terms and shows the dominant central concepts in PPP studies. Through this visualization, the relationships between terms such as "PPP," "infrastructure," "schools," and "effectiveness" can be clearly seen, illustrating how these topics are interrelated in the research, as shown in Figure 3.
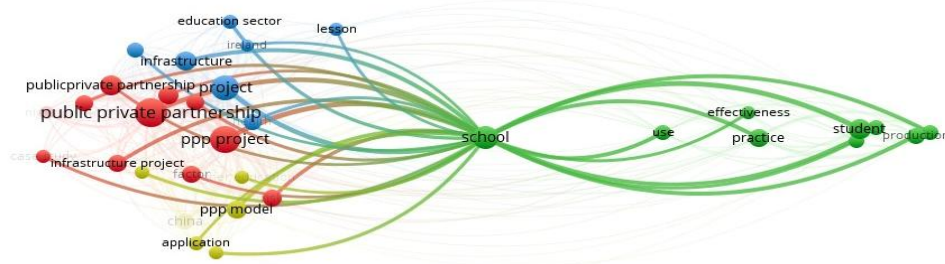

Figure 3. Relationship Between Terms in Public-Private Partnership Research

Visualization in Figure 3 describes the network of relationships between "public-private partnerships" (PPP) and related concepts, especially in education and infrastructure. The red cluster highlights PPP's strong relationship with infrastructure projects, while the blue cluster links it to the development of educational infrastructure. The green cluster, which features terms such as "school," "effectiveness," and "student," emphasizes the impact of PPP on schools and student learning outcomes. The strong relationship between PPP, "school," and "effectiveness" demonstrates its role in improving education through infrastructure improvements and optimized learning outcomes.

The Role of Schools in Public-Private Partnership (PPP) Research

The term "school" is crucial in analyzing Public-Private Partnerships (PPP) in education, as they represent the collaborative, policy, and management aspects involved in the implementation of PPP in the education sector. The network mapping visualized the role and connection of the term "school" within this framework, showing how schools are the main focal points in various PPP projects, which relate to infrastructure, education policies, and learning outcomes.

Thus, "schools" play a role not only as units that receive impact but also as essential actors in policy implementation and the success of PPP projects in improving the quality of education, where the mapping of the role of schools in public-private partnership (PPP) research is shown in Figure 4.
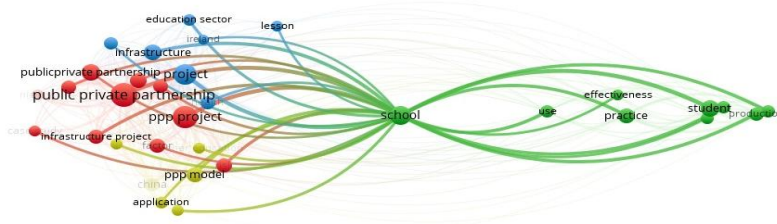

Figure 4. Visualization of the Role of Schools in Public-Private Partnership (PPP) Research

The visualization depicted in Figure 4 positions the "school" at the centre of the research network on public-private partnerships (PPP), highlighting its key role in the implementation of PPP in education. "School" is closely related to terms such as "public-private partnerships," "PPP projects," and "infrastructure," which indicate their relationship to infrastructure development through public-private collaboration. In addition, its relationship to "effectiveness," "practice," and "students" suggests a research focus on the impact of PPP on school effectiveness, learning practices, and student outcomes.

Education Sector Relations in Public-Private Partnership Research

The term "education sector" is at the heart of discussions about Public-Private Partnerships (PPP), as it defines the broader context of these collaborations. Visualizing the relationship in research highlights key themes such as policy, funding, and institutional roles. The following network mapping illustrates their relationships within the PPP framework, where the relationship is shown in Figure 5.
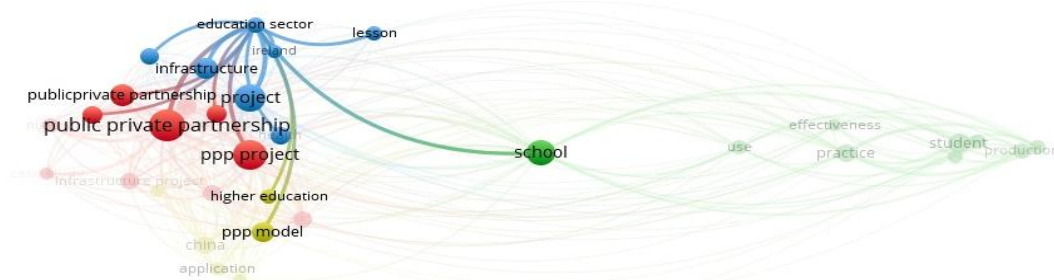

Figure 5. Education Sector Relations in Public-Private Partnership Research

Figure 5. visualizes the network of education-related terms in PPP research. "School" (green) is central, strongly associated with concepts such as "effectiveness" and "exercise" through thin lines, which indicate a low-frequency connection. Meanwhile, "public-private partnerships," "PPP projects," and "infrastructure" (red and blue) have thicker connections, suggesting a stronger link to education. It highlights the role of PPP models and infrastructure in the development of schools and educational projects.

