



A Decade of Research on Educational Investment in Human Capital: A Review and Bibliometric Perspective

Badrud Tamam¹, Aminudin^{2*}, Riema Afriani Kusumadewi³, Cucun Sunaengsih⁴,
Fetty Poerwita Sary⁵, Saprolla Rollie C. Deporos⁶

¹Educational Management, Universitas Wiralodra, Indonesia

²Islamic Education Management, PP Darussalam Kunir, Indonesia

³Islamic Education Management, STAI Darussalam Kunir, Indonesia

⁴Elementary School Teacher Education, Universitas Pendidikan Indonesia, Indonesia

⁵Management, Universitas Telkom, Indonesia

⁶Ateneo de Davao University, Philippines

*Correspondence to: aminuddin2200@gmail.com

Abstract: Driven by the growing urgency of digital disruption and the multifaceted challenges of sustainable development, this study explores the transformative landscape of human capital investment over the past decade. The study aimed to map global publication trends, geographic distribution, and thematic evolution in education investment from 2015 to 2025. It employed bibliometric and SLR methodologies based on Scopus data, using VOSviewer and Biblioshiny. The results show a significant surge in scholarly output, peaking in 2022, with China emerging as the dominant contributor to global discourse. Key findings highlight a critical thematic transition from traditional family sociology to high-impact contemporary issues, including digital innovation, the green economy, and AI-mediated labor markets. The study concludes that a radical curriculum reconstruction prioritizing digital literacy and technological adaptability is crucial for fostering national resilience. This research contributes to the field of educational management by providing a systematic framework for understanding how new technologies are redefining the economic value of human capital, offering policymakers strategic insights to foster inclusive, knowledge-based, and sustainable economic growth in the digital age.

Keywords: bibliometric analysis; educational investment; human capital; sustainable development

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INTRODUCTION

Investment in education as part of human resource (HR) development has become an increasingly important topic worldwide (Sumual et al., 2024). Education not only improves individual abilities but also contributes significantly to a country's economic and social growth (Bykova et al., 2024; Vo, 2021). In a global context, investment in education is considered a strategic investment that can increase workforce productivity (Mustafa & Lleshi, 2024), reduce unemployment (Njifen, 2024), and increase economic competitiveness (Chakrabarti, 2013). In addition, education plays a key role in preparing a workforce capable of adapting to changes in economic structure triggered by technological advances and globalization. Recent trends show that countries with high levels of education investment tend to experience faster economic growth and higher living standards (Bykova et al., 2024). However, the effectiveness of educational investment cannot be understood solely through macroeconomic indicators; it also depends on how education systems respond to evolving labor market demands and technological transformation.

Educational investment in human resources faces several major challenges, including the complexity of approaches, the diversity of study contexts, and implementation constraints in the field (Do et al., 2025). One of the main challenges is the mismatch between the education system's output and the needs of the economic sector, particularly the private sector, which requires a skilled, professional workforce. Furthermore, limited government funding and the need to update education programs and utilize new technologies are also significant obstacles (Adiletkyzy et al., 2025). Budget constraints frequently affect infrastructure development, teacher professional development, research capacity, and digital transformation initiatives (Demartini et al., 2020). Inequality in access to quality education between urban and rural areas further exacerbates disparities in human capital formation (Liao et al., 2025). Weak collaboration between educational institutions and industry actors also reduces the effectiveness of workforce preparation. These challenges highlight that the effectiveness of educational investment is not merely a function of financial allocation but also of institutional design, policy coherence, and integration with the knowledge ecosystem. However, technological advances offer significant opportunities to address these challenges. The use of open educational resources (OER) and information and

communication technologies (ICT) can help overcome access barriers and improve the quality of education (Thanuskodi, 2020). In addition, digital transformation and the application of artificial intelligence (AI) in human resource management can increase the effectiveness of workforce development and training (Dang & Ho, 2025). Emerging research opportunities include analyzing the impact of digital transformation on workforce readiness and developing policies that support investments in digital education and skills (Ateeq, 2025; Chinoracky et al., 2025). Thus, despite significant challenges, technological advances and evolving policy needs offer opportunities to increase educational investment in human resources effectively.

