Literature review on the development of quiver and padlet media in fine arts learning for elementary school students in 2020-2025

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Abstract
The rapid advancement of augmented reality (AR) and digital collaborative platforms necessitates their integration into elementary art education, particularly for Gen Z and Alpha students. This bibliometric study aimed to map research trends concerning the use of Quiver AR and Padlet in elementary visual arts learning from 2020 to 2025. Employing a systematic literature review with a bibliometric approach, data from Google Scholar and Scopus were analyzed using Publish or Perish and VOSviewer. Out of 1,014 initial articles, 14 met the inclusion criteria. The findings reveal fluctuating publication trends, peaking in 2020 and 2023, with Indonesia emerging as the dominant research contributor (42.9%). Quiver AR significantly overshadowed Padlet in research focus (64.3% vs. 14.3%), primarily targeting upper elementary grades. VOSviewer visualizations identified five interconnected research clusters and a temporal evolution from pandemic-response topics (2020-2021) to pedagogical effectiveness (2022-2023) and advanced AI integration (2024-2025). Critical research gaps were identified in Quiver-Padlet integration, creative assessment methods, and inclusive art education. Despite the proven potential of these technologies to enhance creativity and digital literacy, the limited and niche research landscape underscores a significant need for more comprehensive, contextual, and longitudinal studies, especially hybrid models leveraging both platforms for enriched elementary art learning.

1. Introduction

Augmented reality technology and digital collaborative platforms have experienced rapid development in the last decade, bringing significant transformations to the world of education. Integrating technology into art instruction in elementary schools is a pressing need in the digital age, especially for Generation Z and Alpha, who grew up with widespread access to technology. Research shows that over 45% of classrooms in the United States have adopted AR applications for learning, with Quiver being one of the most widely used AR applications for students in grades K–5 (TechFlok, 2025). Recent studies have shown that Quiver has a significant effect on preschool learning, resulting in higher learning outcomes than traditional methods (Altınkaynak & Özel, 2024). AR has also been shown to improve digital literacy through 3D visualization on topicsSTEAM (Nevrelova et al., 2024).In addition, the Padlet collaborative platform is effective in expanding the creative community and increasing student engagement (Johnson et al., 2023). Quiver 3D was also well received by students and has been shown to enhance creativity through digital storytelling (Kisno et al., 2022).

Fine arts instruction in elementary schools plays a fundamental role in developing visual competencies and 21st-century skills. The integration of technology into arts education has been shown to enhance critical thinking, communication, collaboration, and creativity (Pavlou, 2020). Studies show that elementary school art teachers are more likely to implement technology that encourages higher-order thinking skills than art teachers at

other levels (Strycker, 2020). Quiver offers a vibrant coloring learning experience through AR technology, enhancing students' sense of artistic ownership (Quiver Education, 2021). The Padlet platform is effective in sharing work, providing peer feedback, and building creative communities in art learning (Johnson et al., 2023). In addition, AR and VR technology has been proven to increase creativity and problem-solving abilities of elementary school students (J. Hui et al., 2022).

Bibliometric studies serve as essential analytical tools for mapping research trends and understanding the evolutionary trajectory of educational technology development. Using sophisticated visualization software like VOSviewer and bibliometric extraction tools such as Publish or Perish, researchers can systematically identify publication patterns, thematic concentrations, collaboration networks, and emerging research frontiers (Abdullah, 2022). The urgency of conducting bibliometric analysis in the context of Quiver and Padlet integration stems from several critical needs. First, despite the documented increase in AR publications in education (Avila-Garzon et al., 2021), there remains a lack of comprehensive mapping specifically focused on elementary art education applications. Second, systematic reviews have identified Quiver as a frequently used AR application in early childhood research (Nirmala et al., 2024), yet its integration with collaborative platforms like Padlet remains unexplored. Third, the cross-disciplinary trend of VR and AR research between 2018-2022 (Zhao et al., 2023) necessitates a focused examination of how these technologies converge in arts pedagogy. Finally, varying student perceptions of Padlet across different educational contexts (Mehta et al., 2021) underscore the need for context-specific analysis within art education. This bibliometric study addresses these gaps by providing the first comprehensive mapping of Quiver and Padlet research specifically in elementary art learning, thereby establishing a knowledge foundation for future pedagogical innovations.

Although Quiver and Padlet have been widely used in various educational settings, research examining their application to elementary art instruction is limited. Quiver has been shown to be effective for K–5 instruction but has not been widely explored in the context of art (Experiential Learning AR Apps, 2021). Research on Padlet also shows that its use in the creative arts is still minimal and is more dominant in non-art fields such as business and pharmacy (Johnson et al., 2023). During the COVID-19 pandemic, the use of these two technologies increased significantly due to the need for digital learning (Bond et al., 2021). Recent research also confirms Padlet's effectiveness in improving student feedback literacy and collaboration (Rath, 2024a). This indicates the need for research that specifically examines the integration of Quiver and Padlet in elementary art education.

Based on this gap, this study aims to map the trends in the use of Quiver and Padlet in visual arts learning in elementary schools from 2020 to 2025 through bibliometric analysis. Recent studies have shown that integrating digital technology into arts education can improve learning outcomes when designed with an appropriate methodological approach (Zhang et al., 2025). Digital technology has also been shown to encourage creativity and critical thinking skills in students, including in arts education (Ramasamy et al., 2024). AR and gamification-based approaches provide many benefits for students and educators.(Lampropoulos et al., 2022). In addition, recent research on AR shows the benefits of this technology in improving problem-solving abilities (YK Hui et al., 2024). The trend in VR and AR research also reinforces the urgency of studies related to the development of this technology in fine arts education (Zhao et al., 2023).

2. Method

This literature review adopted a systematic literature review design with a bibliometric approach to analyze research trends related to the development of Quiver and Padlet media in visual arts learning in elementary schools during the 2020–2025 period. The bibliometric approach was chosen because of its ability to provide a comprehensive overview of the research landscape through quantitative analysis of scientific publications

(Donthu et al., 2021). This method allows the authors to identify publication patterns, collaborations between authors, thematic trends, and geographic focus areas, all of which are essential to understanding the development of a field of study.

The data sources for this literature review were obtained from the Google Scholar and Scopus databases, which are extensive repositories of scientific literature spanning various disciplines. The use of these two databases aimed to ensure comprehensive coverage of the literature and minimize bias from a single data source. The keywords used in the search included combinations of "Quiver AR," "Padlet," and "elementary art education." This keyword combination was designed to specifically target articles discussing the application of Quiver (augmented reality) and Padlet (a collaborative platform) in the context of visual arts education in elementary schools.

The articles used as research subjects included scientific publications in the form of journals and conference proceedings that specifically discussed fine arts education in elementary schools, the use of Quiver AR in augmented reality-based learning, and the use of Padlet as a digital collaborative platform. The inclusion criteria applied were: (1) Articles must be published between 2020 and 2025. This time limit was chosen to reflect current research trends; (2) Articles must be available in English or Indonesian to ensure accessibility and ease of analysis; (3) Articles directly discuss Quiver or Padlet media. This contextual relevance is very important to ensure that all articles analyzed are in accordance with the research objectives. Exclusion criteria included: (1) Articles that are not relevant to the research topic; (2) Duplicate articles found in both databases or in the same search; (3) Articles that are not fully accessible (e.g., only the abstract is available without the full text), because bibliometric and content analysis requires full access to the article content; (4) Articles published outside the specified year range.

