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APPLICATIONS OF ACTOR-NETWORK THEORY IN ISLAMIC EDUCATION: A SYSTEMATIC LITERATURE REVIEW

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Abstract: Actor-Network Theory (ANT) is a sociological framework that explores how relationships between human and non-human entities (actors) form networks that shape social, scientific, and technological practices. This study presents a comprehensive bibliometric analysis of research on Actor-Network Theory (ANT) and its application in education between 2010 and 2024, based on 442 documents retrieved from the SCOPUS database. Data processing was carried out using SCOPUS analysis tools, VOSviewer, and Biblioshiny.The findings reveal a steady growth in publications, particularly influenced by key contributors such as Tara Fenwick, who has played a pivotal role in introducing ANT to educational theory and practice. Although the annual growth rate of publications has declined in recent years, ANT continues to serve as a valuable framework for analyzing the complex interactions among human and non-human actors in educational environments. The most active countries in ANT-education research include the United Kingdom and Australia, with institutions such as Victoria University and Linköping University leading in output. Keyword analysis identified three dominant thematic clusters conceptual/ philosophical, institutional/ applied, and methodological demonstrating ANT's versatility. Future research directions suggest expanding ANT studies into underrepresented regions like Asia, exploring informal and vocational learning contexts, and embracing emerging methodologies such as digital ethnography and participatory design. This review affirms ANT's relevance in rethinking education within increasingly networked and technologically mediated landscapes.

Keyword: Actor Theory Network, Education, Bibliometric, Scopus

INTRODUCTION

Actor-Network Theory (ANT) has emerged as an influential framework for analyzing educational phenomena by foregrounding the complex interactions between human and non-human actors within heterogeneous networks. This approach de-centers traditional human-centric analyses and instead posits that educational practices and policies are co-constructed through interdependent relationships between teachers, students, technologies, texts, and institutional policies (Vlasova & Kornienko, 2024; Tatnall, 2019; Fenwick & Edwards, 2010). By employing ANT, researchers can reframe educational processes as distributed networks where materiality, technology, and pedagogy coalesce to shape learning outcomes, thereby offering novel insights into both contemporary and historically rooted educational issues (Vlasova & Kornienko, 2024; Tatnall, 2019).

Actor-Network Theory (ANT) also known as the "sociology of translations" focuses on how power is exercised through the creation and ongoing maintenance of networks that consist of both human and non-human participants. Developed in the late 1980s by Bruno Latour and Michel Callon at the École Nationale Supérieure des Mines de Paris, along with John Law from Lancaster University in the UK, ANT redefines what it means to be an "actor" (Tatnall, 2019). Within this framework, an actor is any entity whether human or non-human that can assert its presence and influence others. ANT challenges the traditional separation between the social and the technical, asserting that no relationship is purely one or the other; all entities and interactions are a blend of both (Law, 1987).

A key premise of Actor-Network Theory is the recognition of numerous interactions among actors within a network. Each node and connection within the network holds potential significance, depending on the specific function or objective of the network (Latour, 2007). This perspective facilitates a deeper understanding of how projects are executed in configurations that integrate both human and non-human actors. The theory posits a form of symmetry among these actors, granting them equivalent agency. The theory also states that our world is made up of hybrid entities—combinations of human and non-human components—which makes it difficult to isolate one from the other. For instance, when examining AI technology, it's unclear where the line lies between the object itself and the human inputs and interactions that shape it. Such a viewpoint enables a more nuanced analysis of the impact of elements often overlooked in research on the effectiveness of education policy and practices.

A distinctive feature of Actor-Network Theory (ANT) lies in its attention to relationships that are not always structured or predictable, but may instead emerge in unanticipated ways (Ellis & Larsen-Freeman, 2006). This makes ANT particularly well-suited for exploring phenomena that are novel or not yet fully understood. Within ANT, the identity of an actor is not fixed; its size, psychological attributes, and motivations are not assumed a priori (Callon, 2007). This flexibility enables researchers to reconsider what constitutes an actor within a network. ANT thus affords researchers the methodological freedom to identify actors inductively, as the composition of the network is revealed through empirical observation and analysis (Hardy & Williams, 2008).

