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Bibliometric Analysis: Technology Research in Adult Learning Using Vosviewer on Google Scholar

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Abstract

This study aims to investigate the development of research on technology in the context of adult learning over the last ten years. This study used bibliometric analysis to identify research trends, relationships between concepts, and author collaborations. The data is obtained from the Google Scholar database with relevant keywords, and the number of publications is limited to 1,000 journals. The results show fluctuations in the growth of publications about technology in the context of adult learning from 2014 to 2023. Out of 1,000 publications indexed by Google Scholar, only 628 have information on year and publisher, while 308 do not. The peak of publication growth occurred in 2021, with 105 publications (16.7%), while the lowest number of publications was recorded in 2017, with 50 documents (8%). Research shows that the use of technology in adult learning continues to evolve. Nonetheless, there is still a paucity of research on technology and knowledge of andragogical content in adult learning. This provides an opportunity for other researchers to continue to develop this research trend.

Keywords: adult learning, andragogy, andragogical content knowledge, bibliometric analysis, publication

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INTRODUCTION

This research was conducted to enter the main Technological Andragogical Content Knowledge (TACK) study. TACK is a framework that integrates three essential aspects of technology education: technology, adult learning (andragogy), and content knowledge. The essence of TACK is to combine an understanding of how technology can be used effectively in adult learning contexts with knowledge of the material or content being taught (Rita et al., 2021; Sunarti et al., 2022).

In general, here is the gist of each TACK component. First, technology: TACK recognizes that technology is essential in education. Educators who understand TACK should be knowledgeable about the various tools, applications, and technology platforms that can be used to

enhance the adult learning experience (Sarte et al., 2021; V. Wang et al., 2021). They must know how to select, integrate, and manage appropriate technology to achieve learning goals. Second, adult learning: TACK recognizes that adults have different learning characteristics than child ren. Educators who understand TACK should be familiar with adult learning theories, such as the principles of andragogy, relevant teaching strategies, and approaches that respect adult experience and understanding. Third, content knowledge: TACK also emphasizes the importance of understanding the material or content being taught. Educators using TACK must have in-depth knowledge of the subject being taught. They must integrate technology with content knowledge to create meaningful adult learning experiences (Permana et al., 2021; Sunarti et al., 2022).

By combining these three aspects, educators who implement TACK can design learning experiences that are effective, interesting, and relevant for adults. They can use technology wisely to increase learner understanding and engagement while considering adult learning characteristics and focusing on relevant content knowledge (Handayani et al., 2023). TACK does not enter directly into the andragogy study group. TACK is a framework combining three important aspects of education: technology, adult learning, and content knowledge. Andragogy, conversely, is the study of learning and teaching adults. This involves understanding the unique characteristics of adults as learners, the principles of effective learning for adults, and teaching strategies that suit their needs (Tafakur et al., 2023; X. Wang et al., 2017). TACK incorporates elements of andragogy in the use of technology in the context of adult learning, but TACK itself is not an andragogical study. TACK can be used as a framework or approach that assists teachers in integrating technology, adult learning, and content knowledge holistically.

Technology in the context of adult learning is a tool or means used to enhance the learning experience and achieve learning goals for adults. In education, technology can include various types of hardware and software, applications, online platforms, digital media, and other digital resources (Schmidt et al., 2010). The use of technology in adult learning can provide various benefits, including accessibility. Technology can enable more comprehensive access to learning materials and resources through online learning platforms, learning videos, e-books, etc. (Amiruddin et al., 2023). This can facilitate distance learning, self-study, or flexibility of time and place.

Second is engagement. Technology can increase the engagement and motivation of adult learners by providing interactive, multimedia, and engaging learning experiences (Stanney et al., 2023). For example, simulations, educational games, learning videos, and online discussion forums can generate students' interest and active participation. The third is collaboration. Technology can facilitate cooperation and collaboration between adult learners in face-to-face and remote learning environments. Students can collaborate on projects, share ideas, and provide feedback through online communication and co-working tools like video conferencing, file-sharing platforms, and online discussions (Arwin et al., 2022; Zhang et al., 2013). Fourth is personalization. Technology can assist in providing learning experiences tailored to individual learners' needs, preferences, and levels of understanding. Using adaptive learning tools or personalized computer programs, adult learners can learn at their own pace and learning style (Blaschke, 2019). The use of technology in adult learning requires particular understanding and skills from educators to select, integrate, and manage appropriate technology (Banseng et al., 2021; Todd et al., 2021). This involves understanding how to effectively use technology to support learning, promote digital literacy, and address challenges that may arise in using technology.

METHODS

The method used in this study is a descriptive bibliometric analysis through published data on technology topics in the context of adult learning in the 2014–2023 range with the limitation of six fields of study, including technology, technological, andragogy, andragogical, content, and

knowledge, and a limit of 1,000 documents. This is done to narrow the search for the field of education on the topic of technology in the context of adult learning. The Publish or Perish application will collect data by searching for article publications in Google Scholar-indexed journals.