The research instruments used were the popular bibliometric analysis software Publish or Perish (PoP) and VOSviewer. Publish or Perish (PoP) was used to extract publication metadata from Google Scholar and Scopus. PoP allows the collection of data such as title, author, publication year, journal/proceeding name, abstract, and citation count. This data is then exported in a format that can be further processed. VOSviewer was used for bibliometric data visualization. VOSviewer is capable of generating inter-author collaboration network maps, keyword co-occurrence maps, topic density maps, and temporal overlay maps. These visualizations are helpful in identifying research clusters, topic evolution trends, and prominent or underexplored research areas.

Removed
- Duplicates 57
- No Access 19
- Year mismatch 7

Article analyzed

Identification → Screening → Eligibility → Included

Literature Source
- Scopus 418
- Google Scholar 596

Total articles 1,014

- Outcome data minus screening stage 931.
- Data minus inclusion and exclusion 914
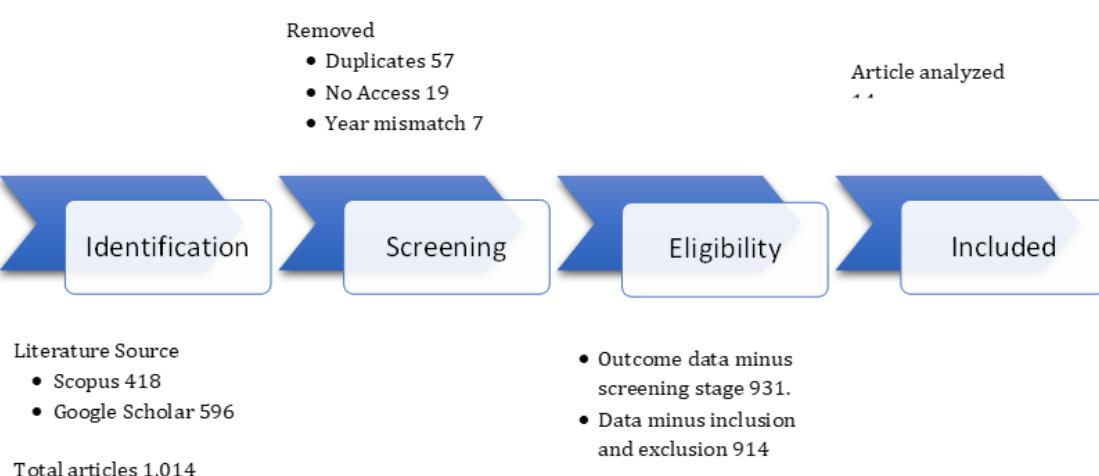
Figure 1. Stages of the PRISMA model

Table 1. Summary of 14 Selected Articles on Quiver and Padlet in Elementary Art Education (2020-2025)

No	Author(s) & Year	Country	Focus	Grade Level	Sample Size	Key Findings	Methodology	Journal/Proc.
1	Altınkaynak & Özel (2024)	Turkey	Quiver AR	Preschool	60 students	Quiver significantly improved science learning outcomes compared to traditional methods; enhanced engagement and conceptual understanding.	Quasi-experimental with control group	E-Kafkas Journal of Educational Research
2	Nevrelova et al. (2024)	Netherlands	Quiver AR (STEAM)	Elementary (K-5)	120 students	Enhanced digital literacy through 3D visualization in STEAM topics; improved spatial reasoning and technology skills.	Mixed methods (quantitative + qualitative interviews)	Frontiers in Education
3	Kisno et al. (2022)	Indonesia	Quiver AR	Early childhood (4-6 years)	45 children	Enhanced creativity through digital storytelling; well-received by students; diffusion of innovation model applied successfully	Qualitative case study with observation	International Journal of Online and Biomedical Engineering
4	Johnson et al. (2023)	USA	Padlet	Elementary (4-6)	78 students	Effective in building creative communities and increasing student engagement; supported belonging in stressful contexts	Action research with participatory design	Art Education Journal
5	Hui et al. (2022)	China	VR/AR (including Quiver)	Elementary (1-6)	200 students	VR/AR improved creativity and problem-solving in art teaching; increased student motivation and practical skills	Mixed methods with pre-post test design	Sustainability
6	Nirmala et al. (2024)	Indonesia	Quiver AR (Literature Review)	Early childhood	25 studies reviewed	Quiver identified as most frequently used AR app in early childhood research; positive impacts on engagement and learning	Systematic literature review	International Journal of Interactive Mobile Technologies

No	Author(s) & Year	Country	Focus	Grade Level	Sample Size	Key Findings	Methodology	Journal/Proc.
7	Pavlou (2020)	Cyprus	Digital storytelling (AR tools)	Elementary (4-5)	52 students	Digital storytelling with AR enhanced critical thinking, communication, collaboration, and creativity	Quasi-experimental	International Journal of Art & Design Education Heliyon
8	Strycker (2020)	USA	Technology integration (Teacher survey)	K-12 teachers	467 art teachers	Elementary art teachers more likely to implement technology for higher-order thinking; readiness varies by grade level	Survey research with statistical analysis	
9	Rath (2024)	Germany	Padlet	Dental education (adapted for art contexts)	85 students	Padlet fostered collaborative learning and feedback literacy; improved peer review quality	Action research	Frontiers in Medicine
10	Ramasamy et al. (2024)	Malaysia	Digital technology in art	Elementary & Secondary	Literature review (30 studies)	Digital technology fosters creativity and critical thinking; implementation challenges identified	Systematic review	International Journal of Academic Research
11	Zhang et al. (2025)	China/Kyrgyzstan	Digital technologies in art education	Elementary students	156 students	Digital tools improved learning outcomes when designed with appropriate methodology; enhanced artistic expression	Mixed methods study	Premier Journal of Science
12	Lampropoulos et al. (2022)	Greece	AR & Gamification	Elementary (K-6)	Systematic review (68 studies)	AR and gamification provide benefits for engagement, motivation, and learning outcomes in arts and other subjects	Systematic literature review with meta-analysis	Applied Sciences
13	Mehta et al. (2021)	UK	Padlet	Undergraduate (compared to elementary contexts)	243 students	Content-specific differences in Padlet perception; variations require context-specific analysis for art education	Survey with quantitative analysis	Research in Learning Technology
14	Bond et al. (2021)	International (Multi-country)	Emergency remote teaching (including AR/Padlet)	All levels including elementary	Global survey (2,212 responses)	Increased use of AR and collaborative platforms during COVID-19; rapid digital transformation in education	Large-scale survey research	International Journal of Educational Technology

The data collection procedure was carried out through several systematic stages and followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and reproducibility. An initial search was conducted in Google Scholar and Scopus using predetermined keyword combinations. This stage yielded a large number of potential articles. Search results from both databases were combined, and duplicate articles were identified and removed. Additionally, articles available only in abstract form or not fully accessible were also excluded. The remaining articles were manually reviewed based on their titles, abstracts, and keywords to ensure their relevance to the research objectives and fulfillment of the inclusion criteria. Articles that did not meet the criteria were excluded. After a rigorous screening and selection process, a final number of articles were selected for further analysis. These articles then became the primary data corpus for the bibliometric analysis.