According to Fenwick (2010), ANT is particularly insightful in delineating how certain elements are incorporated or excluded from a network and why some connections succeed while others do not. Importantly, ANT ascribes agency to both human and non-human actors, acknowledging their capacity to influence, negotiate, or resist interactions within the network.

At the core of Actor-Network Theory lies the concept of translation, which is fundamental to the formation of actor-networks. According to ANT, while translators may reinterpret or reshape the original intentions of other entities, it is precisely through this process of translation that connections between actors are established. Translation unfolds in four distinct phases:

1. Problematization – during this phase, key actors and obligatory passage points (OPP) are identified, setting the foundation for network formation.
2. Interessement – this involves analyzing the motivations and constraints of all potential actors, wherein the primary actors propose incentives aligned with others' interests.
3. Enrollment – the stage at which actors are successfully drawn into the network.
4. Mobilization – the coordination and organization of enrolled actors to form alliances and collaboratively pursue the network's objectives with efficiency (Zhou & Guan, 2024).

In the field of education, ANT has been applied across various contexts. Fenwick and Nerland (2014) highlighted the relevance of non-human elements in professional learning environments. The application of ANT has ranged from micro-level classroom analyses to macro-level national systems. For example, Kamp (2017) used ANT to unpack the complexity of workplace learning in Ireland, highlighting the significant roles of non-human actors and proposing their intentional inclusion in vocational education design to improve learning outcomes. Tatnall (2019) also underscores the importance of viewing computers and educational technologies as components within a broader socio-technical network, where agency is not confined to human users but is shared with the technological artifacts involved. This lens enables a deeper exploration of how digital innovations are integrated into pedagogical and institutional structures, drawing attention to the often-overlooked processes of negotiation, translation, and alignment that shape their implementation.

Applications of Actor-Network Theory (ANT) in educational contexts frequently involve tracing the interplay of actors during curriculum development and enactment. For example, Tanaka-Ellis (2017) reconceptualizes a foreign language curriculum as an actor-network, illustrating how elements such as curriculum designers, instructors, digital technologies, and physical classroom arrangements collaboratively influence the educational process. Similarly, Paledi and Alexander (2017), through an ANT-informed study of mobile learning readiness, demonstrate how the problematization phase serves to unite students, faculty, and administrative staff in addressing the technological and instructional barriers present in higher education.

Latour (2007) and Law (2009) also addressed the curriculum as a heterogeneous network composed of human actors and material components, such as classrooms, documents, and computers. Carroll (2018) noted that these networks could be granular, capturing even interpersonal relationships—such as collegial support or tension—and preferences for specific teaching practices or tools.

Over the past decade, the application of Actor-Network Theory in education research has provided scholars with a nuanced analytical framework to examine everything from curriculum innovation and digital learning integration to the multifaceted policy networks that underpin educational reforms. By emphasizing the distributed agency among both human and non-human actors, ANT

uncovers the subtle, yet powerful, mechanisms through which educational change is negotiated and enacted in contemporary society (Fenwick, 2019).

While ANT has been increasingly adopted in education studies, a comprehensive overview of its contributions is lacking. This paper sought to fill this gap by presenting a systematic literature review of ANT-based applications in education. In this sense, a bibliometric study was conducted that addressed the following questions.

1. RQ1: What are the emerging trends of Actor Theory Network and education ?
2. RQ2: What are the most influential contributors of ANT andeducation research ?
3. RQ3: What are the future research directions for ANT andeducation studies ?

Bibliometric studies have been conducted in various domains related to Actor-Network Theory (ANT) and education. For instance, Aka (2025) carried out the first comprehensive review of how ANT has been applied within sustainability research. Drawing on 197 peer-reviewed journal articles indexed in Scopus from 1999 to 2024, the study employed bibliometric and science mapping techniques—including performance analysis, co-citation analysis, bibliographic coupling, and co-word analysis—using VOSviewer and Biblioshiny software. The review identified a significant increase in ANT-related sustainability publications over the past decade, with the UK, USA, and the Netherlands as leading contributors. His research highlights ANT's relevance in addressing the complexity of sustainability issues and offers a framework for future studies to explore the socio-technical, relational, and temporal dynamics of sustainability transformations.

