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Is PjBL Integrated into Learning Media Effectively Improve Students' Creativity on Biology Topics?: A Systematic Literature Review and Bibliometric Analysis

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Abstract: Research on integrated PjBL in learning media has grown rapidly in recent years, attracting increasing attention from academics and practitioners. However, the literature examining the impact of integrated PjBL on learning and enhancing student creativity is currently sparse and lacks a comprehensive view of how such integration works in education. To bridge this gap, our review comprehensively examined 16 academic articles sourced from the Google Schoolar database, synthesizing previous research on the integration of PjBL in learning media, specifically in biology topics. Using a systematic literature review and incorporating bibliometric analysis, our study provides an analysis of the current management research landscape on how PjBL integrated into learning media can enhance student creativity in biology topics. Our study shows that the integration of PjBL with learning media, particularly interactive digital media, is significantly positively correlated with increased student creativity, manifested through originality, elaboration, and idea fluency. Based on our literature review, we establish a future research agenda and provide practical implications.

Keywords: Biology topics; Creativity; Learning media; Project based learning; SLR

Introduction

The contemporary world, characterized by unprecedented global development and the complexity of challenges, demands a paradigm shift toward lifelong learning as a fundamental competency. This need for continuous adaptation is at the heart of 21st-century education, which is tasked with preparing students to navigate and contribute to a changing world (Meyer & Norman, 2020; Cahya et al., 2023). In this context, human civilization is required to adapt and devise solutions to complex problems, a responsibility that extends to the student population as well. While rapid global development brings numerous benefits, it has also introduced significant negative externalities, including the degradation of moral and ethical frameworks and widespread environmental pollution. As active members of society, students are obligated to engage in a critical examination of these phenomena and develop sustainable solutions. Therefore, equipping students with creativity is crucial to fostering their capacity to address the complex issues stemming from global progress (Habib et al., 2024; Setyani et al., 2024).

Creativity, defined as the ability to generate new ideas or build new connections between existing concepts, is a crucial skill that enables students to propose innovative solutions to real-world problems. This capacity for innovation is intrinsically linked to active engagement in the learning process (Li et al., 2022; Zhan et al., 2023). To foster creativity, educators must design pedagogical environments that encourage students to express their ideas freely. This can be

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achieved through various strategies, such as providing opportunities for students to express their opinions, ask questions, create products or works, and interact with peers (Scott-Barrett et al., 2023; Haleem et al., 2022). Frequently measured indicators of creativity include fluency, flexibility, originality, and elaboration.

In an effort to foster creativity, learning activities should ideally empower students to develop ideas independently, with the teacher acting as a facilitator, providing freedom of exploration Fitriani et al., 2025; Mashfufah et al., 2024). However, in reality, biology learning is often teacher-centered and less than optimal in its implementation. This is exacerbated by the limitations of learning media that are less engaging and interactive, resulting in low student engagement and limited opportunities for creative expression. This phenomenon is confirmed by previous research findings, which indicate that most students experience difficulty expressing their ideas during classroom discussions or explanations (Giberti et al., 2025; Patterson & Ding, 2025).

Therefore, pedagogical interventions are needed to address this stagnation. In this context, Project-Based Learning (PjBL) is highly recommended for integration with learning media. PjBL, as a learning model that places students at the center of inquiry, allows them to directly engage in authentic projects. When PjBL is combined with engaging and interactive learning media, students are encouraged to create original products and articulate their creative ideas effectively, which can ultimately overcome the lack of creativity caused by conventional learning methods and media (Syahlan et al., 2023; Markula & Aksela, 2022).

Project-Based Learning (PjBL) is a highly recommended approach to be integrated with learning media to facilitate the development of student creativity (Fitri et al., 2024; Chen et al., 2022). As a strategy that places students at the center of learning through authentic projects that require collaborative problem-solving, PjBL becomes more effective with interactive media. By embedding learning media into the PjBL structure, teachers can transform this process into a richer and more immersive experience (Goss, 2022). Interactive media, such as digital simulations or collaboration platforms, not only facilitate the delivery of abstract concepts but also provide tools that empower students to develop and elaborate their ideas visually and interactively.