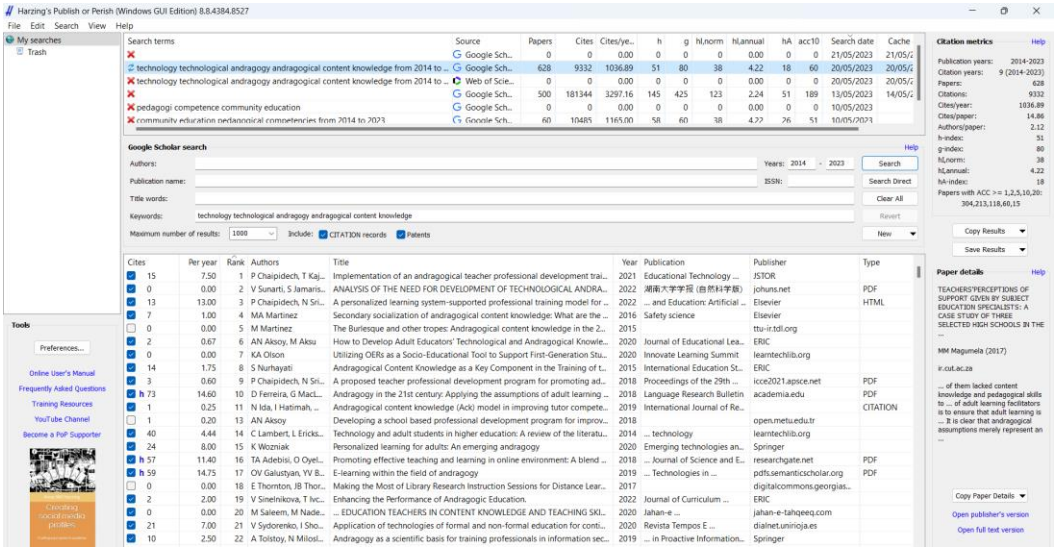


Figure 1. Search method via publish or perish (Source: Publish or Perish 2023)

After obtaining and storing the data in the form of a Research Information Systems (RIS) file, the next step is to import the file into the Vosviewer software, which is intended to visualize bibliometric relationships into three categories, namely network visualization, overlapping visualization, and density visualization. Network visualization aims to display the strength of the relationship between research terms. The overlapping visualization aims to show historical traces based on the year of research publication. Meanwhile, density visualization aims to display dense or focused research groups (Magadán-Díaz & Mivas-García, 2022).

Bibliometric analysis involves applying statistical methods to literature such as books, magazines, online publications, and other communication media (Komarudin et al., 2023). The maps generated by Vosviewer can be used as a reference for conducting accurate content analysis based on the researcher's name, the year of publication, the productivity of the researcher, and research trends in technology topics in the context of adult learning (Kleinke & Lin, 2020; Sicam et al., 2021). In this study, bibliometric analysis was used to analyze author collaboration in research on technology in the context of adult learning and bibliometric relationships based on co-occurrence.

FINDING AND DISCUSSIONS

Development of research publications in the field of technology in the context of adult learning

From journals registered on Google Scholar and accessed through Publish or Perish, 1,000 research documents were found on the use of technology in adult learning. Filtering uses keywords such as technology, technology andragogy, andragogic, content, and knowledge to ensure relevance. The growth trend of publications regarding the use of technology in adult learning between 2014 and 2023, based on data from the Google Scholar database via the Publish or Perish software, shows fluctuating conditions. Of 1,000 documents registered on Google Scholar, 628 have information about the year and publisher, while 308 do not. The highest publication growth occurred in 2021, with 105 documents (16.7%), while the lowest number of publications, apart from 2023 because it had not reached 12 months, was in 2017, with 50 documents (8%).

Table 1. Development of research publications on technology topics in the context of adult learning

Year of Publication	Number of Documents	Percentage
2023	24	3,8%
2022	63	10,0%
2021	105	16,7%
2020	78	12,4%
2019	62	9,9%
2018	52	8,3%
2017	50	8,0%
2016	56	8,9%
2015	73	11,6%
2014	64	10,2%
Total Publications	627	

Source: Results of personal data processing (2023)

In 2016, the number of research documents on technology in the context of adult learning decreased significantly. There were only 56 documents (8.9%) compared to the previous year in 2015, and during the 2016–2018 period, this figure fluctuated and was around 8%. However, after 2019, there was an increase in the number of new documents by 62 (9.9%), and this increase continued with an increase of 2.5% in 2020, reaching a peak in 2021 with 16.7%. However, there was a decrease in 2022, with only 63 documents (10%). Despite fluctuations in that period, the quantitative growth of research on technology in adult learning proves that this topic continues to attract researchers' interest from year to year in Indonesia. Further information about the growth of technology-related publications in the context of adult learning listed on Google Scholar can be seen in Figure 2.