In the field of education and technology, Ispir (2024) presents a comprehensive analysis of the research landscape surrounding augmented reality (AR), virtual reality (VR), and mixed reality (MR) in education. Using both bibliometric and systematic review methods, the study analyzed 1,287 relevant articles from the Web of Science, identifying trends in keywords, contributing countries, institutions, and influential authors. The results show that while VR research in education began in the 1990s, AR and MR studies have gained momentum more recently, particularly over the last five years. The United States and China emerged as the most active contributors, with prominent publication venues including Education and Information Technologies and Interactive Learning Environments. The study also highlights that VR is currently the most widely studied of the three technologies, although interest in AR and MR is rapidly growing. Overall, the study offers valuable insights into how immersive technologies are shaping educational research and practice.

However, no systematic literature review using bibliometric methods has yet been conducted to identify and analyze emerging trends and the intellectual structure of ANT-based applications in education. Therefore, this paper is the first to provide a systematic literature review of ANT applications within education studies.

In doing so, the present paper contributes to unpacking the evolutionary nuances of knowledge in this area while

providing information on productivity trends, geographical distribution, popular keywords, and future research directions. The study highlights a significant number of publications, particularly over the past decade. It identifies the most-cited articles, leading journals, as well as the most productive regions and thematic fields within this research domain. It further identifies four core knowledge foundations underlying ANT-based applications in education.

This paper presents a comprehensive bibliometric review of Actor-Network Theory research from 2010 to 2024, using the Scopus database. Bibliometric methods involve quantitative analyses—such as citation analysis, co-citation mapping, and network visualization—to assess the structure and dynamics within academic publishing (Ninkov et al., 2021). Understanding these aspects can inform the next generation of research questions and methods, guiding scholars toward underexplored dimensions of Actor-Network Theory in education. Moreover, this bibliometric analysis aims to provide an evidence-based foundation for practitioners and policymakers interested in integrating ANT principles into curricula, educational policies, or programs.

METHODS

This study adopts a bibliometric analysis methodology. As defined by Mukherjee et al. (2022), bibliometric analysis involves the statistical evaluation of academic publications and is widely regarded as an effective means of detecting emerging research trends and mapping the intellectual structure of a given field. Additionally, bibliometric analysis serves as a mapping tool that enables researchers to distill large volumes of unstructured data into meaningful insights, facilitating the identification of literature gaps and the discovery of new research directions (Donthu et al., 2021). Following this, a systematic review was conducted to analyze the most highly cited works. This method supports the rigorous identification, critical appraisal, and structured synthesis of research relevant to a specific topic (Moher et al., 2010).

To initiate the study, a global literature search was performed in March 2025 using the SCOPUS database through SCOPUS Analyses, Biblioshiny, and the Publish or Perish program, targeting publications related to Actor-Network Theory (ANT) and education between 2010 and 2024. The search strategy included the keyword “Actor Theory Network” within the abstract and “education” within the title, abstract, or keywords. Initially, the search was broad, with no restrictions on subject areas, document types, or language, to ensure inclusivity. This was followed by a series of refinements: the selection of subject areas relevant to education and social sciences to align with the research focus; the restriction to peer-reviewed formats, including articles, book chapters, and review papers; and finally, the inclusion of only English-language documents to maintain consistency in interpretation.

After applying these filters, a total of 442 documents were obtained from SCOPUS. These records were then exported from Google Scholar in RIS format and from SCOPUS in CSV and RIS format. The exported data included the author’s name, article title, year of publication, source title, volume, issue,

article number (if applicable), DOI, citation counts, and other relevant bibliographic details. The retrieved dataset was analyzed using SCOPUS, VOSviewer, and Biblioshiny as analytical software tools, focusing on the title and abstract fields.