The integration of Project Based Learning (PjBL) into learning media presents a promising pedagogical innovation. This approach encourages active learning by engaging students in authentic projects while utilizing diverse and contextualized media aligned with student needs (Mejia & Sargent, 2023; Wong & Hughes, 2023; Antari et al., 2023). Consequently, PjBL integrated with instructional media has gained recognition for its potential to enhance students' conceptual understanding, academic achievement, and creativity in biology.

With the rapid advancement of educational technology, a variety of digital media have emerged to support PjBL implementation. These tools not only assist in content delivery but also offer interactive and contextual experiences that support students' independent and collaborative work. Through PjBL, students are encouraged to explore, design, and implement projects aligned with learning objectives, enabling them to build meaningful creativity (Markula & Aksela, 2022; Silma et al., 2024; Williamson, 2024; Omelianenko & Artyukhova, 2024). In biology, PjBL fosters the development of scientific literacy, critical thinking, and the ability to analyze data, as well as teamwork skills in an authentic learning environment. (Hornejas & Guntalidad, 2024). However, the challenge remains in effectively integrating PjBL with learning media that reflect contemporary technological advances.

Several research results have shown that the use of learning media integrated with PjBL has a positive impact on student creativity. This media not only helps students understand the material more concretely but also increases their motivation and engagement in the learning process. For example, in biology learning, project-based media empowers students not only to observe phenomena and collect data but also to design original investigative approaches. Thus, students are encouraged to develop unique ideas when processing data and presenting their conclusions in creative products, which directly enhances flexibility and originality in thinking (Vista, 2025; Siregar et al., 2024).

Along with advances in educational technology, learning media are now easier to develop and integrate with the Project-Based Learning (PjBL) model (Rusmansyah et al., 2023; Naqiyyah & Widiyanti, 2024). Various types of interactive media, both digital and non-digital, have been developed to support the implementation of learning projects relevant to students' real-life situations. Therefore, it is important to review and evaluate various studies to determine the effectiveness of integrating learning media within the Project-Based Learning (PjBL) approach in enhancing student creativity, particularly in biology. Despite its significant potential, the integration of PjBL into learning media and its impact on student creativity remains underexplored.

Given the significance of this topic and the extensive body of research already conducted, a systematic and comprehensive review is necessary to synthesize and analyze existing findings. A Systematic Literature Review (SLR)is the most suitable method for this purpose. A SLR is a research methodology that

gathers, evaluates, and synthesizes all relevant evidence from published studies regarding a specific research question (Carrera-rivera, 2022; Fathullah, 2023; Marzi et al., 2025).

Bibliometric analysis offers a rigorous means of charting the evolution of scientific literature within a particular discipline. By leveraging quantitative metrics and network visualization, researchers can systematically uncover publication patterns, emergent trends, and the scholarly impact of studies (Kumar, 2025; Marzi et al., 2025; Astuti et al., 2025). In this context, the present study applies bibliometric tools to investigate how project-based learning (PjBL) has been incorporated into biology education media over the past five years, with an emphasis on its role in cultivating student creativity. The analysis further seeks to identify gaps and opportunities that may inform future research trajectories.

The outcomes of this investigation are expected to assist academics, pedagogues, and policy architects in formulating more strategic, collaborative, and high-impact research agendas. To accomplish these aims, this study examines longitudinal publication growth and deploy co-occurrence network mappings, overlay visualizations to trace emerging thematic developments, and density plots to detect potential clusters of inquiry. The subsequent sections present the results of our bibliometric review, followed by an organized synthesis of the current literature's structure. Finally, this study delineates the study's theoretical and practical contributions and propose directions for forthcoming research endeavors.

