

BIBLIOMETRIC ANALYSIS OF PBL FOR VISUAL COMMUNICATION DESIGN EDUCATION: THEME DEVELOPMENT AND OPPORTUNITIES FOR NEW CRITICAL THINKING

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Abstract. This study aims to map the thematic development of research on Problem-Based Learning (PBL) in the context of Visual Communication Design (VCD) education linked to critical thinking and visual/creative thinking over the period 2015–2025, while identifying potential areas for research novelty. A bibliometric approach was employed by retrieving data using Publish or Perish (PoP) with Google Scholar as the data source and the following query: ("problem-based learning" OR "PBL") AND ("critical thinking") AND ("visual thinking" OR "creative thinking") AND ("visual communication design" OR "graphic design education" OR "design education"). Retrieved metadata were exported in .RIS format and analyzed using VOSviewer to generate term-mapping visualizations, including density, network, and overlay maps. The results indicate a corpus of 500 documents with 11,988 citations, an average of 23.98 citations per paper, and impact indices of h-index = 52 and g-index = 99. VOSviewer mapping shows “critical thinking” as the most dominant and central node, surrounded by pedagogical implementation and design terms such as implementation, model, and effect, as well as educational context terms including teaching, teacher, and higher education. The terms technology and collaboration also appear connected within the network, while visual-creative outcome terms such as creative thinking ability and students' creative thinking emerge as part of the thematic structure. Overall, these findings suggest that the retrieved research landscape is strongly centered on critical thinking and pedagogical implementation, with notable links to higher-education contexts and technology–collaboration supports.

Keywords: Problem-Based Learning, Visual Communication Design Education, Critical Thinking, Visual Thinking, Creative Thinking

Abstract. Penelitian ini bertujuan memetakan perkembangan tema riset tentang *Problem-Based Learning* (PBL) dalam konteks pendidikan Desain Komunikasi Visual (DKV) yang dikaitkan dengan *critical thinking* serta visual thinking/creative thinking pada periode 2015–2025, sekaligus mengidentifikasi area yang berpotensi menjadi arah kebaruan penelitian. Metode yang digunakan adalah bibliometrik dengan penarikan data melalui Publish or Perish (PoP) berbasis Google Scholar menggunakan kueri: ("*problem-based learning*" OR "*PBL*") AND ("*critical thinking*") AND ("*visual thinking*" OR "*creative thinking*") AND ("*visual communication design*" OR "*graphic design education*" OR "*design education*"). Metadata hasil penelusuran diekspor dalam format .RIS dan dianalisis menggunakan VOSviewer untuk menghasilkan pemetaan istilah berupa *Density Visualization*, *Network Visualization*, dan *Overlay Visualization*. Hasil menunjukkan korpus berjumlah 500 dokumen dengan total 11.988 sitasi, rata-rata 23,98 sitasi per dokumen, serta indeks dampak h-index 52 dan g-index 99. Pemetaan VOSviewer menampilkan “*critical thinking*” sebagai node paling dominan dan sentral, dikelilingi istilah yang terkait implementasi dan rancangan pedagogis seperti *implementation*, model, dan *effect*, serta konteks pembelajaran seperti *teaching*, *teacher*, dan *higher education*. Istilah *technology* dan *collaboration* juga tampak terhubung dalam jejaring, sementara istilah kreatif-visual seperti *creative thinking ability* dan *students creative thinking* muncul

sebagai bagian dari struktur tema. Secara keseluruhan, temuan ini menegaskan bahwa lanskap riset PBL pada pendidikan desain yang terindeks melalui kueri penelitian berporos pada penguatan berpikir kritis, dengan keterkaitan pada aspek implementasi, konteks pendidikan tinggi, serta dukungan teknologi-kolaborasi.