RESULTS AND DISCUSSION

Data collected from SCOPUS indicates that articles discussing "Actor-Network Theory" and "Education" were published between 2010 and 2024, showing a significant increase in publication activity over this period. A total of 442 references were identified in the SCOPUS database, with the majority of documents published as journal articles (73%), followed by book chapters (10.4%).

RQ1: What are the emerging trends of Actor Theory Network and education ?

The number of publications related to Actor-Network Theory (ANT) and education has shown a steady increase over time, as illustrated in Figure 1. This upward trajectory suggests that the topic has garnered growing attention in academic research. Over the years, ANT has undergone methodological refinement and has been effectively adapted across various disciplines, particularly within the field of education (Vlasova & Kornienko, 2024). Although the volume of research specifically connecting ANT to education remains relatively limited, the consistent growth in studies highlights a positive trend and affirms the increasing relevance of ANT in educational research.

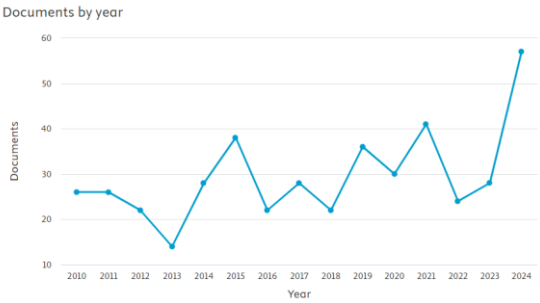

Figure 1Trends of Publications Related to ANT and Education from 2010-2024

According to Figure 1 above, 442 articles were published in SCOPUS between 2010 and 2024. This relatively low annual output may be attributed to the limited mainstream media attention given to the topic, as well as the insufficient recognition of Actor-Network Theory (ANT) by educators, policymakers, and academics within the field of education. There was a noticeable decline in publication numbers between 2012 and 2014, although the figures began to rise again after this period. The increase in publications from 2014 to 2019 could be linked to the discussions following the release of articles by Fenwick in 2014 and 2019. Tara Fenwick has been pivotal in incorporating ANT into educational research, particularly in areas such as professional learning, workplace education, and policy analysis. While she is not considered a founder of ANT, Fenwick's contributions have been crucial in demonstrating how ANT's focus on both human and non-human actors—such as tools, technologies, texts, and environments—can provide a more comprehensive understanding of how learning and educational change unfold. Fenwick reconceptualizes learning as an emergent process shaped by dynamic networks, rather than being driven solely by individual cognition or social

structures. Through her collaborations, notably with Richard Edwards and Nerland, she has contributed to key works like *Actor-Network Theory in Education* (2010), where she highlights how ANT can shed light on the often-overlooked material and relational aspects of educational reform, policy, and practice.

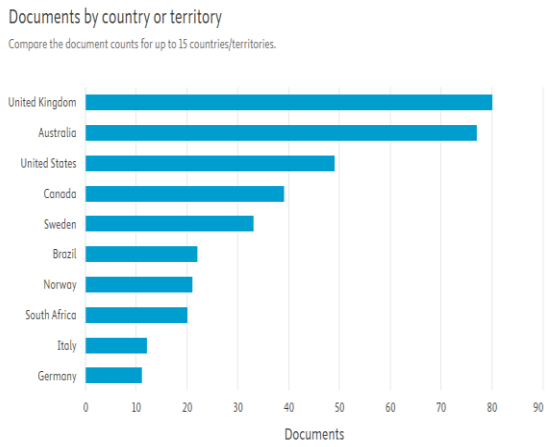

Figure 2 Highest publications by country

Figure 2 above illustrates the global distribution of publications related to Actor-Network Theory (ANT) and education, highlighting the research output across various countries. The United Kingdom leads with the highest number of publications, followed closely by Australia, both of which indicate a strong academic engagement with ANT in educational settings. The United States ranks third, contributing a moderate amount of research, while Canada, Sweden, and Brazil also show significant academic activity in this area. Countries such as Norway, South Africa, Italy, and Germany produce fewer publications but still demonstrate an interest in the application of ANT within their educational research. Overall, the chart highlights the growing global interest in ANT, with particularly prominent research hubs in the UK and Australia.