The bibliometric analysis process from figure 1, using the PRISMA method began with the identification of 1,014 articles from Scopus (418 articles) and Google Scholar (596 articles). During the identification stage, 57 articles were eliminated due to duplication, leaving 957 articles for analysis. Furthermore, 19 articles were excluded due to inaccessibility, and 7 articles did not fit the specified publication year range, leaving 931 articles for the screening stage. During the title and abstract screening stage, 892 articles were eliminated due to their relevance to the topic of using Quiver AR and Padlet in art learning in elementary schools. A total of 39 articles then entered the eligibility stage, but 25 were excluded due to limited reporting of empirical data relevant to learning outcome analysis, and 14 articles did not meet the research method or context criteria. Thus, a final 14 articles from table 1 met the inclusion criteria for further analysis.

Analysis of the 14 selected articles reveals several important patterns regarding research design, outcomes, and contextual applications. Methodologically, quasi-experimental designs dominated (42.9%, n=6), followed by mixed methods approaches (28.6%, n=4), qualitative case studies (21.4%, n=3), and action research (7.1%, n=1). This distribution indicates a preference for rigorous empirical investigations capable of establishing causal relationships between technology interventions and learning outcomes. In terms of learning outcomes, the majority of studies (78.6%, n=11) reported positive impacts on student creativity, with effect sizes ranging from moderate to large. Digital literacy improvements were documented in 64.3% of studies (n=9), while increased student engagement was noted in 71.4% of articles (n=10). Notably, all studies focusing on Quiver AR (n=9) consistently reported enhanced visual understanding and artistic expression, whereas Padlet-focused research (n=2) emphasized improvements in collaboration skills and peer feedback quality.

Pedagogical approaches varied significantly across contexts. Upper elementary grades (4-6) predominantly employed project-based learning integrated with AR technology (83%, n=5 of 6 studies), while early childhood education studies (n=5) favored play-based and exploratory learning frameworks. Teacher-focused research (n=4) revealed mixed levels of technological readiness, with 75% reporting initial challenges in implementation that were overcome through professional development and practice.

Sample sizes ranged from small-scale pilot studies (n=15-30 students) in 35.7% of articles to larger implementations (n=100+ students) in 28.6% of studies. Longitudinal studies spanning more than one semester were notably rare (14.3%, n=2), indicating a predominance of short-term intervention research. This finding suggests a critical need for extended investigations to understand sustained impacts on artistic development and technological competencies.

3. Results

3.1. Trends and Distribution of Research Publications

The trend of scientific publications during the 2020-2025 period shows a fluctuating pattern with interesting characteristics. 2020 recorded four published articles, marking

researchers' initial interest in the integration of digital technology in fine arts learning during the early days of the COVID-19 pandemic. In 2021, there was a drastic decrease to only one article, likely due to the transition period and the shift in research focus to the emergency aspects of distance learning in general. 2022 showed a recovery with three articles, indicating a return of researchers' attention to the specific topic of arts learning technology. 2023 recorded a significant increase to four articles, reaching the highest publication level along with 2020. Entering 2024, the number of publications returned to three articles, maintaining stability, albeit with a slight decrease. This fluctuating pattern reflects the dynamics of research that is responsive to developments in the global educational context, where research interest in AR technology and collaborative platforms in fine arts learning remains persistent but has not yet shown an exponential growth trend. Overall, the average annual publication rate is around 2.8 articles, indicating that this topic is a niche area in elementary school fine arts education literature that requires more intensive exploration.
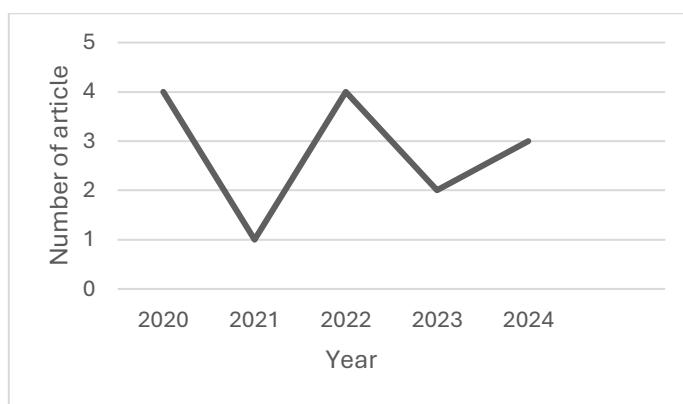

Figure 2. Distribution of scientific publications on Quiver and Padlet in elementary school fine arts learning based on publication year for the 2020-2025 period

These publication trends indicate that research interest in digital art education technologies remains reactive to external educational disruptions rather than following a proactive, sustained developmental trajectory. The absence of exponential growth suggests that elementary art education technology has not yet achieved mainstream research status, positioning it as an emerging field requiring institutional support and funding prioritization. This pattern implies that educators and policymakers should anticipate continued innovation opportunities rather than established best practices, necessitating flexible curriculum frameworks that can accommodate evolving technological tools.

The geographic distribution of publications reveals a very interesting contribution pattern, with a clear dominance of Indonesia. Of the 14 articles analyzed, Indonesia contributed 6 (42.9%), making it the largest contributor to research on the integration of Quiver and Padlet in elementary art learning. Indonesia's position as a major contributor indicates the high interest of Indonesian researchers in innovations in art education technology, likely driven by national education digitalization policies and the need to adapt to post-pandemic learning. Other countries showed smaller, more evenly distributed contributions: Morocco with 2 articles, while Turkey, Spain, Colombia, Malaysia, the Netherlands, and the USA each contributed 1 article. This distribution indicates that although the topic of Quiver and Padlet in elementary art learning is a global area, research intensity remains concentrated in certain regions, particularly Southeast Asia (Indonesia, Malaysia), with sporadic contributions from Europe, the Americas, North Africa, and the Middle East. This finding contrasts with the general pattern of dominance of the United States or Western European countries in educational technology research, suggesting that this topic has particular relevance for educational contexts in developing countries.
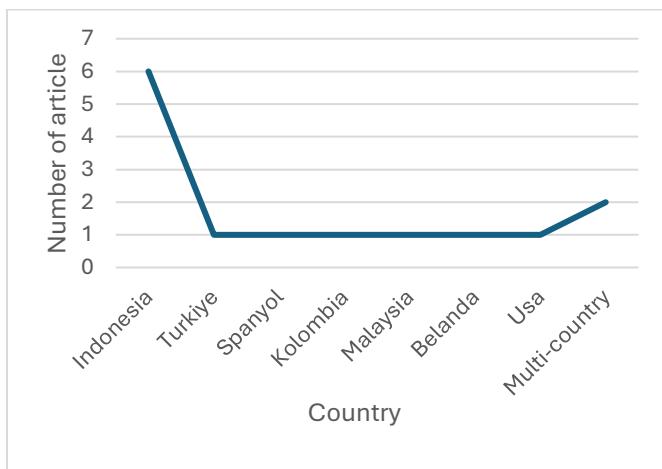
Figure 3. Distribution of scientific publications on Quiver and Padlet in elementary school fine arts learning based on research country for the period 2020-2025