Numerous literature studies have been conducted on the effect of PjBL on creativity (Zulyusri, 2023; Pratiwi & Ikhsan, 2024; Sari et al., 2025). However, research on PjBL integrated into learning media to enhance creativity in biology learning has never been conducted by previous researchers. This research is necessary considering that PjBL is a learning model that can provide gradual support to students and help them understand complex concepts through interactions with teachers or peers, while fostering creativity (Basri et al., 2024; Naseer et al., 2025).

Based on the description above, these findings support the idea that PjBL integrated learning media is an appropriate and adaptive way to provide students with the creativity boost they need to navigate today's complex workplace, social, and professional challenges. This study aims to clarify the importance of creativity skills in the learning process in schools and demonstrates that the use of PjBL integrated learning media significantly helps students improve their creativity, which impacts their academic achievement.

Method

First Phase: Systematic Literature Review (SLR)

This Systematic Literature Review (SLR) was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to assess and screen relevant scientific articles on the effects of integrated PJBL on learning media on biology learning (Lawal & Oguns-Obasohan, 2025). A comprehensive depiction of the SLR procedure is presented in Figure 1. The initial stage involved identifying research gaps and setting a clear objective, namely, to explore the effects of integrated PJBL on learning media on biology learning in improving student learning outcomes.

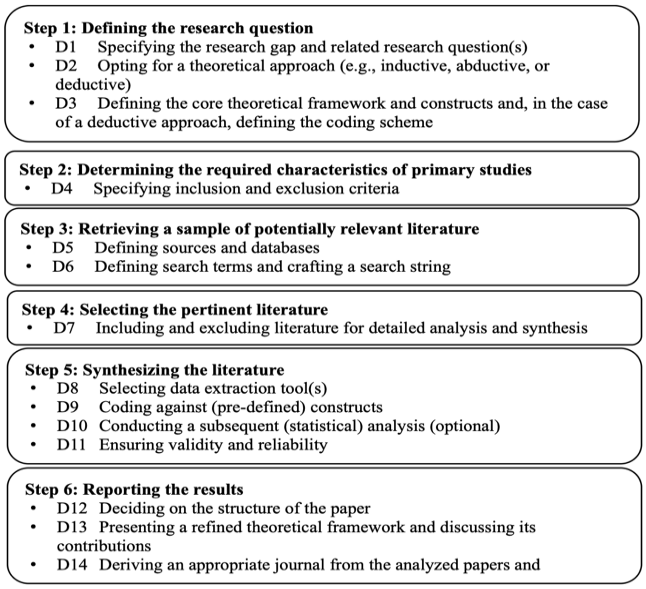

Figure 1. The 6 steps and 14 decisions of the SLR process (Sauer & Seuring, 2023)

The search process used primary keywords such as "PjBL," "creativity," "learning media," and "biology learning," which were strategically combined using Boolean operators (and, or) to increase the precision and scope of the search. Data collection was conducted through Publish or Perish software, which was retrieved from two academic databases: Scopus, Google Scholar, Pumbed, Open Alex, Semantic Scholar, and Crossref. The search was limited to articles published between 2020 and 2025.

The entire article selection process is illustrated through a PRISMA flowchart, which outlines the number of articles identified, excluded, and finally included in the final analysis. The culmination of this SLR process is the identification of key findings summarized in a report that shows whether PjBL integrated into learning media effectively improves students' learning outcomes and creativity in science

topics. This structured and transparent methodology ensures that SLRs are conducted with academic rigor, accountability and clarity (Idris et al., 2022).