The data further reveals that ANT has received relatively little attention in Asian countries, including Indonesia. This is partly due to the limited coverage of ANT in university curricula. While there are some studies that apply ANT in Indonesia such as those exploring military contexts (Trias & Cook, 2022), cultural studies (Prasetyo&Ekomadyo, 2021), and politics (Dwinarko et al., 2023)—the Scopus database from 2010 to 2024 reveals a lack of research on ANT in the field of education in Indonesia.

RQ2: What are the most influential contributors of ANT andeducation research ?

In this second research question, the study focuses on the most productive and influential authors, authors' production over time, the most influential institutions, and the most impactful keywords in the field of Actor Theory Network and education.

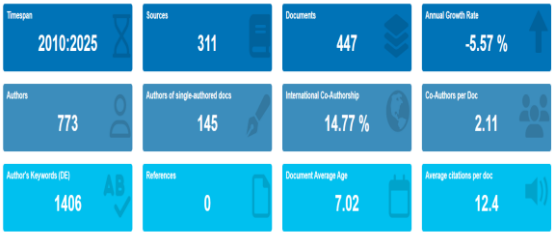

Figure 3 Global information about publication

Over the 15-year period shown in Figure 3 above, 447 documents were published across 311 different sources, involving 773 authors. Despite the relatively robust participation from authors, the field experienced a negative annual growth rate of -5.57%, indicating a decline in publication activity over time. Co-authorship was moderately common, with an average of 2.11 authors per document, and 14.77% of the publications

involved international collaborations. Notably, 145 documents were written by single authors, suggesting a fair balance between individual and collaborative work. On average, each document received 12.4 citations, reflecting a solid impact within the academic community. The keyword diversity was notable, with 1,406 distinct author keywords, showcasing the thematic variety within the research. However, the average age of the documents was 7.02 years, indicating that much of the research might not be very recent. Additionally, the "0" references indicator might be a placeholder or a data processing error. Overall, this snapshot reveals a well-established yet possibly waning research area, with steady international collaboration and moderate citation influence.

Figure 4 and Table 1 below show the most productive and influential authors in the SCOPUS database. In general, the seven most productive authors are: Tatnall A. (13 documents), Tummons J. (10 documents), Muchaldy D. (8 documents), and Fenwick T., Koyama J., and Landri P. (7 documents each).

In the bibliometric analysis concerning Alan Tatnall's contributions to the field of Actor-Network Theory (ANT) in education, as shown in Table 1, it is evident that from 2011 to 2019, he authored at least 10 publications that integrate ANT with topics such as ICT in education, e-health, societal change, and project management education. His most cited work is "The Value of Using ICT in the Education of School Students with Learning Difficulties" (2017), which garnered 34 total citations (TC) and holds the highest citations per year (TCpY) at 3.778. This indicates strong and sustained relevance. Other notable publications include studies on ICT and older people in Australia and a historical review of computing education in Victoria, both receiving moderate citations.

However, several of his works—such as those on e-health and project management—have received no citations, suggesting limited impact or recency. The diversity of sources (SO), including Education and Information Technologies, IFIP Advances in ICT, and Technological Advancements and the Impact of ANT, reflects Tatnall's interdisciplinary approach. Overall, while some works show strong academic influence, others highlight the uneven citation landscape typical in specialized fields like ANT, pointing to varying degrees of resonance within the academic community.