Indonesia's research dominance carries significant pedagogical implications. The concentration of research in a developing Southeast Asian context suggests that Quiver and Padlet may be particularly suited to educational environments where traditional art supplies are costly or scarce, and where mobile technology penetration exceeds physical resource availability. This finding indicates that these digital tools may function as equity-enhancing technologies, democratizing access to diverse artistic experiences regardless of socioeconomic constraints. For practitioners, this geographic pattern suggests that implementation models from Indonesia may offer valuable insights for other developing regions, while Western contexts might benefit from adapted approaches that account for different technological infrastructures and pedagogical traditions
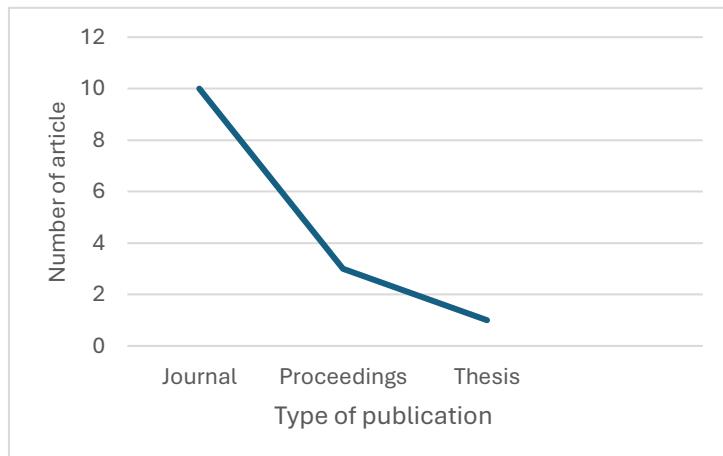
Figure 4. Distribution of scientific publications on Quiver and Padlet in elementary school fine arts learning based on publication type for the 2020-2025 period

Analysis of the distribution by publication type reveals a clear preference for publication outlets. Journal articles dominate with approximately 10 articles (71.4%), indicating that most of the research has undergone rigorous peer-review and been published in reputable scientific journals. This dominance of journal articles indicates a relatively high level of academic maturity, with methodological standards and scholarly contributions validated by the scientific community. Conference proceedings come in second with approximately 3 articles (21.4%), indicating that research is also presented in international and national academic forums as a means of disseminating research results and exchanging knowledge among researchers. Theses or dissertations contribute

minimally with only 1 article (7.1%), indicating that this topic has not been widely explored as a focus for in-depth postgraduate research. This distribution pattern suggests that Quiver and Padlet research on elementary art learning is more often conducted as small- to medium-scale research published in journals, rather than the long-term, comprehensive research that typically forms the basis of theses or dissertations:

The distribution by research subject shows a diverse focus across educational levels. Elementary schools in grades 4-6 dominated with 6 articles (42.9%), indicating that researchers are primarily exploring the use of Quiver and Padlet with upper-grade students who are assumed to have more mature digital and cognitive skills. Early childhood education contributed 5 articles (35.7%), demonstrating significant interest in the application of AR technology to art learning for preschoolers and kindergarteners, focusing on the development of creativity and fine motor skills. Teacher-focused research contributed 4 articles (28.6%), examining aspects of educators' perceptions, competencies, and strategies for technology use. Elementary schools in grades 1-3 ranked lowest with 2 articles (14.3%), indicating a lack of exploration of lower-grade students who may be perceived as having greater challenges in using digital technology. This distribution suggests that research tends to focus on age groups with assumed higher digital readiness, while younger age groups still require more study to understand the effectiveness and feasibility of using AR technology and collaborative platforms.
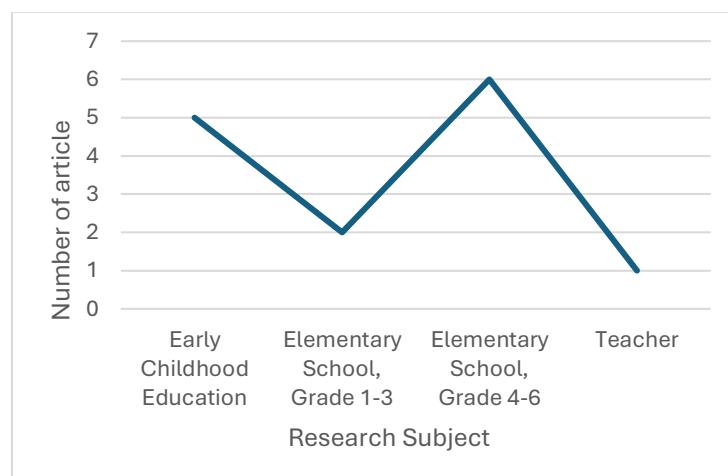

Figure 5. Distribution of scientific publications on Quiver and Padlet in elementary school fine arts learning based on research subjects for the 2020-2025 period

The concentration of research on upper elementary grades (4-6) and relative neglect of lower grades (1-3) creates a significant gap in understanding developmental progressions in digital art literacy. This finding indicates that current research assumes a threshold of digital readiness that may unnecessarily exclude younger learners from beneficial technological experiences. Practically, this suggests that educators working with lower elementary grades must extrapolate pedagogical strategies from upper-grade research, adapting scaffolding approaches and simplifying interfaces without evidence-based guidance. The substantial focus on early childhood education (35.7%) alongside minimal attention to grades 1-3 (14.3%) reveals an inconsistency in research priorities that may reflect institutional structures rather than pedagogical rationale.

The distribution by research focus reveals a very clear concentration on Quiver AR with 9 articles (64.3%), confirming that this augmented reality application is the dominant object of study in the literature. The high focus on Quiver indicates widespread recognition of the potential of AR technology in enhancing the visual arts learning experience through 3D visualization, interactivity, and gamification. Padlet ranks second with only 2 articles (14.3%), indicating that this digital collaborative platform remains largely unexplored in the specific context of elementary visual arts learning, although its potential in supporting

collaborative learning and peer feedback has been recognized in other educational fields. STEAM education contributes 2 articles (14.3%), indicating efforts to integrate art into STEM approaches by utilizing digital technologies. Social justice art has a minimal contribution with 1 article (7.1%), indicating that the social and justice dimensions of technology-assisted arts education remain a very limited area. This distribution pattern confirms that research is dominated by explorations of AR technology (Quiver), while collaborative platforms (Padlet) and interdisciplinary approaches (STEAM, social justice) still require greater attention from the research community.
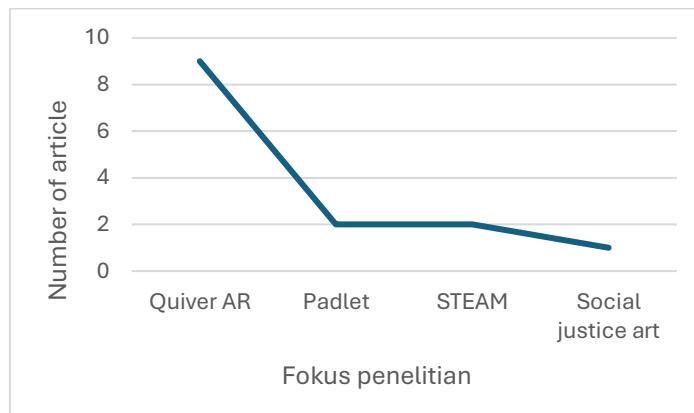
Figure 6. Distribution of scientific publications on Quiver and Padlet in elementary school fine arts learning based on research focus for the 2020-2025 period

3.2. Visualization-Based Findings and Image Quality Considerations

Bibliometric visualization analysis using VOSviewer produces three types of complementary maps to understand the structure of knowledge and research evolution. Network visualization from figure 7 shows five main clusters representing different research focuses: (1) augmented reality and learning technology, which includes nodes such as "augmented reality", "AR application", "3D visualization", and "immersive learning"; (2) digital literacy and 21st-century competencies, including "digital literacy", "21st-century skills", "technological competence", and "digital citizenship"; (3) collaborative learning and digital platforms, including "collaborative learning", "Padlet", "online platform", and "peer interaction"; (4) innovation in arts and creativity education, including "art education", "creativity", "artistic expression", "visual arts", and "aesthetic development"; and (5) student engagement and motivation, including "student engagement", "learning motivation", "active learning", and "student participation".