Keywords: *Problem-Based Learning*, Pendidikan Desain Komunikasi Visual, *Critical thinking*, *Visual Thinking*, *Creative Thinking*

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INTRODUCTION

The development of Visual Communication Design (DKV) education in the last decade has been increasingly characterized by the demands of 21st-century competencies that place higher-order thinking at the core of learning, going beyond mere technical mastery. DKV students are not only required to produce aesthetic designs, but also to be able to formulate and justify visual decisions through analysis of context, audience, ethical representation, and communication effectiveness. Within this framework, *Problem-Based Learning* (PBL) is relevant because it positions authentic problems as learning triggers, encouraging inquiry, collaboration, and evidence-based decision-making. Various cross-disciplinary studies have shown that PBL is correlated with strengthening critical thinking, namely the ability to evaluate information, formulate alternative solutions, and reflect on the consequences of choices (Rokhman et al., 2025). Although originating from a non-DKV context, these findings confirm the pedagogical mechanisms of PBL, which are theoretically aligned with the needs of DKV in framing visual communication problems and testing design solutions. However, DKV's uniqueness lies in the dominance of visual reasoning and evaluation of visual rhetoric, so the PBL discourse needs to be placed within a visual-creative-based critical thinking framework, rather than simply a generic critical thinking framework.

Pedagogically, PBL shares a close relationship with the studio and project-based learning traditions that have long been the foundation of design education, but it offers a more explicit problem structure and decision justification. In visual arts education, PBL has been shown to influence creativity and critical thinking dispositions (Ulger, 2018), which is relevant for DKV because the design process demands divergent ideation that is then selected through critical assessment. Similarly, problem-based design thinking projects in higher education have also been reported to enhance creativity, including divergent thinking skills and creative self-efficacy (Choi et al., 2024). Systematic studies of creative thinking in art and design education

indicate that experiential learning, interdisciplinary approaches, and the use of digital technologies are dominant strategies, marking a widespread methodological approach in this field (Samaniego et al., 2024). However, this abundance of empirical findings presents a new challenge: the difficulty of reading the complete knowledge map, including dominant themes, key actors, and research gaps that are most relevant to DKV.

The uniqueness of Visual Communication Design (DKV) as a visual-based discipline demands an understanding of critical thinking as the ability to interpret, evaluate, and construct arguments through visual representations. The literature shows that strategies such as Visual Thinking Strategy (VTS) and problem-posing supported by concept mapping can deepen visual analysis and critical thinking tendencies (Hu & Hwang, 2024), while the application of VTS also contributes to improving argumentative skills and the analysis of visual works (Smolkowski et al., 2020). In the Indonesian context, the application of PBL in art criticism learning shows that PBL can be operationalized for evaluative activities based on visual artifacts (Amirudin & Muhajir, 2019). However, this evidence is scattered across the domains of visual arts education, argument writing, and design thinking, which are not always identical to the DKV ecosystem. As a result, knowledge about the relationship between PBL, critical thinking, and the visual realm is fragmented and has not been systematically mapped within the DKV domain.

It is at this point that bibliometrics becomes a strategic methodological approach. Bibliometrics allows mapping the structure of knowledge through quantitative analysis of a large corpus of literature to identify trends, thematic clusters, and research gaps (Passas, 2024). This approach is relevant for Visual Communication Design (DKV) because it can reveal the extent to which PBL is positioned within visual-based education, how it relates to creativity, visual literacy, and critical thinking, and whether the issue of "visual-based critical thinking" has become a central theme or a peripheral one. Furthermore, bibliometrics helps overcome the bias of partial reading and highlights areas that are still under-researched, such as the evaluation of critical thinking based on visual artifacts or the integration of PBL with studio pedagogy.

Thus, this research gap lies in the absence of a bibliometric map that explicitly centers PBL in DKV education and examines how visual-creative-based critical thinking is constructed in global literature. The novelty of this research lies in its meta-level contribution: mapping the PBL-DKV knowledge structure to integrate findings on creativity (Ulger, 2018; Choi et al., 2024), visual literacy and critical thinking scaffolding (Hu & Hwang, 2024; Smolkowski et al., 2020), and local practices of visual criticism learning (Amirudin & Muhajir, 2019) into a unified scientific landscape. Different from single-class empirical studies, this research offers

a conceptual and methodological foundation for a future DKV research agenda.

Based on the background, gaps, and novelty, the purpose of this study is to map and analyze the development of themes and research knowledge structures regarding *Problem-Based Learning* in Visual Communication Design education, with a focus on the development of visual-based and creative critical thinking. This study is formulated in one research question: how are the development of themes, knowledge structures, and research gaps of PBL in DKV education related to strengthening visual-creative critical thinking.?