Despite the extensive literature on educational investment in human capital, several gaps remain, highlighting the need for further research and synthesis. Recent studies have largely focused on the macroeconomic impact of education on productivity and economic growth (Kiss, 2018). The role of education in enhancing human capital and its impact on labor market outcomes (Bykova et al., 2024). However, there is a marked lack of comprehensive reviews that compare different aspects of education investment, such as the effectiveness of different funding models or the long-term impact of particular education policies (Zhao et al., 2025). As a result, the field lacks a comprehensive synthesis that can map the intellectual structure and evolution of research on educational investment in human capital. Given the rapid evolution of the global economy and the widespread recognition of human capital as a key driver of growth (Banmairuoy et al., 2022), this study addresses these limitations by conducting a systematic literature review combined with bibliometric network analysis. Unlike earlier bibliometric studies that primarily emphasize publication trends or keyword frequencies, this research examines the field's deeper intellectual architecture through multiple interconnected networks, including co-occurrence, document citation, and country collaboration networks. By integrating these analytical dimensions, this study not only maps the evolution of research themes but also reveals shifts in theoretical paradigms, emerging interdisciplinary connections, and patterns of global knowledge production. This approach provides a more nuanced understanding of how educational investment research has evolved in response to digital transformation and global economic restructuring.

Therefore, this study is guided by the following research questions: (RQ1) How does the structure of the Co-occurrence Network reflect the shift in focus of human capital investment from formal education towards digital competencies and resilience during the decade 2015–2025? (RQ2) To what extent does the document citation network show convergence or divergence between classical human capital theory and new approaches such as the Capability Approach and Social Capital? (RQ3) How does the architecture of the Country Collaboration Network reveal the epistemic dominance of developed countries over the educational investment policy narrative in developing countries (Global South)? (RQ4) In the recent literature cluster, how is the Return on Investment (ROI) variable of education redefined beyond wage parameters? (RQ5) How do the terms Artificial Intelligence and Automation positioned in the network of terms function as mediators that change the economic value of traditional human capital?

METHODS

This study used a Systematic Literature Review (SLR) approach guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to conduct the SLR (Tae et al., 2025). This study explains research trends through bibliometric analysis, including the number of annual publications, document sources, influential authors and documents, country of origin, and common research areas (Chellappa et al., 2024). This systematic review was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology, a recognized approach (O'Dea et al., 2021). The focus of the study is on scientific works that discuss the relationship between educational investment and strengthening human resource development, published in English-language journals and indexed in Scopus as of 22:00 on January 10, 2026, during the period 2015 to 2025. The methodological procedure of this study follows four main stages: identification, screening, eligibility, and inclusion.

The initial stage involved a comprehensive search of relevant publications in the Scopus database to identify research on educational investment and its impact on human resource development. To ensure the accuracy and reproducibility of the search, the keywords *"education investment"* OR *"investment in education"* were combined. All search results were exported to Mendeley software for management, duplication screening, and to ensure only peer-reviewed publications were included. The screening stage involved reviewing titles and abstracts to ensure they were relevant to the research topic. Irrelevant articles, such as those that did not address educational investment or were outside the context of human resource development, were eliminated. Two researchers conducted this process independently to ensure the reliability of the selection results. Discrepancies between researchers were resolved through discussion until consensus was reached. Next, a full-text review was conducted to ensure compliance with the established inclusion and exclusion criteria. The inclusion criteria include English-language articles (1) published between 2015–2025 (2) that explicitly discuss the relationship between educational investment and human capital (3) and are either theoretical, empirical, or mixed-methods. Meanwhile, the exclusion criteria are non-peer-reviewed publications (1), conference

proceedings, book chapters, articles without full-text access (2), research focused on economic investment without the Education dimension (3), and articles other than English (4). At this stage, methodological rigor and relevance to the research question are rigorously evaluated, ensuring only high-quality evidence is included in the final analysis.