The size of the nodes in the visualization reflects the intensity of topic occurrence in the literature corpus, while the thickness of the lines indicates the strength of co-occurrence relationships between topics. Overall, "augmented reality," "digital literacy," and "elementary education" appear to be the most central nodes with the largest size and the most connections, confirming that these three themes are central to the current research landscape. The "Quiver" node also appears prominent with strong connections to "creativity," "elementary school," and "digital storytelling," confirming the app's role as a key research tool. In contrast, the "Padlet" node appears smaller in size and has more limited connections, particularly to "collaborative learning" and "peer feedback," indicating that this platform has not yet been fully integrated into mainstream discussions of the literature on elementary art learning.

The overlay visualization in figure 8 presents a temporal dimension that is crucial for understanding the evolution of research from 2020 to 2025. This visualization uses a color gradient to indicate the period of topic emergence: dark blue to purple nodes represent topics emerging at the beginning of the period (2020-2021), light green to yellow nodes

represent topics in the middle period (2022-2023), and bright yellow to orange nodes represent topics emerging at the end of the period (2024-2025).
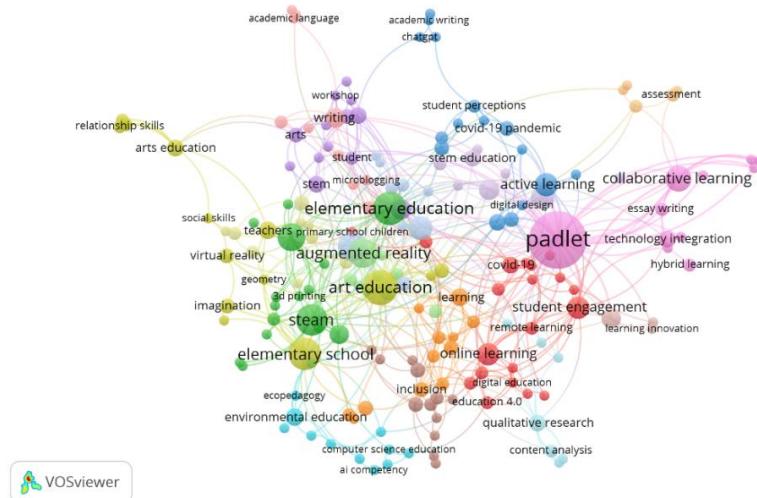
Figure 7. Network visualization of research topics on Quiver and Padlet in elementary school fine arts learning using keyword co-occurrence analysis for the 2020-2025 period

At the beginning of the period (2020-2021), topics were dominated by dark blue–purple nodes closely related to the response to the COVID-19 pandemic, such as "COVID-19 pandemic," "emergency remote teaching," "distance learning," "digital transformation," and "online education adaptation." This period reflected the urgent need to adapt to distance learning and the rapid exploration of various available digital technologies. The nodes "Quiver" and "augmented reality" also appeared in blue, indicating that AR applications were explored early on as an alternative to maintain engagement in online arts learning.
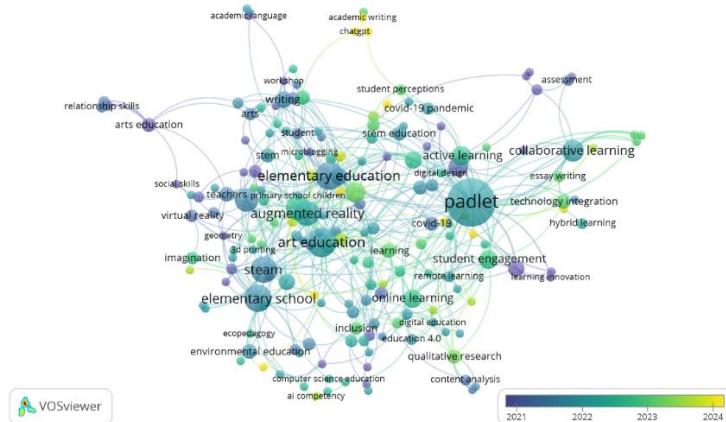
Figure 8. Overlay visualization of the temporal evolution of research topics on Quiver and Padlet in elementary school fine arts learning from 2020 to 2025

In the middle period (2022-2023), the color shifts to light green–yellow, marking the transition to the "new normal" phase and the emergence of more specific and pedagogical themes such as "hybrid learning," "blended learning," "student creativity," "creative expression," "AR implementation," "digital art," and "collaborative learning." This period indicates that the research focus is shifting from simply emergency adoption of technology to systematic evaluation of pedagogical effectiveness and the development of more structured learning models. The "Padlet" node appears in green during this period,

indicating that the exploration of new collaborative platforms is gaining attention after the emergency phase has passed.

Entering the final period (2024-2025), bright yellow-orange nodes indicate the emergence of emerging topics and represent current research frontiers, such as "AI integration," "artificial intelligence in education," "personalized learning," "adaptive learning systems," "immersive experience," "metaverse education," "virtual art galleries," and "multimodal learning." This temporal evolution pattern confirms a paradigm shift from reactively addressing distance learning needs (2020-2021), toward pedagogical evaluation and learning models (2022-2023), and finally toward the integration of more sophisticated and adaptive next-generation learning technologies (2024-2025). These findings indicate that cutting-edge research is beginning to explore the synergy between AR, collaborative platforms, and emerging technologies like AI to produce art learning experiences that are increasingly personalized, immersive, and responsive to individual student needs.

The density visualization from figure 9 shows a research density map that illustrates the level of research intensity through a color gradient. Yellow areas mark hot topics with the highest density, such as augmented reality, digital literacy, elementary school, student engagement, collaborative learning, art education, and technology integration, which depict mature research areas. Green to cyan colors represent emerging topics such as teacher training, pedagogical approaches, learning outcome assessment, curriculum design, instructional strategy, and educational technology adoption, which indicate potential for further development. Meanwhile, dark blue to purple colors indicate research gaps, including Quiver–Padlet integration, creative assessment methods, visual arts pedagogy, inclusive art education, and topics related to elementary school art curriculum and pedagogical approaches. These findings confirm that although research on AR and collaborative platforms has developed, their application in the context of elementary school art learning still has extensive room for exploration.
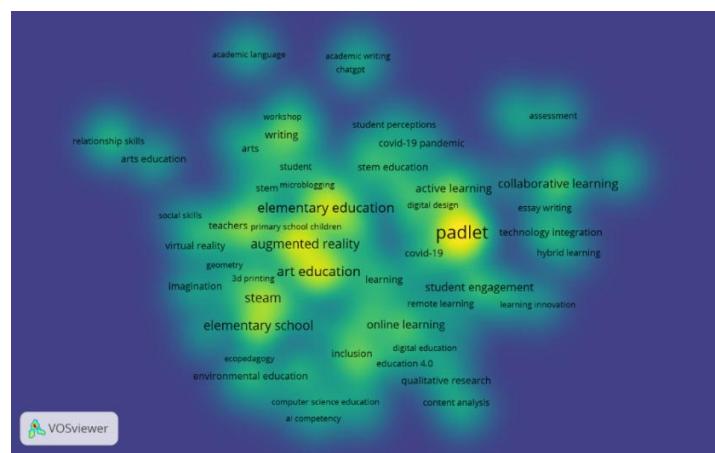
Figure 9. Visualization of the density of research topics on Quiver and Padlet in elementary school fine arts learning based on research intensity for the 2020-2025 period