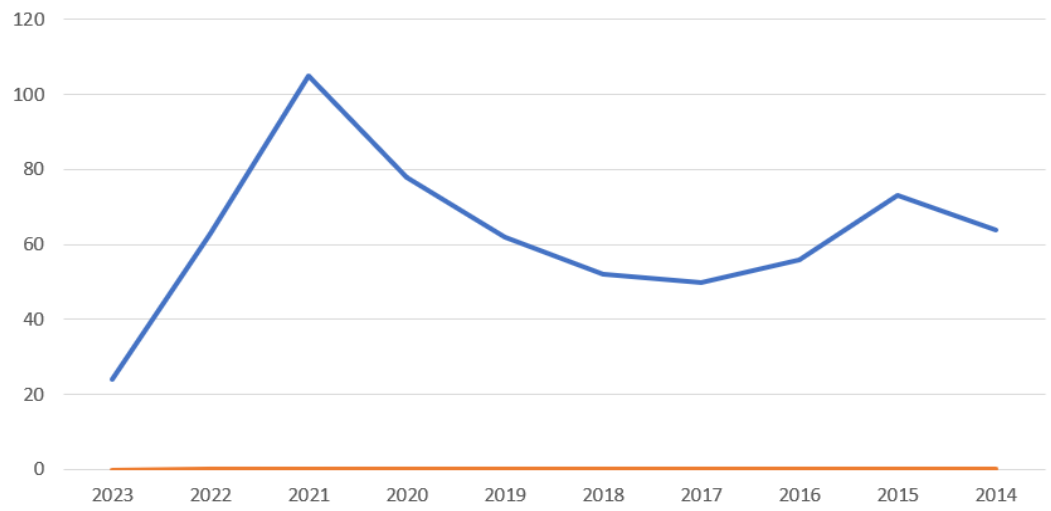
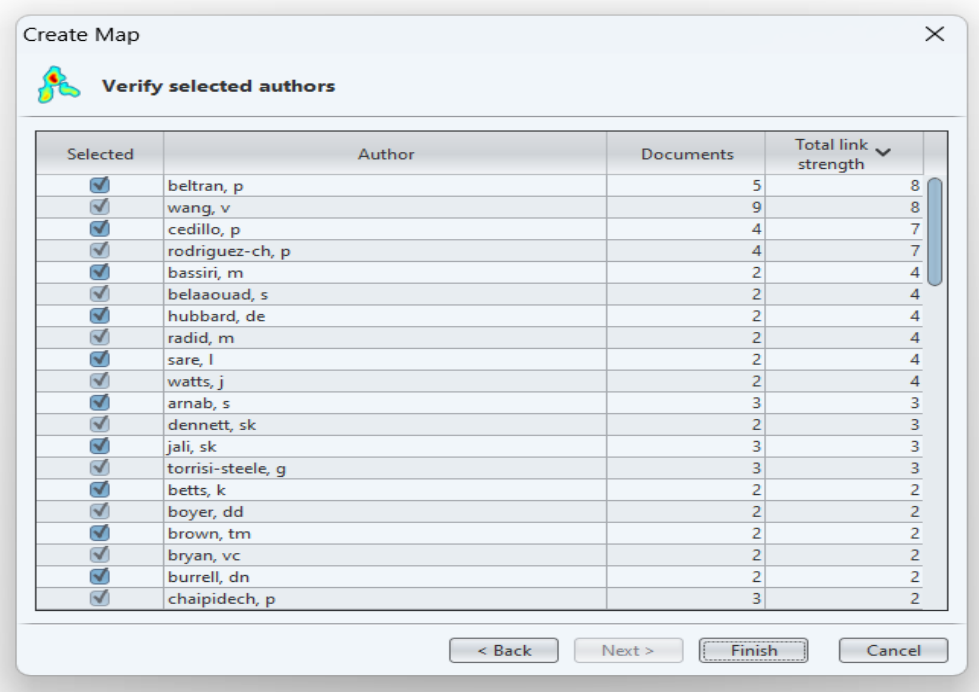


Figure 2. Google scholar-indexed information (Source: Results of personal data processing 2023)

Development map of research publications on technology in the context of adult learning based on co-authorship



Selected	Author	Documents	Total link strength
☑	beltran, p	5	8
☑	wang, v	9	8
☑	cedillo, p	4	7
☑	rodriguez-ch, p	4	7
☑	bassiri, m	2	4
☑	belaaouad, s	2	4
☑	hubbard, de	2	4
☑	radid, m	2	4
☑	sare, l	2	4
☑	watts, j	2	4
☑	arnab, s	3	3
☑	dennett, sk	2	3
☑	jali, sk	3	3
☑	torrisi-steele, g	3	3
☑	betts, k	2	2
☑	boyer, dd	2	2
☑	brown, tm	2	2
☑	bryan, vc	2	2
☑	burrell, dn	2	2
☑	chaipidech, p	3	2