METHOD

This study uses a bibliometric design with a performance analysis and science mapping approach to map the development of themes, networks, and opportunities for new research related to *Problem-Based Learning* (PBL) in the context of design education oriented towards critical thinking and visual-creative thinking. Bibliographic data sources were obtained through the Publish or Perish (PoP) tool with the Google Scholar database, because Google Scholar provides a broad coverage of journals and proceedings relevant to the field of design education. The publication period is limited to 2015–2025 to capture the dynamics of the last decade that are most representative of the development of *Problem-Based Learning* and discourse on higher-order thinking skills in the design realm. The search process was carried out using a string of keywords that were tightly locked to match the research focus, namely: ("problem-based learning" OR "PBL") AND ("critical thinking") AND ("visual thinking" OR "creative thinking") AND ("visual communication design" OR "graphic design education" OR "design education"); This string was entered into the PoP search field and filtered with a start year of 2015 and a finish year of 2025. After the initial results were obtained, a title and abstract-based screening was conducted to ensure that the documents truly discussed PBL as a learning approach (not just a passing mention), and were within the realm of visual communication design education, graphic design education, or design education that was still relevant to visual practice. Inclusion criteria included: journal articles or proceedings that were scientifically traceable, within the 2015–2025 period, contained PBL elements, and linked discussions to critical thinking and visual/creative thinking in the context of design/design education; while exclusion criteria included duplications, documents without adequate metadata, works unrelated to design education, and documents that did not allow source verification. To ensure repeatability, each result that passed the screening was then exported from PoP to RIS format (.ris) ensuring that the minimum metadata fields (title, author, year, source, and citation/reference if available) were retained, and the RIS file became the final corpus for

analysis. The next stage was data cleaning, which focused on normalizing keyword terms and bibliographic entities, including unifying variations of terms such as “PBL” and “problem-based learning,” and equating field terms such as “visual communication design” and “graphic design education” when they appeared as synonyms, so that thematic mapping was not fragmented by differences in spelling or phrase form. Bibliometric analysis was conducted using VOSviewer with RIS files as the primary input. Then run co-occurrence mapping for keywords (author keywords and/or terms from title-abstract according to metadata availability) to identify theme clusters that represent the PBL–critical thinking–visual/creative thinking knowledge structure in design education. In addition to co-occurrence, network analysis such as co-authorship can be applied to see the collaboration patterns of authors/countries/institutions if Google Scholar metadata is sufficient in the RIS file, and citation mapping can be used to mark the most influential documents in the corpus. VOSviewer parameter settings are set explicitly to be replicable, including determining the unit of analysis (keywords/terms), counting method (full counting or fractional counting as needed), and the minimum threshold for term occurrences so that the map is not too noisy but remains representative of the corpus; the final results are visualized in the form of Network Visualization, Overlay Visualization (to read temporal trends), and Density Visualization (to see the density of themes). The research output in the form of thematic cluster maps, term emergence trends, and author/document networks were then used to compile a narrative of bibliometric findings: dominant themes, themes that are starting to rise, and the most obvious research gaps, especially at the nodes that connect PBL with the development of visual and creative-based critical thinking in DKV education.

RESULTS

Citation Metrics and Publication Performance Index

Based on the citation metrics output from PoP, the corpus of 500 documents generated a total of 11,988 citations. The citation value per year (cites/year) was recorded at 1,089.82, while the citations per document (cites/paper) was 23.98. From the authorship aspect, the authors/paper value was 2.64, which indicates the average number of authors per document in the corpus. In the citation index indicator, PoP produced an h-index = 52 and a g-index = 99. In addition, there are additional indicators in the form of $hI_{norm} = 34$, $hI_{annual} = 3.09$, and $hA-index = 25$ according to PoP calculations on the same corpus. PoP also displays a summary of cumulative citation thresholds (papers with $ACC \geq 1,2,5,10,20$) of 323, 245, 158, 88, and

33 documents, respectively, which depicts the number of documents that reach or exceed a certain citation threshold in the 2015–2025 corpus.

Table 1. Summary of PoP (google scholar) citation metrics for the period 2015–2025

Indicator	Mark
Publication years	2015–2025
Citation years	11 (2015–2026)
Number of documents (papers)	500
Total citations	11,988
Citations per year (cites/year)	1,089.82
Citations per document (cites/paper)	23.98
Authors per document (authors/paper)	2.64
h-index	52
g-index	99
hI, norm	34
hI,annual	3.09
hA-index	25
Papers with ACC \geq 1,2,5,10,20	323, 245, 158, 88, 33

Distribution of Documents Based on Citation Threshold

The distribution of documents based on the PoP citation threshold shows that out of a total of 500 documents, there are 323 documents that have citations \geq 1, 245 documents have citations \geq 2, 158 documents have citations \geq 5, 88 documents have citations \geq 10, and 33 documents have citations \geq 20. This distribution presentation is a quantitative summary of PoP related to the distribution of documents at a certain citation level in the corpus. The citation threshold data is placed as part of the description of the corpus performance and is not used for interpretation in this results section.