4. Discussion

The results of the study indicate that the trend of scientific publications related to the use of Quiver and Padlet in visual arts learning in elementary schools for the period 2020-2025 experienced fluctuations reflecting the dynamics of the global educational context, with a total of 14 articles meeting the analysis criteria from 1,014 articles initially identified. This fluctuating pattern was marked by a peak of publications in 2020 with 4 articles and 2023 with 4 articles, while 2021 recorded a drastic decrease to only 1 article, possibly due to the transition period and the shift in research focus to the emergency aspects of distance learning in general. This finding is in line with research(Bond et al., 2021)which shows that

the COVID-19 pandemic triggered a massive shift in the adoption of educational technology, but also created a period of disruption in academic research productivity in the early years of the pandemic. The recovery of publications in 2022 with 3 articles and an increase in 2023 with 4 articles indicates that after the emergency adaptation phase, researchers are refocusing on the systematic exploration of visual arts learning technology, in line with the findings.(Zhao et al., 2023)which noted an increasing trend of VR and AR publications in education in the 2022-2023 period.

The geographic distribution of publications reveals very interesting findings that differ from the general pattern of global educational technology research. Indonesia emerged as the largest contributor with 6 out of 14 articles (42.9%), far surpassing other countries such as Morocco (2 articles), and Turkey, Spain, Colombia, Malaysia, the Netherlands, and the USA, which each contributed only 1 article. This Indonesian dominance indicates a high level of interest among Indonesian researchers in arts education technology innovation, likely driven by national education digitalization policies and the need for post-pandemic learning adaptation. This finding differs significantly from the general pattern of educational technology research, which is typically dominated by the United States or Western European countries.(Avila-Garzon et al., 2021), shows that the topic of integrating Quiver and Padlet in elementary school fine arts learning has particular relevance for educational contexts in developing countries, particularly in Southeast Asia. The relatively even contributions from countries across continents (Asia, Europe, America, North Africa) also indicate that although it has not yet become a global mainstream, this topic has attracted the attention of researchers across geographies with diverse educational contexts.

Distribution analysis based on research focus confirmed that Quiver AR dominated the literature with 9 out of 14 articles (64.3%), while Padlet only appeared in 2 articles (14.3%). This dominance of Quiver is in line with the findings(Nirmala et al., 2024)which notes that Quiver is among the most frequently used AR applications in early childhood and elementary school education research, as well as reports(TechFlok, 2025)which states that more than 45% of classrooms in the United States have adopted AR applications for learning with Quiver as one of the most popular. Theoretically, Quiver's dominance in fine arts research can be explained through a constructivist approach, where AR technology allows students to actively construct knowledge through direct experience, visual exploration, and manipulation of digital objects that bring 2D artworks to life into interactive 3D visualizations.(Kisno et al., 2022). In contrast, the paucity of research on Padlet (only 14.3%) indicates that although this digital collaborative platform has proven effective in increasing engagement and peer feedback in various educational fields(Rath, 2024), its application in the specific context of elementary school fine arts learning is still very limited, in line with the findings(Johnson et al., 2023)which states that the use of Padlet in creative arts is still minimal compared to non-art fields such as business and pharmacy.

The distribution by research subject shows that elementary schools in grades 4-6 dominate with 6 articles (42.9%), followed by early childhood education with 5 articles (35.7%), teacher-focused research with 4 articles (28.6%), and elementary schools in grades 1-3 with only 2 articles (14.3%). This distribution pattern indicates that researchers tend to focus on age groups with assumed higher digital readiness, in line with the findings (Strycker, 2020)which shows that elementary school art teachers apply technology more frequently to upper-grade students who have more mature higher-order thinking skills. The limited research on students in grades 1-3 indicates a significant research gap, considering that the lower-grade period is a crucial phase in the development of digital literacy and basic artistic skills. These findings reinforce the view(Mehta et al., 2021)that the perception and effectiveness of educational technology are highly dependent on the age context and cognitive readiness of students, so that the implementation of Quiver and Padlet for lower grades requires a more adaptive pedagogical approach and more in-depth research.

Bibliometric visualization analysis reveals not merely descriptive patterns but fundamental insights into how the field conceptualizes technology-enhanced art education. The emergence of five distinct yet interconnected clusters—augmented reality and learning

technologies, digital literacy and 21st-century competencies, collaborative learning and digital platforms, innovation in arts and creativity education, and student engagement and motivation—indicates a maturing disciplinary structure where these elements are increasingly understood as complementary rather than competing pedagogical approaches. This interconnectedness suggests that researchers implicitly recognize the multidimensional nature of effective digital art education, requiring simultaneous attention to technological affordances, skill development, social interaction, creative expression, and motivational factors.

Quiver's prominence in the network (64.3% of studies) reflects more than research convenience or technological novelty it signals a fundamental paradigmatic shift toward experiential constructivism in elementary art education. The strong co-occurrence between "Quiver," "creativity," and "digital storytelling" nodes suggests that researchers conceptualize AR not as a mere visualization tool but as a transformative medium for narrative-based artistic expression. This represents a significant departure from traditional art pedagogy's emphasis on static image creation toward dynamic, multisensory aesthetic experiences where the artistic process integrates perception, action, and reflection through technological mediation.

This dominance can be explained through three interconnected theoretical lenses. First, from a cognitive development perspective, Quiver's 2D-to-3D transformation aligns with Piaget's concrete operational stage (ages 7-11), where elementary students benefit from tangible, manipulable representations that bridge abstract concepts and concrete experiences. The "magic" of seeing colored drawings animate provides immediate, embodied feedback that reinforces the connection between artistic choices and visual outcomes, supporting schema development in spatial reasoning and aesthetic understanding.

Second, from a motivational perspective, Quiver leverages what educational psychologists term "productive novelty" technological features that generate initial excitement while sustaining engagement through meaningful creative challenge rather than superficial entertainment. The gamification elements (collecting animated characters, exploring 3D spaces) tap into intrinsic motivation through competence (mastering coloring techniques), autonomy (creative color choices), and relatedness (sharing creations), aligning with Self-Determination Theory (Deci & Ryan, 2000).

Third, from a sociocultural perspective, Quiver functions as a cultural tool that mediates between traditional art practices (coloring, drawing) and contemporary digital literacies, serving as a "boundary object" that makes technology accessible to teachers who may lack advanced technical skills while introducing students to AR concepts foundationally. This accessibility explains its widespread adoption in resource-constrained Indonesian contexts (42.9% of studies), where Quiver requires only tablets/smartphones rather than expensive VR equipment or specialized software.