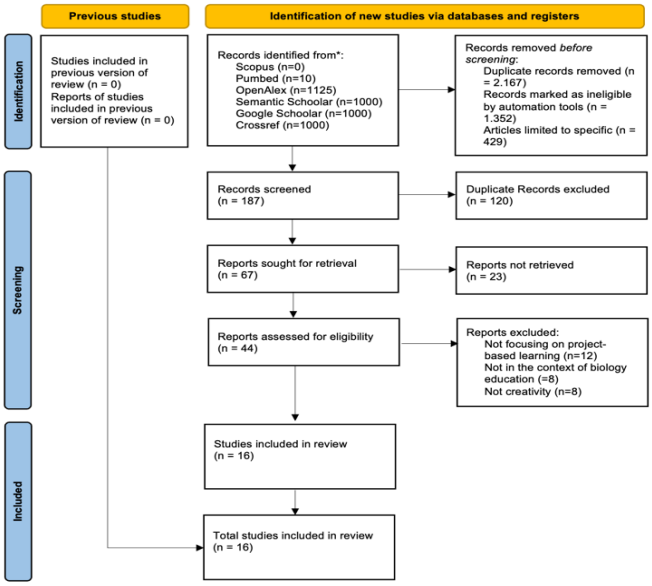

Figure 2. Systematic literature review methodology PRISMA flow diagram

Article Selection Criteria

Of the total 3,135 articles initially retrieved, only 16 articles were deemed relevant and included as reference materials for this study. The inclusion was based on certain criteria, including articles written in Indonesian and directly related to the field of education—specifically research discussing the development of media that integrates Project-Based Learning (PjBL) aimed at improving student crearivity. A total of 3,123 articles were excluded because they focused on unrelated disciplines such as economics, health, and psychology.

The search strategy was further refined using the keyword 'learning media' and restricted to open access publications, resulting in the selection of 16 articles. After a thorough review, the excluded articles were found to be outside the scope of education, not aligned with the research objectives, or using appropriate methodologies. Detailed inclusion and exclusion criteria are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria (Accepted Articles)	Exclusion Criteria (Article Rejected)
Articles published between January 1, 2020, and August 3, 2025.	Publications dated outside the range of January 1, 2020, to August 3, 2025.
Development research.	Not development research.
Mainly focused on project-based learning in the context of biology education and creativity.	Not focusing on PjBL in the context of biology education and creativity.
Freely accessible in full-text format (open access).	Not available in full text or restricted (closed access).

Second Phase: Bibliomertic Analysis

We continued our analysis with a bibliometric analysis. This approach employs quantitative techniques to characterize, assess, and monitor published research outputs, thereby enhancing objectivity and transparency while mitigating biases commonly associated with qualitative methods (Zhang et al., 2025). By systematically quantifying key metrics, this method facilitates an impartial examination of the relevant literature, enabling the identification of collaboration networks, keyword distributions, and overarching trends in scientific publication dynamics.

Data for this study were extracted from the Google Scholar database, selected for its extensive indexing of globally recognized scientific journals. The search was confined to publications issued between 2020 and 2025 and restricted to document types including journal articles, conference papers, conference reviews, and review articles. A rigorous screening process was implemented to ensure that only studies directly pertinent to the research topic and meeting established quality criteria were included. To guarantee thematic relevance, keyword selection was carried out with precision. Search queries combined terms such as "PjBL" AND "learning media" AND "biology," ensuring that the retrieved literature accurately reflected the intersection of project-based learning integration and biology education objectives.

This process began with data collection from the Google Scholar database, followed by article selection based on inclusion criteria, data processing, bibliometric analysis, visualization of results, and interpretation of insights. Each phase was carefully designed to uphold the validity and relevance of the findings. A flowchart of the research framework is provided to visually represent the workflow and clarify the sequential steps of the study (Engeness, 2021).

The metadata for all retrieved publications were extracted from Google Scholar and subjected to initial processing in Microsoft Excel, where records were cleaned, consolidated, and semantically equivalent keywords were harmonized. This preprocessing step ensured consistency in term usage and prepared the dataset for downstream analysis. The refined dataset

was then imported into VOSviewer for comprehensive bibliometric mapping. VOSviewer was selected for its advanced capabilities in rendering interactive network, overlay, and density visualizations. These graphical outputs enabled the identification of co-occurrence patterns, thematic clusters, and dominant research trajectories within the literature. A subsequent descriptive analysis of these visualizations provided insight into the evolution of research topics and the prevailing disciplinary emphases.