Figure 3. List of authors of research on technology in the context of adult learning on vosviewer (Source: Vosviewer 2023)

After saving the data set in RIS format using metadata from Publish or Perish, the next step is to analyze the dataset using the Vosviewer application by selecting the "data create a map based on bibliographic data" option (Gupta, 2021). The method used to calculate the dataset is complete counting, where the aim is to perform calculations that include all researchers who have conducted research on technology in the context of adult learning. Figure 3 shows that each author has at least two documents in this analysis, and the mapping only visualizes the relationship between researchers and other researchers.

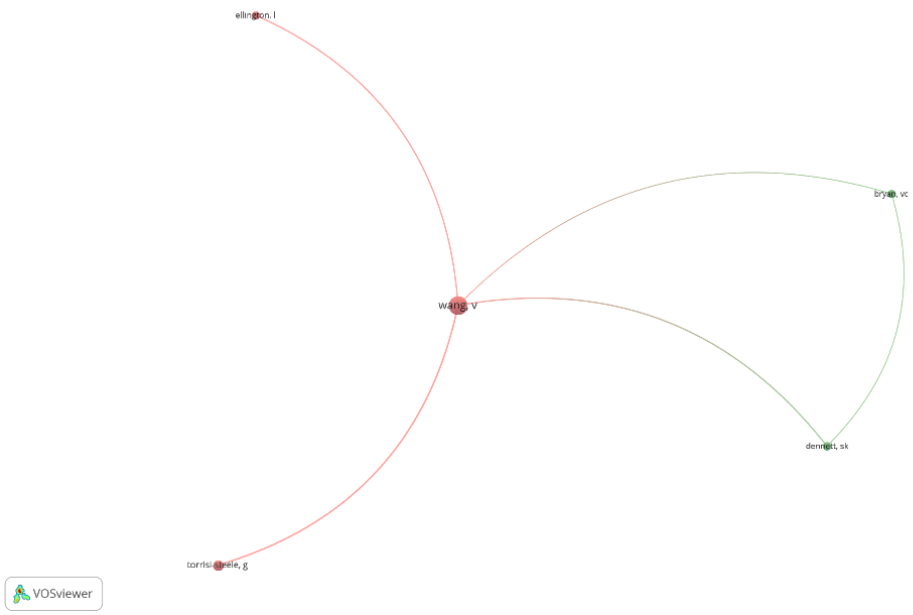


Figure 4. Network visualization on co-authorship (Source: Vosviewer 2023)

Figure 4 displays network visualization in co-authorship, indicated by nodes representing the authors and edges representing the relationship between the authors or researchers. The collection of nodes connected by edges explains the relationship between researchers in research on technology in the context of adult learning. Bibliometric analysis that focuses on researchers or authors shows that Viktor Wang from Liberty University, United States (Gregory et al., 2021; V. Wang et al., 2021) is the center of the network. The network also indicated that there was a relationship or collaboration between Viktor Wang and four other writers, namely Linda Ellington (Kaushik, 2021), Geraldine Torrisi-Steele (Wang & Torrisi-Steele, 2022), Valerie C. Bryan (Moore et al., 2018; Nicolaou et al., 2022), and Susan K. Dennett (Gillespie & Hopgood, 2021; Örs & Titrek, 2018).