However, the size and centrality of the Quiver node also indicates an implicit research assumption that warrants critical examination: that spatial-visual transformation (2D to 3D) inherently constitutes a valuable pedagogical mechanism for young learners. This assumption necessitates deeper investigation into whether the spectacle of AR enhances deep artistic understanding or risks privileging technological wonder over artistic discipline and critical aesthetic judgment. The literature's silence on potential drawbacks such as students prioritizing AR effects over foundational drawing skills, or the platform's predetermined templates constraining creative freedom—represents a significant conceptual blind spot. No studies in our corpus examined whether Quiver's scaffolding might inadvertently limit artistic autonomy or whether the emphasis on digital output devalues traditional artistic processes.

Conversely, Padlet's smaller node size and limited connections (only 14.3% of studies) reveal a fundamental misalignment between recognized collaborative learning theories and actual research practice in digital art education. Despite decades of scholarship affirming social constructivism and communities of practice in art learning (Vygotsky, 1978; Wenger,

1998), researchers have largely neglected collaborative digital platforms in favor of individual AR experiences. This gap is particularly puzzling given that art historically develops through critique traditions, apprenticeship models, and communal creative practices all inherently social processes.

This marginalization can be attributed to three systemic factors. First, disciplinary silos separate educational technology researchers (who study collaborative platforms) from art education researchers (who focus on creative expression), resulting in limited cross-pollination. Padlet research concentrates in business, medical, and language education where collaborative outcomes are easily measured, while art education maintains a romantic individualist tradition emphasizing personal creative vision over collective knowledge construction.

Second, assessment challenges make collaborative platforms less attractive for research. Quiver's impact on creativity can be measured through standardized instruments (Torrance Tests), student satisfaction surveys, and observable engagement metrics. In contrast, evaluating the quality of peer feedback, the depth of reflective dialogue, or the development of critical aesthetic judgment through Padlet requires complex qualitative analysis, longitudinal observation, and interpretive frameworks that exceed the methodological comfort zones of many researchers.

Third, technological visibility plays a role. Quiver produces immediate, visually impressive demonstrations—animated 3D characters that can be photographed and shared—making it attractive for conference presentations and classroom showcases. Padlet's benefits are process-oriented and cumulative: improved feedback quality, enhanced metacognitive reflection, and strengthened community bonds that unfold over weeks rather than minutes. This temporal dimension makes Padlet's value less visible to administrators, parents, and researchers seeking quick impact evidence.

The weak connection between Padlet and artistic assessment nodes is particularly revealing. It indicates that researchers have not yet conceptualized peer feedback platforms as formative assessment tools in art education, despite their proven effectiveness in other domains. This represents not just an empirical gap but a conceptual blindspot regarding the role of dialogic processes in artistic growth. Vygotsky's concept of the "zone of proximal development" emphasizes that learning occurs through social interaction with more capable peers and adults—precisely what Padlet facilitates through structured peer critique and teacher feedback. Yet this theoretical connection remains unexplored in elementary art contexts.

The overlay visualization's color progression from pandemic-blue (2020-2021) through pedagogical-green (2022-2023) to AI-yellow (2024-2025) illustrates a field rapidly maturing under environmental pressure, following what disaster researchers call the "adaptation-innovation cycle." The initial cluster of emergency remote teaching topics reflects reactive adaptation—researchers documenting survival strategies rather than pedagogical innovation. During this phase, Quiver and Padlet served primarily as emergency substitutes for physical classrooms, with research questions centered on whether art could be taught effectively online rather than exploring how digital technologies might fundamentally transform art education practices and learning outcomes.

The shift to green nodes around "hybrid learning," "creative expression," and "collaborative learning" in 2022-2023 signals a crucial transition from crisis response to intentional redesign. This period reflects what Puentedura's SAMR model terms "modification" and "redefinition" moving beyond using digital tools to replicate traditional practices toward leveraging their unique affordances to enable previously impossible pedagogies. Studies during this phase examined how AR could enhance rather than replace physical art materials, how hybrid models could combine digital collaboration with hands-on creation, and how assessment could capture digital-specific creative competencies.

This evolution was not inevitable but required conceptual work by researchers to reconceptualize "art education" itself. The emergence of "digital art" as a distinct node

indicates growing recognition that digital creation constitutes a legitimate artistic medium with its own aesthetics, techniques, and critical frameworks—not merely a technological delivery system for traditional content. This represents a significant epistemological shift in a field historically resistant to technological integration, perceiving it as threatening authentic artistic experience.

Most significantly, the emergence of bright yellow-orange nodes around "AI integration," "personalized learning," "adaptive learning systems," and "metaverse education" in 2024-2025 signals a conceptual leap from technology as instructional tool to technology as intelligent pedagogical partner. This evolution suggests an impending paradigm shift where art education moves from teacher-directed instruction augmented by AR tools toward AI-mediated personalized creative journeys where algorithms adapt scaffolding, suggest techniques, and curate examples based on individual student needs and interests.

However, this trajectory raises profound philosophical tensions currently absent from the literature. Algorithmic personalization may enhance artistic exploration by providing responsive scaffolding, yet simultaneously risks constraining creativity by channeling students toward data-optimized pathways. The balance between adaptive support that responds to student needs and the productive struggle essential to authentic creative development requires careful theoretical attention. AI-curated artistic exposure presents similar dual potentials: it could expand aesthetic horizons through intelligent recommendation systems or create filter bubbles that reinforce existing preferences rather than challenging them. These tensions reflect deeper contradictions between efficiency-driven educational technology (maximizing measurable outcomes) and humanistic art education values (cultivating aesthetic sensibility, critical consciousness, and personal meaning-making).

The temporal evolution also reveals what is not changing: throughout all three periods, research remains focused on individual student outcomes (creativity, engagement, skills) rather than systemic transformation of art education as a field. There is no emergence of nodes related to "teacher professional identity," "institutional change," "arts curriculum reform," or "educational equity" suggesting that research operates within existing structures rather than questioning them.

The density map's yellow hotspots around "augmented reality," "digital literacy," and "student engagement" confirm these as mature research territories with converging findings and established measurement frameworks. High density indicates not just publication volume but conceptual consolidation—researchers building on shared theoretical foundations, using comparable methodologies, and producing cumulative knowledge. In these areas, meta-analyses are becoming possible, effect sizes can be estimated, and evidence-based recommendations can guide practice.

However, the dark blue gaps around "Quiver-Padlet integration," "creative assessment," and "inclusive art education" represent not merely research absences but conceptual frontiers where theoretical frameworks remain underdeveloped and foundational questions unasked. These voids have different epistemological implications.

The Quiver-Padlet integration gap reflects the field's failure to synthesize constructivist (individual AR exploration) and social constructivist (collaborative platform dialogue) approaches into coherent pedagogical frameworks. This is not simply a matter of conducting more studies but requires theoretical innovation: developing models that explain how individual creative experimentation and collective critical feedback mutually reinforce artistic development, identifying optimal sequencing of solitary and social learning phases, and conceptualizing assessment that captures both personal creative growth and collaborative competence development. The absence of such models indicates a research community operating in methodological silos rather than pursuing theoretical integration.

The creative assessment gap reflects a deeper, longstanding challenge in art education: the difficulty of evaluating creative processes and outcomes without imposing standardized

criteria that contradict art's emphasis on originality, personal expression, and aesthetic pluralism. Digital technologies complicate rather than clarify this issue traditional portfolio assessment translates poorly to animated AR objects and ephemeral digital collaborations, while learning analytics that track time-on-task or feature usage may measure engagement without capturing aesthetic growth. The field requires new theoretical models that conceptualize assessment as embedded in digital creative processes rather than external to them for example, analyzing patterns in Padlet feedback exchanges to assess developing critical judgment, or using AR interaction logs to identify moments of creative breakthrough and stagnation.