The Impact of Public-Private Partnerships on Students in Education

The term "school" plays a vital role in analyzing public-private partnerships (PPP) in education, as it represents key aspects such as collaboration, policy, and management in the implementation of PPP. In this context, schools serve as the main focal point for the implementation of PPP projects that aim to improve the quality of education, both in terms of infrastructure and learning practices. The network mapping conducted shows the relationship and connection of the term "school" with various other essential concepts, such as infrastructure, PPP projects, and learning effectiveness. This visualization shows how schools play an important role in the successful implementation of education policies through cooperation between the public and private sectors, as shown in Figure 6.
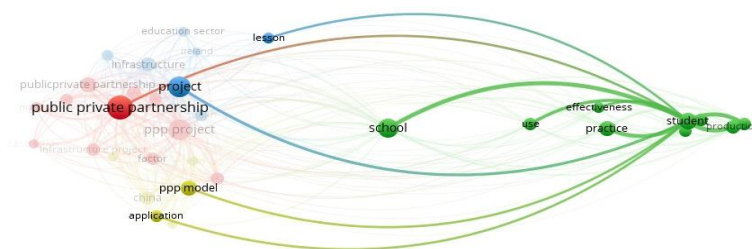

Figure 6. Public-Private Partnerships for Students in Education

Figure 6. The "school" will be positioned at the centre of the research network on public-private partnerships (PPP), highlighting its key role in the implementation of PPP in education. "School" is closely related to terms such as "public-private partnerships," "PPP projects," and "infrastructure," which indicate their relationship to infrastructure development through public-private collaboration. In addition, its relationship to "effectiveness," "practice," and "students" suggests a research focus on the impact of PPP on school effectiveness, learning practices, and student outcomes.

Overlay Visualization: The Evolution of Terms in PPP Research over Time

To analyze the development of PPP research in education, the overlay visualization maps the evolution of key terms over time, highlighting shifting themes and emerging trends. Figure 7. provides an overview of these developments.
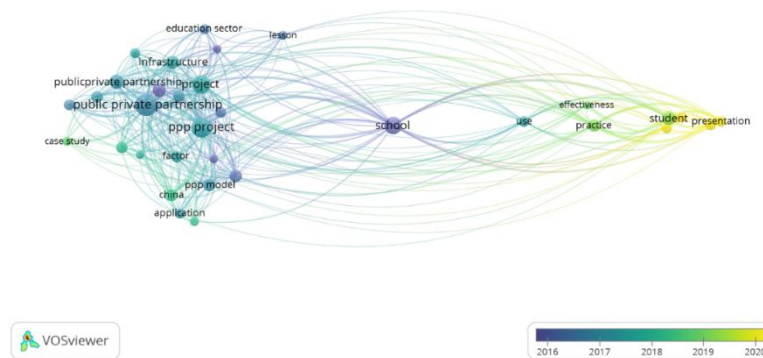

Figure 7. Overlay Visualization

Figure 7 shows that each term's color represents its appearance in the literature, ranging from purple (2016) to yellow (2020). Terms such as "public-private partnerships," "PPP projects," and "infrastructure" (purple and blue) indicate that early research focused on PPP infrastructure projects. Meanwhile, newer terms such as "student presentation" and "exercise" (yellow) reflect a shift towards the study of the effectiveness of school practices and student outcomes in 2019–2020. The term "school" (bluish-purple) serves as a link between infrastructure and its impact on students, appearing prominently in 2017–2018. Overall, PPP research was initially centred on infrastructure but has recently shifted to its impact on student education and achievement.

Density Visualization: Term Frequency in PPP Research

To analyze PPP research in education, density visualization highlights frequent terms, revealing key focus areas. Identifying dense groups of terms helps uncover dominant themes and research gaps. Figure 8. provides a general overview of these findings.
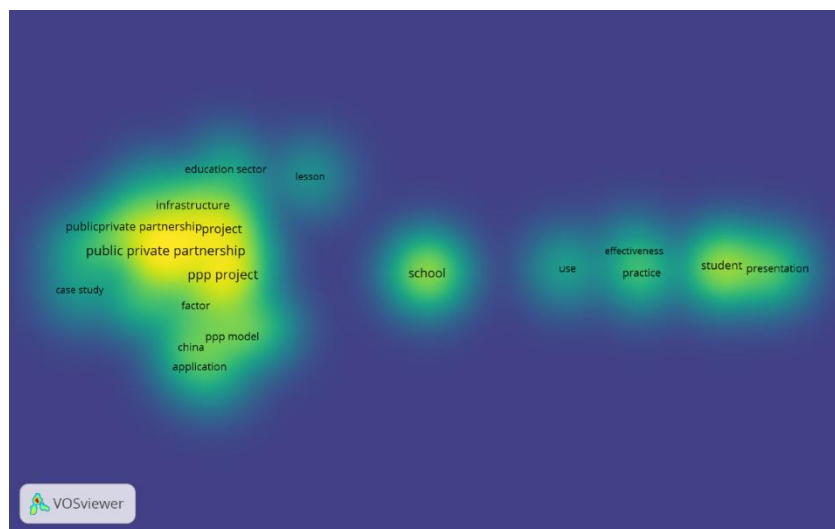

Figure 8. Density Visualization

Based on Figure 8. the most prominent terms, such as "public-private partnerships" and "PPP projects," appear in the middle in bright yellow, indicating the highest frequency and relevance. Terms such as "infrastructure," "education sector," and "case studies" (green-yellow) also appear frequently, signifying a strong relationship with PPP. Meanwhile, terms such as "school," "student presentation," and "effectiveness" (green-blue) have a lower frequency. Overall, this visualization illustrates the interaction of concepts in PPP research, with a primary focus on infrastructure and the education sector.