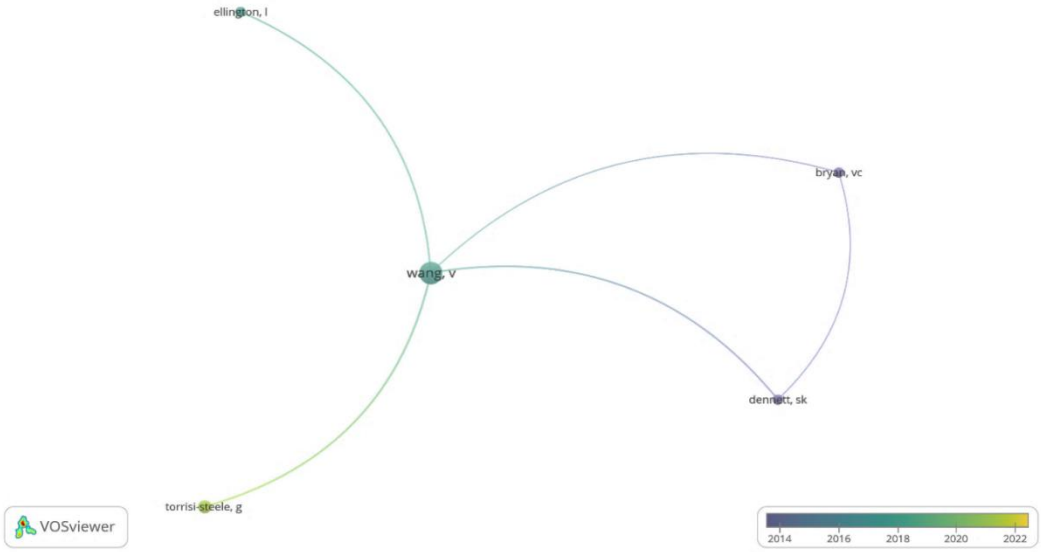


Figure 5. Overlay visualization on co-authorship (Source: Vosviewer 2023)

Figure 5 shows overlay visualization that maps the author's historical footprint in research on technology in the context of adult learning. This mapping is characterized by the presence of nodes that have color variations and edges that connect one author to another. Nodes with a dark color indicate research conducted in a more recent time period, while nodes with a lighter color indicate research conducted in a more recent time period. As an example, in the figure, the node with the darkest color (purple) represents 2014, while the node with the lightest color (yellow) represents 2022. From this analysis, several explanations can be drawn as follows: (1) Research conducted by Valerie C. Bryan and Susan K. Dennett was cited by Viktor Wang's research in their work; this can be seen from the color of Valerie C. Bryan and Susan K. Dennett's research visualization, which is darker than the color of Viktor Wang's research visualization; (2) The research conducted by Viktor Wang is of the same color as Linda Ellington, indicating that the two collaborated on the research; (3) Geraldine Torrisi-Steele cited research conducted by Viktor Wang; this can be seen from the difference in visualization colors between Viktor Wang's research which is much darker than Geraldine Torrisi-Steele's research.

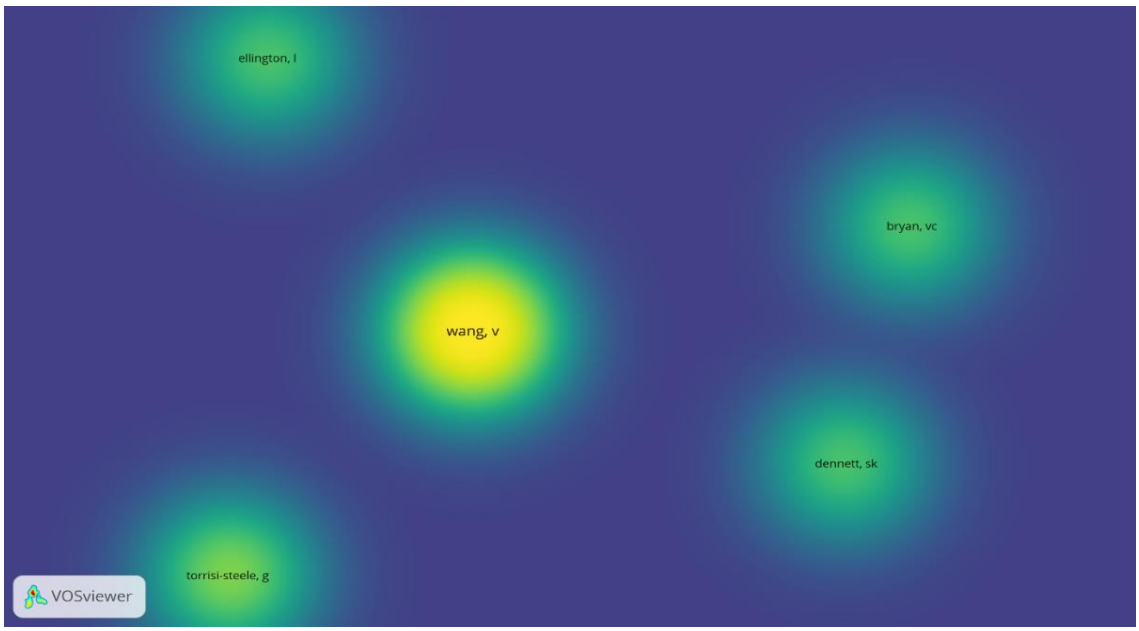


Figure 6. Visualization of density in co-authorship (Source: Vosviewer 2023)

Through the density visualization shown in Figure 6, the emphasis or group of researchers in the technology field in the context of adult learning can be found. The nodes that have this density indicate a relationship and connection between researchers. In addition, the saturation level of the nodes in the density visualization also reflects how many studies cite other studies. For example, research by Viktor Wang is marked with the brightest node density, indicating that this author has conducted research by quoting several other studies demonstrating collaboration in the technology field in the context of adult learning.