Term Density Map (Density Visualization)

The results of the VOSviewer mapping in the form of Density Visualization show the density of occurrence and interconnectedness of terms based on intensity gradations on the map area. In the density map (Figure 1), the term "critical thinking" appears to be the point with the highest density, located in the center of the map. Around this center, several other terms appear with relatively medium to high intensity, including "effect," "implementation," "model," and terms related to the learning context such as "teaching," "teacher," and "higher education." Furthermore, the map also shows the terms "technology" and "collaboration" located in the medium-density area and having a position close to the central term. Some terms that appear in the lower-density area of the map but are still legible include "creative thinking ability," "students' creative thinking," "critical thinking disposition," "practice," "motivation," and "inquiry." Other terms that appear on the edges of the map include "metaanalysis," "problem

solving," "stem," "steam," and "mathematics." All of these terms appear as part of the VOSviewer mapping output based on the analyzed RIS data.

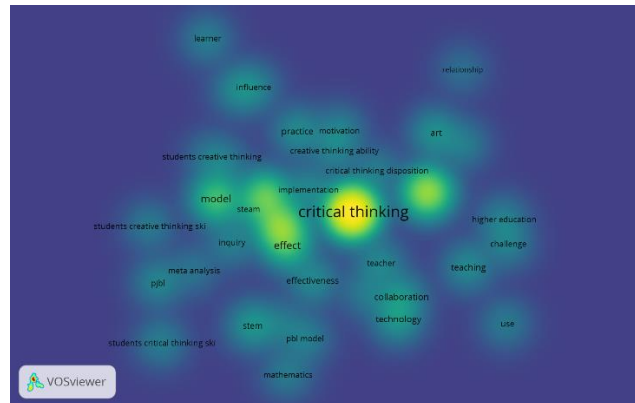


Figure 1. Density visualization VOSviewer on the 2015–2025 corpus

Network Visualization

The VOSviewer mapping results in the form of Network Visualization display nodes (term nodes) and links (connection lines) between terms. In Figure 2, the “critical thinking” node appears as the largest and most central node, indicating the most prominent relative weight compared to other nodes on the network map. Several other nodes appear to be medium-sized and located close to the center, including “effect,” “implementation,” and “model.” On the adjacent side, nodes related to the learning context and educational roles are also visible, such as “teaching,” “teacher,” and “higher education.” In addition, the “technology” and “collaboration” nodes are also visible connected to the central area and appear in the network that forms cross-node relationships. The network map also shows terms related to aspects of process and context, such as “practice,” “motivation,” “inquiry,” and “effectiveness.”

The network also displays a number of terms that are positioned relatively more peripherally but are still connected through links, such as "challenge" and "use" on the right side of the map. Meanwhile, on the other side, terms such as "learner" and "influence" appear, as well as the terms "relationship" and "art" which are at the top of the map and remain connected through relationship lines. Terms that indicate a variety of contexts of specific fields also appear in the network, such as "stem," "steam," and "mathematics," as well as the terms "metaanalysis" and "pjbl" which appear in the bottom-left area of the map. Visually, larger nodes tend to be closer to the center of the network and have more links, while smaller nodes tend to be more spread out on the edges of the network.

In addition to node size and position, the VOSviewer network map also displays the grouping of nodes into several clusters (indicated by different colors on the map). Based on the cluster display, the main nodes can be summarized descriptively as follows.

connecting several areas of the map. This overlay serves as descriptive information about the temporal appearance of the VOSviewer map based on the same corpus.