Result and Discussion

The results of the analysis of 16 articles that met the inclusion criteria are presented in a table to highlight students' creativity skills by integrating PjBL in biology learning media.

First Phase Methodology: Systematic Literature Review (SLR)

Research on the integration of Project-Based Learning PjBL in effective learning media in improving creativity in biology topics that have been published in the last 5 years can be seen in Table 2. This literature review aims to provide information related to the integration of Project-Based Learning PjBL in biology learning media to improve learning outcomes. Articles were searched from the Scopus, Google Scholar, Pumbed, Open Alex, Semantic Scholar, and Crossref databases. This search resulted in 3,135 articles. Then identification was carried out to find similar articles resulting in 2,167 articles. A total of 968 articles that did not have similarities were then reviewed based on their titles. The criteria used to select articles were articles containing PjBL strategies integrated into learning media in biology learning, articles written in Indonesian, articles from SINTA indexed journals, and articles that were only sourced from research results. This screening process resulted in 187 eligible articles. The screening process was continued by reading the abstract. The selection of articles was based on several criteria, namely articles that explain the effect of PjBL-based learning media on science learning on learning outcomes and the screening process resulted in 16 articles.

The entire identification and screening process is described in detail in Figure 2. A total of 16 articles selected in the initial stage of the selection process were reviewed in depth by the three researchers simultaneously. This review process was carried out carefully to ensure that each article met the inclusion criteria that had been set and was relevant to the focus of the study. If there were differences of opinion or review results between the three researchers, intensive discussions were held to align perceptions and reach a standard agreement. This collaborative approach aims to minimize subjectivity, increase the validity of the review results, and ensure that each selected article makes a significant contribution to the analysis and findings of the study. Thus, this review process not only prioritizes caution but also academic integrity in the preparation of the SLR. The results of the review can be presented in the following paragraph. Results should be clear and concise. The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Table 2. Article about Integrated PjBL of Learning Media for Creativity in Biology Topics in the Last 5 Years

Code	Authors	Type of Learning Media	Results
A1	Darmastuti et al. (2025)	E-Module	In this study, the e-module was not only well-aligned with the curriculum objectives but also produced a measurable enhancement in students' creative thinking. The mean normalized gain (N-Gain) for creative thinking was 0.45.
A2	Triandro et al. (2025)	E-Book	The findings of this study demonstrate that the use of e-books in the learning process significantly enhances students' creative thinking abilities. With an overall normalized gain (N-Gain) score of 0.73, categorized as high according to Hake's criteria, the e-book intervention proved to be highly effective in fostering creativity. This substantial gain indicates that students showed marked improvement in key aspects of creative thinking, including originality, fluency, flexibility, and elaboration.
A3	Hulu et al. (2024)	Pop-Up Book	The results of this study indicate that the pop-up book media was not only deemed highly feasible for classroom implementation, but also demonstrated a strong positive impact on students' creative thinking abilities. In Cycle II, 96% of students achieved the 'very good' category in the assessed creative dimension, reflecting a substantial improvement compared to previous cycles.