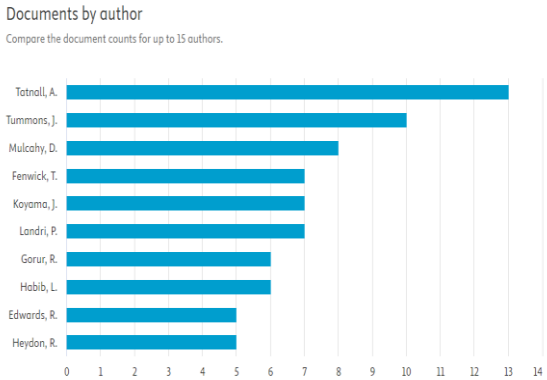

Figure 4 Most Productive Authors

Table 1 Tatnall Works as The Most Productive and Influential Author

Author	year	TI	SO	DOI	TC	TCpY
TATNALL A	2019	RESEARCHING COMPUTERS AND EDUCATION THROUGH ACTOR-	IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY	10.1007/978-3-030-28764-1_10	1	0,143
TATNALL A	2018	BIRTH, LIFE AND DEATH OF THE VICTORIAN EDUCATION ULTRANET	EDUCATION AND INFORMATION TECHNOLOGIES	10.1007/s10639-017-9679-x	4	0,5
TATNALL A	2017	THE VALUE OF USING ICT IN THE EDUCATION OF SCHOOL STUDENTS	EDUCATION AND INFORMATION TECHNOLOGIES	10.1007/s10639-017-9605-2	34	3,778
TATNALL A	2017	THE VALUE OF PROJECT MANAGEMENT EDUCATION FOR IT	IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY	10.1007/978-3-319-74310-3_28	0	0
TATNALL A	2017	ACHIEVING E-HEALTH SUCCESS: THE KEY ROLE FOR ANT	HEALTH CARE DELIVERY AND CLINICAL SCIENCE: CONCEPTS, METHODOLOGIES,	10.4018/978-1-5225-3926-1.ch028	0	0
TATNALL A	2015	COMPUTER EDUCATION AND SOCIETAL CHANGE: HISTORY OF EARLY COURSES IN COMPUTING IN	INFORMATION TECHNOLOGY AND PEOPLE	10.1108/ITP-09-2014-0202	5	0,455
TATNALL A	2014	TECHNOLOGICAL ADVANCEMENTS AND THE IMPACT OF ACTOR-	TECHNOLOGICAL ADVANCEMENTS AND THE IMPACT OF ACTOR-NETWORK	10.4018/978-1-4666-6126-4	2	0,167
TATNALL A	2014	ICT, EDUCATION AND OLDER PEOPLE IN AUSTRALIA: A SOCIO-TECHNICAL	EDUCATION AND INFORMATION TECHNOLOGIES	10.1007/s10639-013-9300-x	17	1,417
TATNALL A	2014	THE IMPACT OF ICT IN EDUCATING STUDENTS WITH LEARNING DISABILITIES IN AUSTRALIAN	TECHNOLOGICAL ADVANCEMENTS AND THE IMPACT OF ACTOR-NETWORK THEORY	10.4018/978-1-4666-6126-4.ch001	1	0,083
TATNALL A	2011	THE ULTRANET AS A FUTURE SOCIAL NETWORK: AN ACTOR-NETWORK ANALYSIS	24TH BLED ECONFERENCE - EFUTURE: CREATING SOLUTIONS FOR THE INDIVIDUAL, ORGANISATIONS AND	NA	5	0,333

Table 2 below highlights the most relevant institutions in the field of Actor-Network Theory (ANT) and education. Victoria University stands out as the leading contributor, with 18 articles, reflecting a strong institutional focus or the presence of influential scholars in this niche. It is followed by Linköping University (14 articles) and the University of Melbourne (13 articles), both of which suggest a high level of academic engagement with ANT-related educational research, likely driven by interdisciplinary or critical theory-oriented programs.

The University of Stirling (12 articles) also emerges as a significant contributor, closely followed by Deakin University and Durham University, each with 9 articles. Several Australian universities—such as Monash, RMIT, and Deakin—are prominently represented in the top ten, underscoring Australia's key role in ANT and education scholarship. Additionally, institutions like the University of South Africa and the University of Arizona introduce some geographic diversity, although the list is predominantly made up of universities from English-speaking and Western countries.

This institutional pattern mirrors earlier country-level analyses, which identified Australia and the UK as major hubs for ANT in education research. It also reinforces the influence of specific universities in shaping and sustaining this academic discourse.