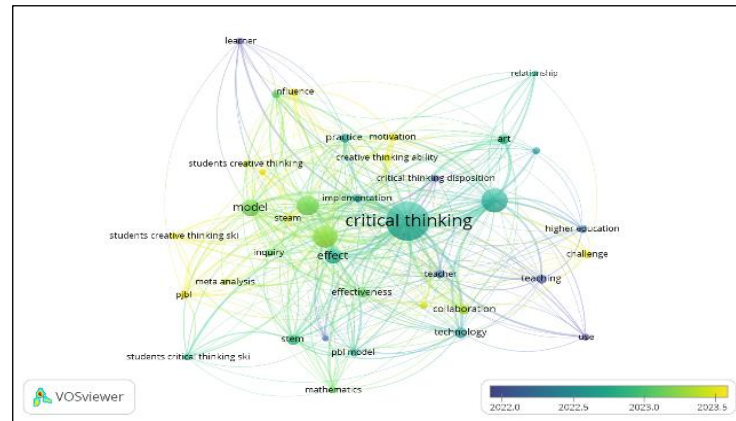


Figure 3. Overlay visualization VOSviewer

DISCUSSION

Bibliometric findings for the 2015–2025 period indicate that PBL discourse associated with visual/creative thinking and design education consistently centers on the conceptual node of “critical thinking.” This dominance confirms the position of critical thinking as a core competency in PBL, in line with the characteristics of PBL that place authentic problem-solving as the primary trigger for higher-level cognitive activity. The VOSviewer map also shows that supporting nodes such as implementation, model, and effect, as well as the pedagogical contexts of teaching, teachers, and higher education, emerge strongly around this center. This pattern indicates that the research corpus is more oriented towards the practice of implementing and evaluating the impact of PBL in educational contexts, rather than abstract conceptual development.

Terms related to the visual-creative domain, such as creative thinking ability, student creative thinking, and critical thinking disposition, do emerge, but they do not extend beyond the "critical thinking" center. This suggests that creativity and critical thinking disposition are generally positioned as learning outcomes measured after PBL implementation. This finding is consistent with empirical evidence showing that PBL influences creativity and critical thinking disposition in visual arts education (Ulger, 2018). Thus, the "critical thinking" center on the bibliometric map can be understood as an umbrella node that connects implementation studies, learning models, and PBL effect measurements.

The relatively prominent presence of the terms "technology" and "collaboration" demonstrates that PBL in the corpus is not understood solely as a conventional classroom strategy, but as a pedagogical practice integrated with technology and collaborative work. This

is relevant to the context of Visual Communication Design (DKV) education, which operates within a digital ecosystem and is based on collaborative projects. The link between technology and critical thinking also aligns with the findings of Hu & Hwang (2024), who demonstrated that Visual Thinking Strategy (VTS)-based problem-posing, supported by concept mapping, can strengthen visual analysis skills and critical thinking tendencies. Thus, the bibliometric map suggests that the effectiveness of PBL in the visual domain depends not only on authentic problems but also on adequate cognitive scaffolding and knowledge organization.

The dominance of the terms "teaching" and "teacher" emphasizes that educator capacity is a key factor in the success of PBL in fostering critical thinking. This finding is reinforced by Smolkowski et al., (2020), who demonstrated that VTS-based professional development enhances teachers' ability to teach and facilitate critical thinking through visual analysis. In the context of Visual Communication Design (DKV), this finding is relevant because studio learning relies heavily on the role of lecturers in guiding design critique, visual argumentation, and evidence-based reflection. Therefore, the mapped PBL discourse cannot be separated from issues of pedagogical design and the quality of instructor facilitation.

The network map also demonstrates the strong context of higher education and challenges, reflecting the focus of PBL research on higher education and the complexity of its implementation. This aligns with the nature of DKV education, which is fraught with subjective assessment issues, complex design problems, and limited iteration time. The prominent Overlay Visualization in the 2022–2023 period indicates that the PBL–critical thinking–visual/creative thinking discourse is a growing contemporary issue, in line with the increasing attention to creativity and higher-order thinking in art and design education (Samaniego et al., 2024).