Code	Authors	Type of Learning Media	Results
A4	Sarwati et al. (2024)	Teaching Module	In this study, revealed significant gains in creative thinking skills. The mean pre-test score of 56.3 (SD = 8.4) increased to 78.9 (SD = 7.1) on the post-test, corresponding to a normalized gain (N-Gain) of 0.60 classified as "high". Paired-samples t-tests confirmed this improvement was statistically significant ($t(119) = 22.45$, $p < 0.001$), with a large effect size (Cohen's $d = 2.05$).
A5	Supiati et al. (2025)	LKPD	Expert evaluation confirmed the Student Worksheets (LKPD) achieved very high validity scores, establishing their suitability for guiding scientific inquiry. When implemented in the classroom, the LKPD produced a notable enhancement in students' creativity, with a mean normalized gain (N-Gain) of 0.60 classified as high.
A6	Alif et al. (2020)	E-Book	In this study, the e-book confirmed its high feasibility and practical applicability for fostering students' creative thinking skills. The intervention assessments yielded a mean normalized gain (N-Gain) of 0.76 classified as high according to Hake's criteria.
A7	Sari et al. (2025)	E-Module	This research confirmed the e-module effectively enhances students' creative thinking abilities. Following its implementation in a classroom setting, the e-module demonstrated a strong impact on student creativity, as evidenced by a normalized gain (N-Gain) score of 0.68, thesignificant gain indicates that the e-module successfully improved students' performance across key indicators of creativity.
A8	Zulfa et al. (2023)	LKPD	This study was designed to evaluate the effectiveness of a developed LKPD in enhancing students' creative thinking abilities. Through a structured implementation involving pre- and post-tests, the research revealed a significant improvement in students' creativity, as evidenced by a normalized gain (N-Gain) score of 0.73. The high N-Gain indicates that the LKPD successfully fostered growth across key dimensions of creative thinking, including fluency, flexibility, originality, and elaboration.
A9	Rori et al. (2021)	E-Module	The results revealed a significant improvement, with a normalized gain (N-Gain) score of 0.70. This indicates that the e-module not only succeeded in increasing student interest but also substantially elevated their creative thinking performance.
A10	Hippy et al. (2024)	Lesson Plans (RPP) and Student Worksheets (LKPD)	In this study, The Lesson Plans (RPP) and Student Worksheets (LKPD) proved to be both practical and pedagogically effective in enhancing students' creative thinking abilities. This study revealed a normalized gain (N-Gain) score of 0.67, which falls within the "high" category. This indicates a significant increase in students' ability to generate original ideas, demonstrate flexible thinking, and elaborate on concepts with depth and detail.
A11	Yana & Khairuna (2024)	Animated Video Learning Media	This study revealed the animated video media demonstrated a significant impact on enhancing students' creative thinking skills. Quantitative analysis of pre- and post-test results revealed a normalized gain (N-Gain) score of 0.74. This indicates a substantial improvement in students' ability to generate original ideas, think flexibly, and elaborate on concepts with depth and creativity.
A12	Shodiq et al. (2025)	Science Learning Module	The study confirmed the module significantly enhanced students' creative thinking abilities. Quantitative analysis revealed a normalized gain (N-Gain) score of 0.76. This substantial gain reflects meaningful improvements in students' capacity for idea generation, flexible problem solving, originality, and elaboration.
A13	Lissa et al. (2025)	Scrapbook Media	The results of scrapbook media was not only pedagogically sound but also highly effective in stimulating student creativity. Statistical analysis yielded a t-count of 1.82, which exceeds the t-table value of 1.73. As a result, this scrapbook significantly enhances student creativity.
A14	Royanti et al. (2020)	Interactive IPAS Learning Media	The Interactive IPAS Learning Media showed a significant positive impact on students' creative thinking abilities. Quantitative analysis of pre- and post-test scores revealed a normalized gain (N-Gain) of 0.71. This substantial gain reflects marked improvements across core dimensions of creativity, including fluency in generating ideas, flexibility in approaching

Code	Authors	Type of Learning Media	Results
			problems, originality in concept development, and elaboration in expressing thoughts.
A15	Fitriani et al. (2024)	e-Teaching Module	In this study, the e-Teaching Module was found to be both pedagogically feasible and impactful. Quantitative results from pre- and post-test assessments revealed a normalized gain (N-Gain) score of 0.70. This significant gain demonstrates the module's effectiveness in enhancing students' creative thinking abilities.
A16	Azis (2023)	Canva Media	The implementation of canva media produced a normalized gain (N-Gain) of 0.74 in students' creative thinking skills classified as "high" by Hake's criteria and was 27.5% more effective than the traditional inquiry-based method, which yielded an N-Gain of 0.58. This substantial improvement reflects marked gains across all creativity.