Map of the development of research publications in the field of technology in the context of adult learning based on co-occurrence

After the data set is saved in RIS format using the Publish or Perish metadata, the next step is to analyze the data set using Vosviewer with the option "create a map based on text data." This analysis aims to form networks or relationships between terms based on text data. The terms are extracted from the title and abstract of the dataset, and the method for calculating the dataset is complete counting, which counts the occurrence of terms directly according to technology-related research in the context of adult learning. As a result, 379 documents have a related occurrence, and each term appears in at least three documents.

Bibliometric analysis was performed by visualizing in the form of network, overlay, and density. The purpose of this visualization is to understand the bibliometric network between online journal articles that are in the downloaded metadata. The bibliometric network consists of nodes in the form of circles or circles that represent keywords, while the edges (network nodes) show the relationships between the connected nodes. Mapping and clustering in bibliometric analysis using Vosviewer software complement each other. This mapping provides a detailed description of the structure of the bibliometric network (Waltman et al., 2010). In addition, clustering is also used to provide insight into clustering in bibliometric analysis.

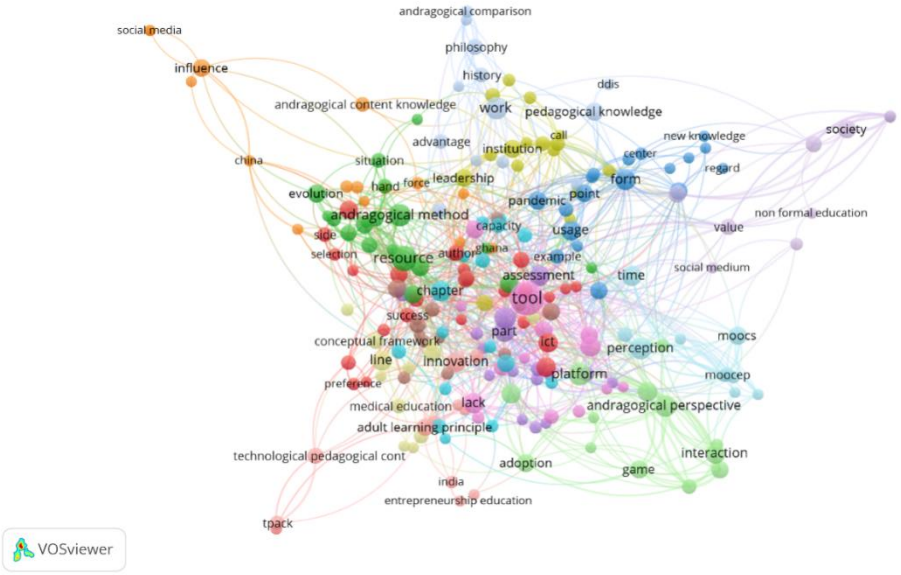


Figure 7. Network visualization on co-occurrence (Source: Vosviewer 2023)

Figure 7 shows a network visualization of co-occurrence which illustrates the relationship between one term and another in research on technology in the context of adult learning from 2014 to 2023. In a dataset of 1,000 articles indexed on Google Scholar, 15 groups (clusters) can be identified based on the color of the nodes of each keyword.

Cluster 1 (red) which includes the terms (terms), namely adult learning process, andragogical training, author, blended, collaboration, device, English, evaluation, expert, ICT, online environment, participation, pilot study, preference, range, recommendation, reflection, relationship, response, selection, side, simulation, success, and the term andragogy. "ICT" (12 links and total link strength of 16) is the term with the most occurrences (9). Cluster 2 (green) includes terms: andragogical method, business, college, comparative analysis, content expertise, emphasis, and evolution, hand, integrating adult learning, integration, lesson, mind, Nigeria, overview, resource, section, situation, technical skills, and technological innovation. The term "resource" (23 links, total link strength is 29) is the term with the most occurrences (15).

Cluster 3 (blue), the terms in this cluster are andragogical focus, andragogical process, andragogical strategy, benefit, center, country, e-learning technology, example, focus, form, learning technology, new knowledge, pandemic, pedagogy andragogy, point, regard, scenario, and usage. "Form" is the term with the most occurrences (10), is a term that has 28 links, and the total link strength is 32. Cluster 4 (lemon yellow) includes terms (terms): andragogy theory, attention, call, comparison, current state, formation, future, institution, leadership, light, nature, period, reality, social justice, theoretical framework, and Ukraine. Of these terms, "institution" has the most occurrences (8) with 12 links, and the total link strength is 16.

Cluster 5 (purple) includes an article, assessment, confidence, digital andragogy, empowerment, essence, Finland, formal education, heutagogical approach, number, paper, part, relevance, technical education, technical university, and technological progress. "Article" is the term with the most occurrences (11) with 23 links, and the total link strength is 29. Cluster 6 (light blue) includes adult educator, capacity, chapter, contribution, graduation student, idea, insight, instrument, leader, ODL, promise, scholar, technological application, thought, transfer, and transformative learning. The term "chapter" has the most occurrences, with 15 links and 17 link strengths.