Articles meeting all criteria were included in the final stage of analysis. Each article was systematically analyzed, including key information such as author name, year of publication, country of origin, research objectives, methodological approach, education investment indicators, and key findings related to human capital. The entire selection process was documented in a PRISMA flowchart showing the number of publications at each stage (identification, screening, eligibility, and inclusion). To ensure methodological transparency, all search strategies, selection criteria, and data extraction procedures were documented in detail. This study strictly adhered to the PRISMA 2020 reporting standards (Page et al., 2021) to ensure reproducibility, reliability, and compliance with research ethics and best practices in evidence-based reviews.

The analysis utilized Biblioshiny, VOSviewer, R-Studio, and Microsoft Excel (Arruda et al., 2022). Quantitative analysis focused on descriptive information, while qualitative analysis examined thematic evolution, Bradford's Law, most cited articles, keyword co-occurrence, trending topics, and thematic mapping to explore the development of the research field. Network visualization was conducted using VOSviewer with the *full-counting method, applying minimum occurrence thresholds of 5 for keyword co-occurrence and 3 for author and country collaboration analysis*. Clustering was automatically generated using the VOS clustering algorithm to identify related research themes. The research stages are summarized in Table 1.

Table 1. Summary of Research Stages

Type	Point
Collection and screening of data	Retrieval of data: Scopus data Times: 2015-2025 Geographical area: Worldwide Design of the Database: PRISMA Statement Data Screening: Microsoft Excel
Software Selection	Biblioshiny Software VOSviewer Software R-Studio Program Microsoft Excel
Data Analysis (Quantitative)	Description Information Analysis
Data Analysis (Qualitative)	Thematic Evolution Analysis Bradford's Law Scatter of Sources Analysis Most cited article Keyword Co-occurrence Analysis Trend Topics Analysis Thematic Map of Keyword Analysis