Table 2 Most Active Institutions

Affiliation	Articles
VICTORIA UNIVERSITY	18
LINKÖPING UNIVERSITY	14
UNIVERSITY OF MELBOURNE	13
UNIVERSITY OF STIRLING	12
DEAKIN UNIVERSITY	9
DURHAM UNIVERSITY	9
UNIVERSITY OF SOUTH AFRICA	8
MONASH UNIVERSITY	6
RMIT UNIVERSITY	6
UNIVERSITY OF ARIZONA	6

Table 3 below highlights the most influential academic journals contributing to the field of Actor-Network Theory (ANT) and education. Pedagogy, Culture and Society stands out as the leading journal with 13 articles, reflecting its strong alignment with sociocultural and critical perspectives that resonate with ANT's theoretical foundations. Close behind is Educational Philosophy and

Theory with 12 articles, indicating the journal's receptivity to philosophical frameworks such as ANT and its engagement with posthumanist and materialist thought.

Other significant contributors include Studies in Continuing Education (8 articles), Journal of Curriculum Studies (7 articles), and Journal of Education Policy (7 articles), suggesting that ANT is being used to critically examine educational structures, policies, and lifelong learning contexts. The presence of Discourse and Globalisation, Societies and Education (6 articles each) further underscores ANT's relevance in critical policy analysis and discourse studies within education.

The list also includes more technically focused or interdisciplinary journals, such as IFIP Advances in Information and Communication Technology (5 articles), pointing to ANT's application in digital education and educational technologies. Similarly, journals like Journal of Educational Administration and History and Postdigital Science and Education (5 articles each) highlight ANT's contributions to historical, administrative, and postdigital perspectives in educational research.

Overall, these sources demonstrate the diverse disciplinary intersections where ANT is being applied, particularly in critical, theoretical, policy-oriented, and technologically mediated educational research.

Table 3 Most Relevant Sources

Sources	Articles
PEDAGOGY, CULTURE AND SOCIETY	13
EDUCATIONAL PHILOSOPHY AND THEORY	12
STUDIES IN CONTINUING EDUCATION	8
JOURNAL OF CURRICULUM STUDIES	7
JOURNAL OF EDUCATION POLICY	7
DISCOURSE	6
GLOBALISATION, SOCIETIES AND EDUCATION	6
IFIP ADVANCES IN INFORMATION AND COMMUNICATION TEC	5
JOURNAL OF EDUCATIONAL ADMINISTRATION AND HISTORY	5
POSTDIGITAL SCIENCE AND EDUCATION	5

As shown in Figure 5 below, the keyword analysis using VOSviewer reveals the thematic structure of research at the intersection of Actor-Network Theory (ANT) and education. Three distinct clusters emerge: the red cluster focuses on conceptual and philosophical themes, including assemblage, materiality, classroom, and curriculum. This reflects how ANT is employed to reconceptualize educational spaces, agency, and human-nonhuman interactions. The green cluster centers on institutional and applied contexts, with keywords such as institution, implementation, framework, and higher education, highlighting ANT's role in analyzing policy, digital technology, and organizational challenges. The blue cluster addresses methodological concerns, with terms like interview, framework, and observation, indicating ANT's use as an analytical lens in empirical research.

These clusters collectively show that ANT serves both as a philosophical framework and a practical tool for studying education. It bridges micro-level phenomena (such as classroom dynamics) with macro-level systems (like universities and policies), while also supporting a variety of methodological approaches. The inclusion of foundational concepts such as assemblage, actor, and Bruno Latour,

alongside applied themes like ICT and integration, underscores ANT's flexibility in addressing the complexities of educational realities.