Cluster 7 (orange) includes the terms andragogical content knowledge, andragogical knowledge, artificial intelligence, china, force, ghana, goal, influence, internet, library, Malcolm Knowles, SDL, social media, and social media technology. The term "influence" (8 links and total

link strength is 10) is the term with the most occurrences (7). Cluster 8 (pear wood brown) includes adult learning experience, andragogical framework, blended learning, creativity, employee, faculty development, inquiry, online professional development, online teaching, possibility, relation, systematic review, technological determinism, transformation, and the United States. "Transformation" is the term with the most occurrences (8), with 18 links and total link strength of 19.

Cluster 9 (pink) includes the terms: andragogical methodology, andragogical principles, distance, distance education, edge technology, experiential learning, feature, lack, order, project, technical knowledge, technological infrastructure, technological support, tool, teaching, and teacher. The term with 27 occurrences is "tool" and is the most common (52 links and 66 total link strengths). Cluster 10 (light brown) includes terms: addition, adult learning principle, andragogical style, availability, entrepreneurship education, India, innovation, online course, respondent, stem education, technological pedagogy, today, TPAK, and TPD. "Innovation," with 17 links and 18 total link strengths, is the term with the most occurrences, namely 10.

Cluster 11 (light green) includes terms: adoption, andragogical perspective, andragogy principle, consideration, game, game technology, interaction, older adult, older person, participant, platform, survey, and technological development. The term with 12 occurrences is the most "platform," with 19 links and 28 total link strengths. Cluster 12 (light blue) includes terms: ability, advantage, andragogical comparison, DDIS, gain, history, pedagogical knowledge, philosophy, professional training, strength, technical issue, update, and work. The most frequent occurrence is 12, found in the term "work," with 16 links and 20 total link strengths. Cluster 13 (gray) includes acknowledgment, andragogical adult, communication, conceptual framework, continuum, curriculum design, effective adult learning, line, medical education, mobile learning, mobile technology, and transition. "Line" has the most occurrences (9), with ten links and 13 total link strengths.

Cluster 14 (purple) includes the terms: andragogical concept, continuous professional, economy, a key element, non-formal education, practical application, social medium, society, technological evolution, and value. In this cluster, "society" has eight links, and 24 total link strengths have the most occurrences, namely 8. Furthermore, cluster 15 (light blue) includes andragogical techniques, creation, elderly people, ICTS, massive open online courses, MOOCEP, MOOCS, perception, systematic literature review, and time. "Perception," with 21 links and 30 total link strengths, has 11 occurrences and is the most in this cluster.

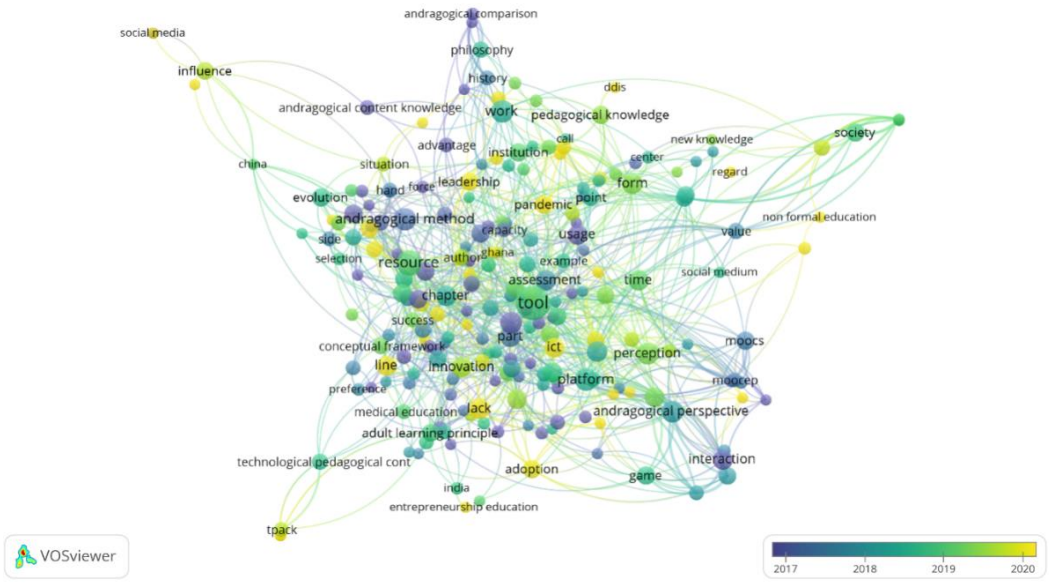


Figure 8. Overlay visualization on co-occurrence (Source: Vosviewer 2023)

After identifying mapping and clustering using network visualization, the next step is mapping and clustering research trends on technology in adult learning based on the year of research publication. Information obtained from the results of the overlay visualization in Figure 7 is used to identify and detect the state-of-the-art (current state) of research in this field within the 2014–2023 timeframe.