Discussion

Public-private partnerships (PPP) play a crucial role in improving the accessibility, quality, and efficiency of education. Studies show that PPP contributes to the development of school infrastructure and the improvement of learning facilities, primarily through the integration of technology in curriculum development (Deladem et al., 2021; Prasad et al., 2024; Schmid et al., 2023). In

addition, PPP supports digital transformation and innovative teaching strategies, improving learning effectiveness (Klarin, 2024). Through a network of partnerships, PPP enables broader educational innovations, including skills development and digital inclusion programs, to address education gaps (Attah et al., 2024; Deppeler et al., 2022; Filho et al., 2024).

The term PPP is closely related to infrastructure, effectiveness, and education policies. Recent studies reveal that PPP plays a key role in financing and managing school infrastructure and facilitates the adoption of innovative technologies and teaching methods (Mehmood et al., 2023). Schools serve as the focal point of PPP implementation, integrating infrastructure development, funding, and education policies to improve the learning environment (Jiang, 2023; Khor et al., 2021; Szabó & Jelinek, 2023). The network visualization highlights schools as a central node in PPP discussions, linking terms such as effectiveness, practice, and student presentation, albeit with weaker chains compared to PPP infrastructure and projects, suggesting stronger relationships. These findings are in line with research that emphasizes the role of PPP in school infrastructure and the challenges in improving the quality of learning (Shu et al., 2024). In addition, public-private collaboration goes beyond infrastructure to sustainability, resource provision, and educational innovation, emphasizing accessibility and equity (Hjaltalin & Sigurdarson, 2024).

These findings are consistent with research highlighting the role of PPP in increasing student engagement through increased access to innovative teaching resources and methods (Sajida & Kusumasari, 2023). PPP also increases the effectiveness of e-learning by encouraging students' active participation through technology (Kulal et al., 2024). In addition, PPP-based literacy programs have a positive impact on students' skills, strengthening the strong relationship between "students" and "schools" (Lennox et al., 2021). Thus, PPP not only affects education policy but also directly impacts student experiences and learning outcomes.

Research trends show a shift in PPP studies from infrastructure to the education sector. Between 2016 and 2018, studies focused on infrastructure projects, as reflected in the dominance of terms such as "PPP projects" and "infrastructure." In 2017-2018, research began to link PPP with education, specifically schools (Larson & Nelms, 2023). This shift became more pronounced in 2019-2020, with an increased emphasis on learning effectiveness, as reflected in terms such as "student presentation" and "practice." Recent studies further highlight the role of PPP in improving access and quality of education rather than just infrastructure development (Chan, 2023; Hoeft et al., 2021; Onu et al., 2024).

The most prominent terms in the PPP literature, such as "public-private partnership" and "PPP project," are centrally positioned in network visualization, demonstrating their high relevance (Prasad et al., 2024). Terms such as "infrastructure," "education sector," and "case studies" also appear frequently, reinforcing the relationship of PPP with infrastructure projects (Leal Filho et al., 2024). Future research should explore under-examined areas such as PPP-based pedagogical innovation, digital equity, student-centred learning, sustainability, AI integration, community engagement, regulatory frameworks, and hybrid PPP models for vocational and higher education. Addressing these aspects can

contribute to a deeper understanding of how PPP improves the effectiveness, accessibility, and sustainability of education in a variety of contexts.

CONCLUSION

The study's findings show that public-private partnerships (PPP) play an important role in improving the accessibility, quality, and efficiency of education. Initially, the study mainly focused on the development of school infrastructure; however, recent trends show a shift towards digital transformation, pedagogical innovation, and increased learning effectiveness. PPP also contributes to skills development and digital inclusion programs to address education gaps. These findings reveal that schools function as a focal point for PPP implementation, integrating infrastructure, education policies, and learning effectiveness. The network visualization highlights that while terms such as "PPP project" and "infrastructure" indicate stronger associations, the relationship between PPP and learning effectiveness is becoming increasingly prominent. In addition, PPP goes beyond the provision of resources to sustainability and educational innovation. Based on these findings, future research should explore under-examined aspects such as PPP-based pedagogical innovation, digital equity, student-centered learning, and hybrid PPP models for vocational and higher education. Further studies on the integration of artificial intelligence (AI), community engagement, and regulatory frameworks within PPP can provide deeper insights into its effectiveness and sustainability in education.

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