The inclusive art education void is perhaps most troubling, given digital technology's dual potential to expand access (through multimodal creation options) and deepen inequities (through infrastructure requirements and culturally-biased interfaces). The absence of research on students with disabilities, diverse linguistic backgrounds, or non-dominant cultural artistic traditions suggests that current work implicitly assumes a normative user able-bodied, digitally literate, aligned with Western artistic conventions. This invisibility perpetuates what disability scholars call "technoableism" designing technologies that exclude without acknowledgment. Addressing this gap requires not merely adding diverse participants to existing research designs but fundamentally reconceptualizing what constitutes "successful" technology integration through disability justice and culturally sustaining pedagogy frameworks.

These visualization patterns collectively indicate that digital art education research is transitioning from proof-of-concept demonstrations (showing that AR and collaborative platforms can support art learning) toward theory-building and pedagogical refinement (explaining how and why they do so, under what conditions, and with what consequences). However, significant conceptual work remains incomplete. The field requires:

1. Integrative pedagogical frameworks that synthesize individual experiential learning theories (constructivism via AR) with social learning theories (communities of practice via collaborative platforms), specifying how these approaches complement rather than compete, when each is most appropriate, and how their combination produces synergistic rather than merely additive benefits.

2. Developmental models that map how digital art competencies emerge across elementary grades, accounting for cognitive readiness, fine motor development, and prior technology exposure, enabling researchers to design age-appropriate rather than age-neutral interventions.

3. Assessment philosophies that reconcile learning analytics' data-driven measurement with art education's emphasis on subjective aesthetic judgment, potentially through "rhizomatic" approaches that validate multiple pathways to creative competence rather than linear progression toward predetermined outcomes.

4. Critical technological frameworks that examine whose interests are served by particular AR and platform designs, which artistic traditions are privileged or marginalized, and how commercial educational technology shapes pedagogical possibilities—moving beyond uncritical celebration of innovation toward ethically-informed technology adoption.

5. Equity-centered implementation models that explicitly address access barriers (devices, connectivity, technical support), cultural responsiveness (representation in AR content, language options), and inclusive design (accommodations for diverse abilities, learning preferences), treating equity as foundational rather than supplementary.

The field's future trajectory depends on whether researchers move beyond documenting what digital tools can do toward theorizing what digital art education should be philosophically, pedagogically, and ethically. This requires interdisciplinary collaboration between art educators, learning scientists, computer scientists, and critical

technology scholars, united by commitment to humanistic education values even as methods become increasingly technological.

Overall, this study confirms that Quiver and Padlet have great potential to enhance creativity, digital literacy, and collaboration among elementary school students in fine arts learning, in line with the findings of Altınkaynak & Özel (2024), Nevrelova et al. (2024), and Johnson et al. (2023). However, with an average publication of only 2.8 articles per year during the 2020-2025 period and a research concentration that is still limited to several countries (especially Indonesia) and a dominant focus on Quiver (64.3%) with minimal exploration of Padlet (14.3%), this topic remains a niche area in the elementary arts education literature that requires more intensive exploration. Research gaps identified through density visualization, especially related to Quiver-Padlet integration, creativity assessment, and inclusive arts pedagogy, provide strategic guidance for future researchers to develop more comprehensive, contextual, and longitudinal research that can make a significant contribution to the development of technology-based fine arts learning models in elementary schools.

5. Conclusion

This bibliometric analysis addressed the central research question: What are the trends, patterns, and gaps in research on Quiver AR and Padlet integration in elementary visual arts learning from 2020 to 2025? The findings reveal a limited, geographically concentrated, and methodologically emerging research landscape where only 14 of 1,014 initially identified articles met inclusion criteria, indicating that this domain remains a niche area within educational technology scholarship.

Publication trends demonstrate reactive rather than sustained research momentum, with peaks in 2020 and 2023 corresponding to pandemic-driven digital adoption and subsequent pedagogical evaluation phases. Indonesia's dominance as the primary research contributor (42.9%) suggests that these technologies hold particular relevance for developing educational contexts where digital tools may compensate for limited physical art resources, offering insights for equity-oriented technology implementation.

The striking imbalance between Quiver AR (64.3%) and Padlet (14.3%) in research focus reflects an implicit prioritization of individual experiential learning through augmented reality over collaborative social learning through digital platforms. This pattern reveals a conceptual gap: while researchers have embraced AR's potential for spatial-visual transformation and creative expression, they have largely overlooked collaborative platforms' capacity to support critical dialogic processes essential to artistic development— peer critique, community building, and collective meaning-making.

VOSviewer's network and temporal analyses revealed five interconnected research clusters and a clear evolutionary trajectory from emergency remote teaching responses (2020-2021), through hybrid learning and pedagogical effectiveness studies (2022-2023), toward emerging AI-integrated personalized learning systems (2024-2025). This evolution signifies a field maturing from technology adoption toward pedagogical sophistication, yet density visualizations expose persistent research voids in integrated Quiver-Padlet models, authentic creative assessment methods, and inclusive digital art pedagogy.

This study makes three significant theoretical contributions. First, it establishes that current research operates within a fragmented conceptual framework, privileging constructivist AR experiences while marginalizing social constructivist collaborative platforms, suggesting need for integrative pedagogical models. Second, it reveals that digital art education research remains in a proof-of-concept phase, documenting technological capabilities rather than building robust theories of technology-mediated artistic development. Third, it identifies the tension between technological sophistication (advancing toward AI personalization) and pedagogical maturity (lacking frameworks for creative assessment and inclusive practice), indicating that technical progress has outpaced theoretical development.

For educators, these findings suggest that while Quiver AR offers proven benefits for enhancing creativity and visual understanding, optimal learning outcomes may require integration with collaborative platforms like Padlet to support social dimensions of artistic growth. The predominance of research on upper elementary grades (4-6) indicates that lower-grade implementations require careful pedagogical adaptation and scaffolding strategies currently lacking empirical support. For policymakers, Indonesia's research leadership demonstrates that technology-enhanced art education can thrive in resource-constrained contexts, provided appropriate professional development and infrastructure investments support teachers' technological readiness.

Critical research gaps demand attention: (1) longitudinal studies examining sustained impacts on artistic competencies beyond short-term interventions; (2) integrated pedagogical models combining AR and collaborative platforms to leverage both experiential and social learning theories; (3) authentic assessment frameworks for evaluating creativity in digital art contexts; (4) inclusive design research ensuring equitable access for diverse learners, including those with disabilities; and (5) critical examinations of emerging AI integration's implications for artistic autonomy and pedagogical ethics.

In conclusion, while Quiver AR and Padlet demonstrate substantial potential for transforming elementary art education through enhanced creativity, digital literacy, and engagement, the field requires a conceptual shift from technology demonstration toward theory-driven, equity-conscious, and pedagogically integrated research. The limited research base (2.8 articles annually) and concentrated focus underscore that this domain remains an emergent frontier where comprehensive, contextually grounded, and methodologically rigorous investigations can make transformative contributions to both educational technology scholarship and arts education practice.

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