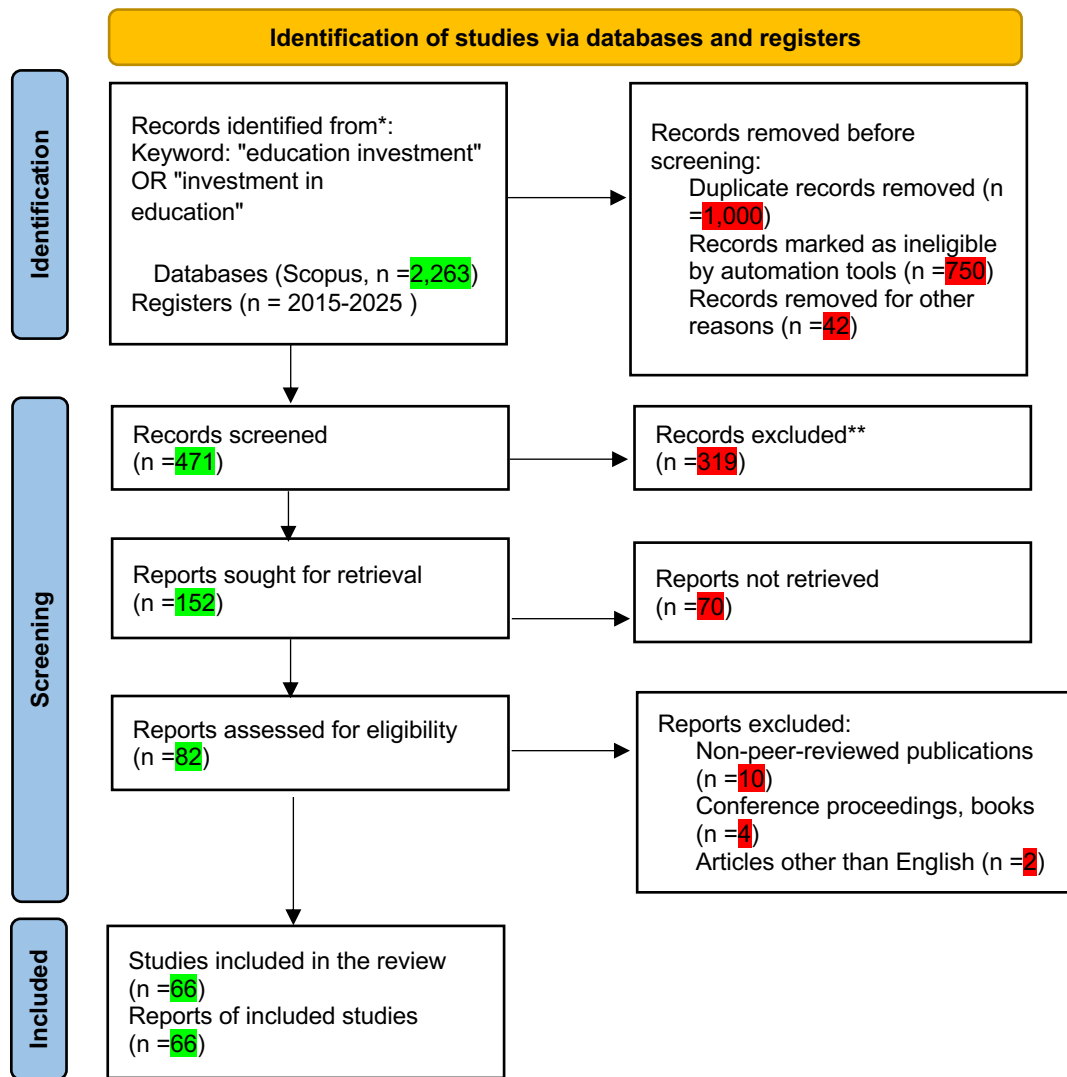


Figure 1. PRISMA DIAGRAM 2020 (Page et al., 2021)

RESULT AND DISCUSSION

The results of the research that has been conducted on the Scopus database, which has been tested for quality with the keywords "education investment" OR "investment in education, at 22.00 on January 10, 2026, obtained 36 articles that have passed the PRISMA Procedure stages which consist of four main stages: identification, screening, eligibility, and inclusion, which then enter the stage for analysis. The research trend is displayed in Figure 2.