Bibliometric analysis was performed using Publish or Perish metadata imported into Vosviewer software, which resulted in overlay visualization. In this visualization, the colors on the nodes represent keywords that indicate the year of publication. For example, if the keyword "andragogical method" is noded purple, the article with that keyword was published in 2017–2018. Another example is the term "platform," depicted with a light green node, indicating that researchers only discussed the term in 2018–2019 in the context of research on technology in adult learning. Furthermore, the keyword "adoption" has a yellow node color. The term "andragogical method" has become an important part of the technology field in adult learning because this method is inseparable from adopting technology platforms in various situations and adult learning activities.

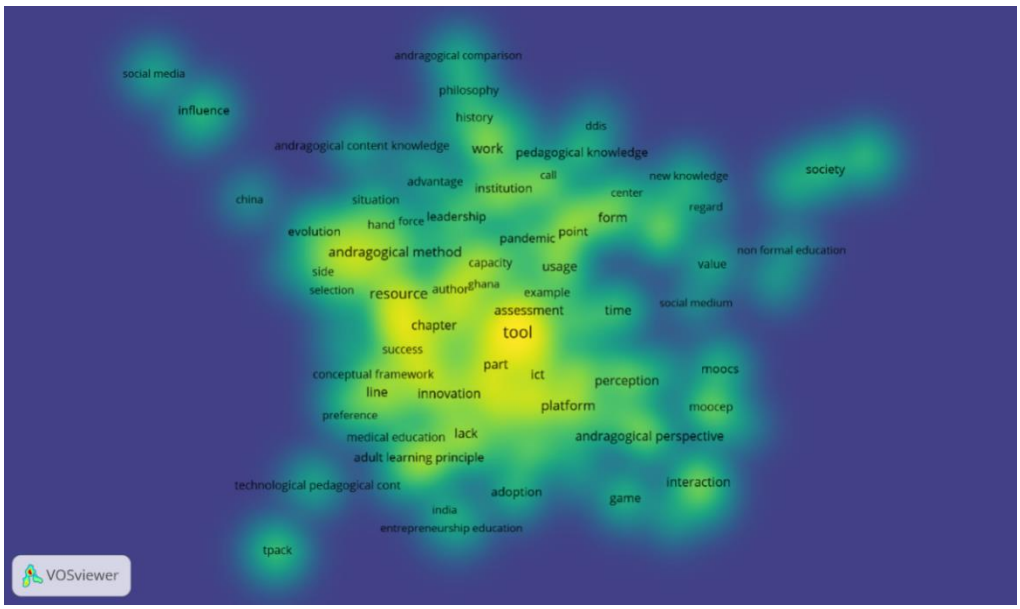


Figure 9. Density visualization on co-occurrence (Source: Vosviewer 2023)

Next, a bibliometric analysis was performed using density visualization. From the visualization results in Figure 8, it can be identified that some areas have a high density between one node and another. The saturation level identified by the number of keywords is marked in yellow, indicating that the area is a topic that has been extensively researched and indexed by Google Scholar. Examples are the keywords "tool", "andragogical method", and "resource".

Meanwhile, the nodes marked with dark colors and estrangement indicates that the topic has not been studied much. This creates opportunities for further research on these topics, such as the keywords "andragogical content knowledge" and "technological pedagogical content". Through bibliometric analysis using density visualization, it can be seen that research on technology in adult learning, especially related to technology and andragogical content knowledge, still needs further research. This density visualization exhibits low strain and intensity, illustrating that the area requires more attention in research and development.

CONCLUSION

To gain an understanding of research developments in the field of technology in the context of adult learning based on co-authorship and co-occurrence, a bibliometric analysis was performed using Vosviewer software. The previous data set was collected through Publish or Perish metadata indexed by Google Scholar, with a limit of 1,000 online publications. Bibliographic mapping using Vosviewer's network, overlay, and density views revealed publication changes in adult education technology research between 2014 and 2023. Only 628 of Google Scholar's indexed 1,000 published publications provide data on the year and publisher. Meanwhile, the publishing year or publisher is unknown for 308 publications. In 2021, there were 105 new publications in this discipline, representing a rise of 16.7 present. Meanwhile, 2017 had the fewest releases (50 papers, or 8%) since 2023 (which has not reached 12 months). The development of research on technology in the context of adult learning is in line with new findings in the study of technology and adult learning. Research on adult learning is evolving, supported by technology platforms. However, there are still very few studies that highlight topics in the fields of technology and andragogical content knowledge, so there are still opportunities for other researchers to develop trends on this research topic.

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