However, the absence of explicit terms such as "visual communication design" or "graphic design education" as dominant nodes indicates the limited representation of domain-specific DKV in the corpus. Cross-disciplinary generic terms such as STEM/STEAM and mathematics appear more frequently, indicating that PBL research in DKV is still scattered or uses alternative terminology. This situation confirms a research gap and an opportunity for novelty: the need for studies that explicitly position PBL within the context of DKV with visual-based critical thinking indicators. This variation in terms is also consistent with the finding that art and design education has a diversity of approaches and methodological labels (Samaniego et al., 2024). Nevertheless, the emergence of the "art" node connected to "critical thinking" and "creative thinking ability" indicates that the corpus still captures the visual-based learning cluster relevant to the DKV ecosystem. Evidence that PBL influences creativity and critical

thinking dispositions in visual arts education (Ulger, 2018), as well as the application of PBL to art criticism activities based on visual artifacts (Amirudin & Muhajir, 2019), strengthens the argument that PBL is compatible with visual learning that demands analysis and evaluation. In DKV, visual literacy and design argumentation are at the core of the studio process, so this connection has strong conceptual significance.

Overall, the contribution of this research is two-fold. First, at the level of scientific field mapping, the bibliometric results indicate that the PBL–critical thinking–visual/creative thinking discourse has a broad and active literature base. Second, at the level of conceptual structure, the VOSviewer map confirms that PBL research focuses on pedagogical implementation and learning impact, while the visual-creative and DKV dimensions have not yet become dominant centers. This is where the contribution and novelty of this research lies: offering a framework that PBL in DKV education needs to formulate critical thinking as critical-visual competencies, which include the quality of visual analysis, justification of design decisions, and reflection on meaning and audience. Thus, the bibliometric results not only capture the landscape, but also serve as the basis for a research agenda and development of PBL pedagogy that is more specific, measurable, and contextual for DKV education.

CONCLUSION

This bibliometric research maps the publication landscape for the 2015–2025 period regarding *Problem-Based Learning* (PBL) linked to critical thinking and visual thinking/creative thinking in the context of visual communication design, graphic design education, and design education through data retrieval in Google Scholar-based Publish or Perish (PoP) and mapping analysis using VOSviewer. The PoP metric results show that the corpus consists of 500 documents with a total of 11,988 citations, an average of 23.98 citations per document, and an impact index of h-index 52 and g-index 99. The distribution of documents based on the citation threshold shows that 323 documents have achieved ≥ 1 citation and 33 documents have achieved ≥ 20 citations, which illustrates the distribution of citations in the corpus. From the VOSviewer mapping perspective, the term “critical thinking” appears as the most dominant and most central node in both the density and network maps, and is surrounded by terms related to the implementation dimension and pedagogical design such as implementation, model, effect, and learning contexts such as teaching, teacher, and higher education. The terms technology and collaboration also appear connected in the network, while terms representing creative and visual outcomes such as creative thinking ability, students’ creative thinking, and critical thinking disposition appear as nodes that contribute to the map

structure. The Overlay Visualization displays the average temporal variation of term occurrence on a scale of approximately 2022.0–2023.5, indicating differences in relative occurrence time between terms within the same corpus network.

In terms of contribution to the field of DKV education, these findings provide a basis for mapping that the PBL discourse in the corpus keyed by the research query primarily focuses on strengthening critical thinking and learning implementation issues, while the visual and creative dimensions emerge as important but not central parts beyond the theme of critical thinking. Therefore, this study concludes that the PBL research agenda in DKV education has opportunities for strengthening in more specific areas: the development of a PBL model that assesses critical thinking as a competency that is sensitive to visual processes and artifacts, while integrating creativity indicators relevant to visual communication design practices. In addition, the network structure that displays technology and collaboration confirms that PBL learning related to higher-order thinking competencies is widely associated with modern learning contexts that are digital and collaborative.

RECOMMENDATION

Future research is directed at three agendas. First, subsequent bibliometric studies need to improve the precision of the DKV domain through term normalization and enrichment of query synonyms (e.g., variations in studio-based design education terminology) so that the resulting map increasingly represents the DKV education ecosystem and is not too absorbed by cross-disciplinary contexts. Second, further research needs to develop and test a more DKV-specific evaluation framework to measure visual-based critical thinking in PBL, such as the quality of visual analysis, the quality of justification for design decisions, and the depth of reflection on the form-meaning-audience relationship, so that the outcome of “critical thinking” does not stop at general indicators. Third, future research needs to position creativity and critical thinking as a series of processes in DKV PBL—from problem framing, ideation, prototyping, to design critique—and examine the role of technology and collaboration as supporting variables that can strengthen *Problem-Based Learning* in the context of visual communication design. With this direction, further research is expected to be able to clarify the position of PBL in DKV education while enriching scientific contributions through indicators, models, and knowledge maps that are increasingly specific to visual-creative practices.

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