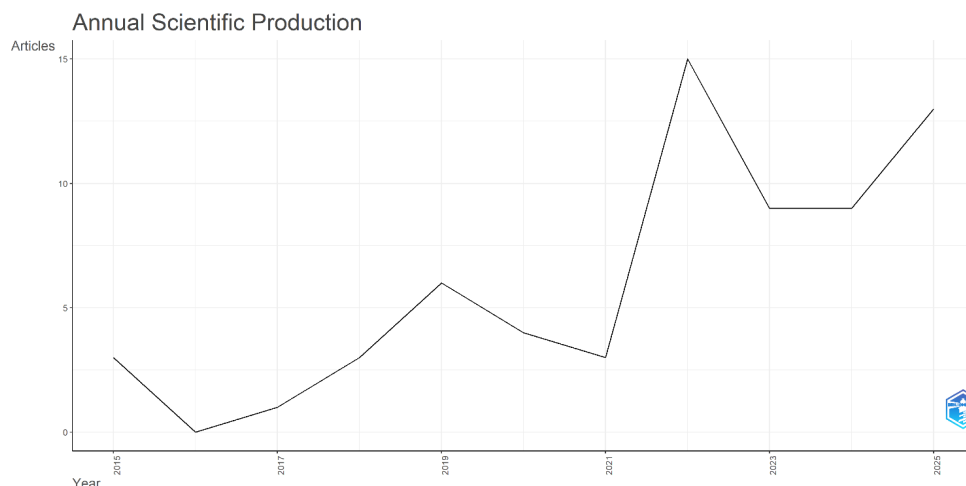


Figure 2. Publication Trend

Research trends on educational investment in human capital during 2015–2025 show a fluctuating yet progressive growth pattern, with a significant turning point after 2021. After an initial stagnant phase with low productivity (0–6 articles), the topic experienced a sharp surge in 2022, reaching a peak of 15 articles, indicating a strong shift in global interest towards the urgency of human capital development in the era of economic recovery. Although there was stabilization in 2023–2024, the trend began to rise again towards 2025, demonstrating that this topic remains a relevant strategic issue and has the potential for continued literature development.

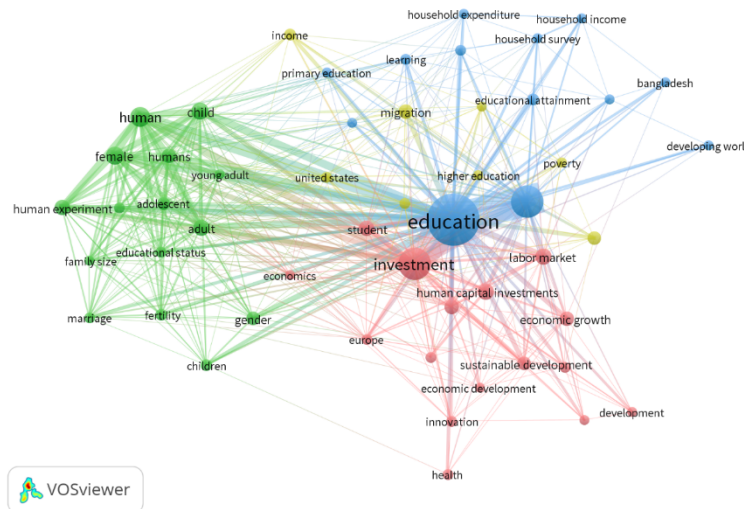


Figure 3. Network Visualization

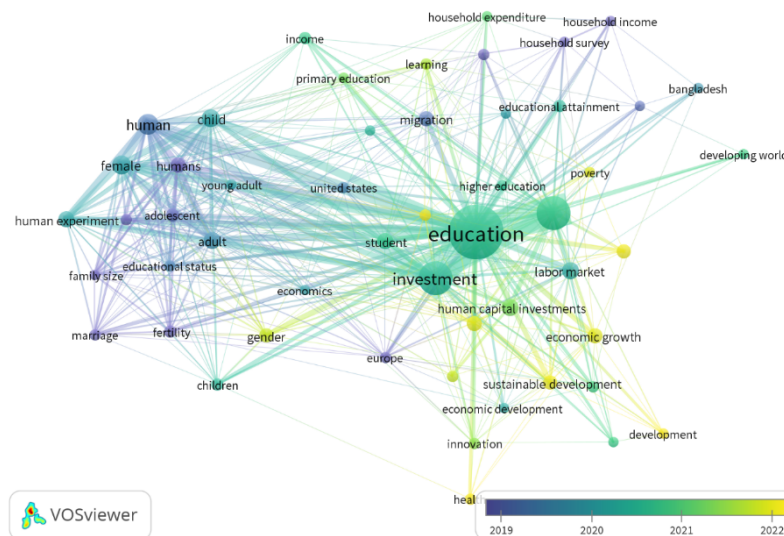


Figure 4. Overlay Visualization

Based on the analysis of the Co-occurrence Network structure on the 2015–2025 dataset, as presented in Figures 3 and 4, the shift in focus of human capital investment is clearly reflected in the network's center of gravity moving from traditional education clusters to digital competency ecosystems. At the beginning of the decade, the network structure was dominated by terms related to formal education, such as "Higher Education" and "Academic Achievement." However, entering the 2020–2025 period, there was a significant increase in the density of connections (edge weight) for the terms "Digital Literacy," "Artificial Intelligence," and "Technical Proficiency." This indicates that human capital investment is no longer viewed linearly through degree accumulation, but has shifted toward technological mastery as a strategic asset for maintaining relevance in a disrupted job market.