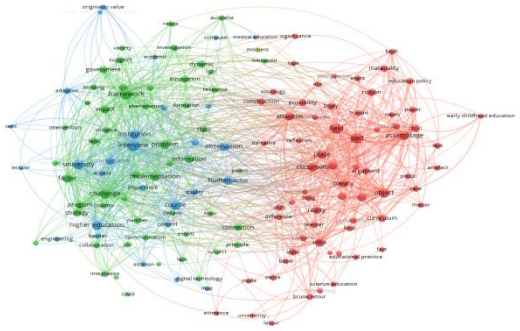

Figure 5 Co-occurance Keyword Analysis

The second research question examines the key contributors and thematic trends in Actor-Network Theory (ANT) and education research over the past 15 years. A total of 447 documents were published by 773 authors, with a modest citation impact and a slight decline in the annual growth rate. Alan Tatnall emerged as the most productive and influential author, with a range of works spanning ICT, e-health, and educational transformation, although his citation performance was uneven. Institutions such as Victoria University, Linköping University, and the University of Melbourne are the leading contributors in terms of research output, with Australia playing a particularly prominent role in this field. Journals like *Pedagogy, Culture and Society* and *Educational Philosophy and Theory* are the most influential publication outlets, reflecting ANT's alignment with sociocultural and theoretical discourses in education.

Keyword co-occurrence analysis further reveals three thematic clusters: conceptual and philosophical themes (e.g., assemblage, materiality), institutional and applied concerns (e.g., framework, higher education), and methodological approaches (e.g., interview, observation). These clusters highlight ANT's adaptability as both a theoretical and empirical tool for analyzing complex educational phenomena. The field demonstrates broad thematic diversity, moderate international collaboration, and sustained influence despite a decline in publication frequency, positioning ANT as a critical framework for both theoretical inquiry and practical application in educational research.

RQ3: What are the future research directions for ANT andeducation studies ?

Based on the current landscape of Actor-Network Theory (ANT) and education research, several promising future directions emerge. First, the observed decline in annual publication growth and the uneven citation distribution, even among prolific authors like Tatnall (2019), highlight the need to reinvigorate ANT scholarship with new applications and greater interdisciplinary engagement. Future studies could focus on underrepresented regions or educational sectors, such as vocational training or informal learning, extending beyond the dominant contributions from institutions in Australia and the UK. There is also an opportunity to enhance methodological innovation by integrating ANT with emerging research paradigms, such as post-qualitative inquiry or digital ethnography, especially given the current emphasis on observation and interview methods in the keyword analysis. Thematic clusters like "assemblage" and

"materiality" invite further exploration of how ANT can help reconceptualize evolving educational challenges in hybrid and postdigital contexts.

Moreover, as higher education increasingly adopts digital platforms and learner-centered models, ANT's focus on socio-technical entanglements offers a valuable framework for analyzing and shaping future educational practices (Lyall et al., 2024; Zatti et al., 2023). Future research should examine how technological actors, such as Learning Management Systems (LMS) or AI tools, interact with human agents to influence pedagogical outcomes, in line with findings from Lyall et al. (2024) and Tatnall (2019). There is also a need to explore participatory design approaches that involve both educators and learners as active agents in shaping educational ecosystems (Ağça& Buur, 2023). Expanding this perspective, research could investigate how ANT-informed curricula might better prepare students for complex, networked professional environments (Fenwick & Edwards, 2019). Emphasizing adaptability and relational awareness among actors, as advocated by Prasetyo&Ekomadyo (2021), could support the development of inclusive, innovative educational frameworks capable of responding to rapid technological and societal changes..

CONCLUSION

In conclusion, the study of Actor-Network Theory (ANT) in education has experienced a steady growth in academic attention from 2010 to 2024, with 442 documents indexed in SCOPUS and a significant increase in publications following influential works by scholars like Tara Fenwick. Although the field remains relatively small, its global reach dominated by countries such as the UK and Australia—and the contributions of key figures like Alan Tatnall reflect a growing interest in ANT's capacity to shed light on the complex, relational dynamics of educational environments. Institutional involvement is most pronounced among universities in English-speaking countries, and the leading journals emphasize ANT's alignment with critical, sociocultural, and policy-oriented research in education. Thematic analysis highlights ANT's versatility, spanning philosophical, institutional, and methodological dimensions. While the field demonstrates moderate international collaboration and citation impact, future research should aim for broader geographic participation, greater integration with emerging methodologies, and a deeper exploration of digital and hybrid learning contexts. This will reinforce ANT's value as a powerful framework for reimagining education in an increasingly networked world.

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