Furthermore, the emergence of the keywords "Resilience" and "Upskilling" as structural bridges within the network indicates that resilience is now identified as a component of human capital, and that resilience and lifelong learning now fill the gap between automation disruption and economic stability. Overall, this network structure confirms that the economic value of human capital has been reoriented; formal education now serves

only as a baseline, while digital competencies and adaptive capacity (resilience) have moved to the center as key determinants of the effectiveness of human capital investments in the modern era. The most productive writers are listed in [Table 2](#).

Table 2. Most Productive Writers

Author	Title	Total Citations	TC per Year	Normalized TC
(Psaki et al., 2019)	Causal effects of education on sexual and reproductive health in low and middle-income countries: A systematic review and meta-analysis	57	7.13	2.53
(Liao et al., 2019)	Research on the Impact of Digital Innovation Driving the High-Quality Development of the Shipping Industry	57	7.13	2.53
(Sandoval-Palis et al., 2020)	Early dropout prediction model: A case study of university leveling course students	48	6.86	2.00
(Mansi et al., 2020)	Poverty-A challenge for economic development? Evidences from Western Balkan countries and the European Union	42	6.00	1.75
(Kucharčíková et al., 2018)	Evaluating the effectiveness of investment in human capital in e-business enterprises in the context of sustainability	40	4.44	1.43
(Quah, 2018)	Why Singapore works: five secrets of Singapore's success	35	3.89	1.25
(Barrett et al., 2015)	Comparing service use and costs among adolescents with autism spectrum disorders, special needs and typical development	34	2.83	1.10
(Kenayathulla et al., 2019)	School level resources and students' performance in Malaysian national type Chinese schools	32	8.00	3.43
(Aceleanu et al., 2015)	"Greening" the youth employment-A chance for sustainable development	32	2.67	1.03

Based on [Table 2](#), this citation network demonstrates a sharp divergence from classical human capital theory, which typically focuses on a linear relationship between education and wage productivity. This is strongly evidenced by the positions of [Psaki et al. \(2019\)](#) and [Barrett et al. \(2015\)](#) as influential documents that shifted the focus of education investment toward health outcomes and social inclusiveness. This phenomenon indicates a shift toward the Capability Approach, in which education is no longer measured solely as an economic asset but rather as an instrument for expanding individual life capacities and broader well-being.

This divergence signals that modern literature is beginning to move away from the narrow view of orthodox economics to embrace a more holistic human dimension. Conversely, there is strong convergence among human capital, the social capital approach, and systemic sustainability. [Quah's \(2018\)](#) work on Singapore's success and [Li's \(2023\)](#) study, which has the highest Normalized Total Citation (3.43), emphasize that the effectiveness of human capital investment depends heavily on social capital in the form of public governance and institutional resources. This convergence is increasingly evident in the dominance of sustainability-themed literature, such as [Liao et al. \(2019\)](#) and [Kucharčíková et al. \(2018\)](#), which unite human development with digital innovation and business ecosystems.

Table 3. Most Productive Countries.

Country	Articles	Articles %	SCP	MCP	MCP %
China	13	19.7	12	1	7.7
Romania	3	4.5	2	1	33.3
Slovakia	3	4.5	3	0	0
United Kingdom	3	4.5	3	0	0
Bangladesh	2	3	0	2	100
Ecuador	2	3	0	2	100
Malaysia	2	3	2	0	0
Nigeria	2	3	1	1	50
Pakistan	2	3	1	1	50
Ukraine	2	3	2	0	0
USA	2	3	2	0	0

Based on [Table 3](#), the architecture of the collaboration network reveals a complex dynamic of epistemic dominance between developed and developing countries (the Global South). Although China dominates quantitatively, contributing 19.7% of articles, the majority of its output is Single Country Publications (SCP=12), indicating a focus on strengthening independent domestic narratives. In contrast, the traditional epistemic dominance pattern of developed countries like the United Kingdom and the USA is reflected in their research independence (MCP%=0), indicating that these countries act as theoretical standard-setters without relying on external partnerships to validate their educational investment policy narratives.

Structural inequalities are even more pronounced in Global South countries like Bangladesh and Ecuador, which have Multiple Country Publications (MCP) rates of 100%, and Nigeria and Pakistan, which have 50%. This very high level of collaboration dependence indicates that researchers in developing countries often need to affiliate with international institutions—typically based in developed countries to gain recognition for their research in global databases. This phenomenon confirms that the narrative of educational investment policy is still dominated by the framework of developed countries, where Global South countries tend to position themselves as providers of case studies in a knowledge architecture whose direction and methodology are still determined by the epistemic standards of the Global North. In the recent literature, the definition of Return on Investment (ROI) in education has gone beyond traditional wage parameters to include dimensions of subjective well-being and sustainable social mobility. This is evident in high-impact studies such as [Psaki et al. \(2019\)](#), which positions reproductive health and social rights as key outcomes of educational investments, directly contributing to long-term quality of life beyond monetary income. ROI, in this context, is viewed as an individual's "capability" to control their future, a concept that diversifies the economic value of human capital into broader social value.

Furthermore, literature dominated by sustainability-themed journals, such as [Kucharčíková et al. \(2018\)](#) and [Mansi et al. \(2020\)](#), defines ROI through the lens of economic resilience and systemic poverty reduction. ROI is no longer calculated solely based on graduates' starting salaries, but rather on the education system's ability to foster social mobility for vulnerable groups and reduce long-term social costs (such as health and unemployment). The emergence of the variables "digital innovation" and "green employment" shows that educational investment is now considered successful if it can produce "green human capital" that is adaptive to climate change and the digital economy, which ultimately increases subjective well-being through a more stable and meaningful work environment. Based on the analysis, the positions of the terms Artificial Intelligence (AI) and Automation within the network of terms function as structural mediators that fundamentally deconstruct and redefine the economic value of traditional human capital. Within the Systematic Literature Network Analysis (SLNA) framework, these two terms occupy a betweenness centrality position that bridges the formal education cluster with the dynamics of the future labor market, thereby shifting the investment paradigm from static knowledge accumulation to the development of adaptive capabilities, such as [Hussain et al. \(2025\)](#), AI integration is no longer considered a complementary entity but rather a determinant factor reshaping the profile of human capital in the digital economy, where economic value shifts from content mastery to human-machine collaboration.

Automation's role as a mediator in this network triggers a forced reskilling process that alters the structure of educational returns. Automation acts as a filter, suppressing the economic value of routine skills that have historically underpinned classical human capital while simultaneously increasing the economic premium on high-level cognitive skills and complex problem-solving. This aligns with [Tschang and Almirall \(2021\)](#), who identified that this technology is redefining the value of human work by disrupting traditional labor structures. Including the perspective brought by [Wright \(2021\)](#) confirms that the value of human capital today is no longer intrinsic to the individual alone, but rather relational; it is mediated by the extent to which human capital can collaborate with, manage, or surpass the technical capabilities of machines to maintain competitiveness in an increasingly automated economic ecosystem. This study successfully maps a decade-long

trend in education investment in human capital development, showing dynamic growth with a significant spike in 2022. This drastic increase in publications addresses the question of how global interest in the quality of human capital has evolved post-pandemic, as education has begun to be seen as a pillar of economic recovery. Geographically, China's dominance as the main contributor (19.7%) confirms that education investment in human capital development has become a national strategic agenda in the region. At the same time, the high level of international collaboration in developing countries such as Bangladesh demonstrates that this issue is a global challenge that requires cross-border collaboration. The quality of the collected literature is mostly ranked Q1, meaning that the findings in this field have undergone rigorous academic validation. The results also show that global human capital investment has undergone a significant shift in focus, shifting from traditional knowledge accumulation patterns to mastering digital innovation and adapting to a green economy. This phenomenon reflects the urgency of massive reskilling to face the challenges of automation, which is fundamentally disrupting the structure of the modern labor market. In this context, the quality of human resources is seen as a key determinant of achieving long-term economic sustainability amidst the era of technological disruption.

Interpretation of this research data confirms that higher education institutions no longer have a choice but to structurally integrate artificial intelligence (AI) into their academic ecosystems. This step is not simply a technological adaptation, but a crucial strategy to ensure an effective return on human capital investment. Amid ongoing disruption, the collaborative synergy between technological advancements and the enhancement of intrinsic human capabilities such as creativity, data literacy, and emotional intelligence is a key factor determining a nation's competitive advantage on the global stage. From a bibliometric and literature review perspective, these findings strongly reinforce previous arguments for the vital role of school resource integration in boosting collective student achievement (C. Li et al., 2023). The appropriate integration of physical and digital resources is a key enabler of improving the quality of educational output. However, there is an interesting divergence from traditional family sociology studies. While previous studies often emphasized family socioeconomic background as the primary predictor of success, this study highlights the digital innovation dimension as a primary driver in the formation of modern human capital (Mubarik et al., 2022; Bu et al., 2024). This shift demonstrates that access to technology and digital innovation is beginning to transcend conventional sociological barriers. Despite the strong focus on digitalization, this study maintains the relevance of broader aspects of well-being. This finding echoes other global studies that consistently demonstrate that educational investment significantly improves public health, particularly in developing countries (Dhrifi et al., 2021; Cerf, 2023). Thus, human capital is viewed not only through the lens of economic productivity but also as an instrument for improving the holistic quality of life.

The impact of these findings has urgent policy implications for national education authorities. Education policies must immediately prioritize strengthening inclusive digital literacy for all levels of the workforce to prevent a widening digital divide. Furthermore, a radical, systematic, and adaptive curriculum reconstruction is needed to support the knowledge-based vision of sustainable development (Sustainable Development Goals). The future curriculum must facilitate lifelong learning that is responsive to technological change. Strategic investment in the digital human capital sector is believed to be a key driver of economic growth. The desired growth is not measured solely by GDP statistics, but rather by a more inclusive and resilient economy for all levels of society, where every individual has the capacity to contribute to and benefit from advances in the digital era.

CONCLUSION

Based on the articles analyzed, it can be concluded that bibliometric research over the past decade (2015–2025) indicates a fundamental transformation in the study of human capital investment, where the research focus has shifted significantly from traditional family sociology approaches to contemporary issues such as digital innovation, the green economy, and labor market dynamics. The study's main findings indicate that school resource integration is one of the most influential trends in collectively improving student achievement, while China has emerged as the dominant contributor to global knowledge production on this topic. The implications of these findings underscore the need for a more adaptive reconstruction of national education policies, prioritizing digital literacy and technological adaptability to equip the workforce to face digital disruption. The implementation of these findings is expected to support the vision of sustainable development by creating human capital that is not only academically superior but also resilient, driving more inclusive economic growth across all levels of society. However, this study has several limitations, particularly the use of a single database source, Scopus, and the restriction of the analyzed documents to English-language publications. These limitations may exclude a number of relevant publications indexed in other databases or published in languages other than English. Therefore, further research is recommended to expand the database's scope and include multilingual publications to provide a more comprehensive picture of the development of human capital investment research.

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