The results of the study showed that the PjBL model integrated into learning media had a positive impact on students' creativity. This is in accordance with the research of Supiati et al. (2025) which stated that the PJBL model integrated into e-LKPD is able to help students explore concepts through experiments, group discussions, and solving real problems with the help of projects that improve student creativity. Based on several previous studies, it was found that there was an increase in creativity through e-LKPD by integrating PjBL in student activities.

In the research of Zulfa et al. (2023) proven effective in improving students' creative thinking skills in biotechnology phase E at SMAN 2 Lubuk Alung. The results showed that students' creative thinking skills in the experimental class (which used LKPD-PjBL integrated with local wisdom) were higher than those in the control class. Quantitatively, the average posttest score for the experimental class was 79, higher than the control class's score of 64. The results of the hypothesis test showed a significance value (2-tailed) of <0.05 (0.01 in the abstract and 0.000 in the hypothesis test results table), confirming the positive effect of using LKPD-based PjBL integrated with local wisdom on students' creative thinking skills. Furthermore, the N-gain results showed a category of "Effective" for the experimental class (53%) and "Ineffective" for the control class (28%), concluding that the use of LKPD integrated with PjBL was 25% more effective in improving students' creative thinking skills. This local wisdom-based PjBL model provides opportunities for students to develop creative thinking through discussions and project implementation, encourages them to be more active in learning, and helps them understand the material conceptually and relevantly to everyday life.

In the research of Darmastuti et al. (2025) the development of e-module based PjBL on virus material has proven effective in increasing student creativity. Based on the research results, the use of PjBL e-modules resulted in a significant increase in students' creative thinking abilities. There was an increase in creative thinking with an N-Gain value of 60% in the medium category. E-module resulted in an average increase in creativity of 42.10% with an N-gain score of 0.77 in the high category. This PjBL e-module provides learning experiences through the completion of real projects, facilitates student-centered learning, and encourages active involvement, which ultimately fosters creative thinking abilities. Also, in the research of Agung et al. (2023) stated that further research is needed on media in the form of e-modules based on PjBL to really emphasize in classroom learning using teaching materials that have been integrated with character education in order to train students to remain critical but have good character in improving student creativity (Kusuma & Mustaji, 2023).

Meanwhile, in the research of Sari et al. (2025) the e-module based PjBL developed on Virus material has been proven effective and feasible to be used to improve the creative thinking skills of grade X students. The results of the effectiveness test using N-Gain show that the increase in students' creative thinking abilities is in the moderate category. This PjBL e-module is designed with a syntax that encourages students to be active, discuss, and seek various original ideas to solve problems in the project, which ultimately can improve students' creativity. Also, Rori et al. (2021) proves that the e-module integrated PjBL very effective in increasing student creativity. This effectiveness is measured through the N-Gain test which obtained a value of 0.76 with a high category. This increase in student creativity is due to the PjBL e-module providing students with the opportunity to create projects that are the result of their own ideas, so that aspects of students' creative thinking abilities can develop optimally (Gurusinga, 2025).

However, in the research of Makatita et al. (2024) learning media in the form of teaching tools has a very positive impact on improving student creativity with research results showing that the learning tools developed significantly improve students'

understanding of the material and their ability to answer questions, as seen from the average student score which is in the range of 81-85 with a relative frequency of 20%. This is because students have an understanding of relevant science through PJBL-integrated learning media (Makatita et al., 2024; Maghfiroh & Agustin, 2024).

In the research of Triandro et al. (2025) proves that the e-book integrated with PjBL on the subject of Biological Technology Innovation is proven to be effective in training the creative thinking skills of high school students. This e-book is declared effective because it shows an increase in learning outcomes with an overall N-Gain score of 0.73, which is in the high category. Furthermore, the project assessment that measures students' creative thinking skills reached 89.2%, which is classified as very effective (Triandro et al., 2025). In the research of Alif et al. (2020), the results showed that E-Book integrated to PjBL showed the effective for use in learning, as evidenced by the N-gain score of 0.76, which is in the high category. This e-book is designed to encourage students' active involvement in hands-on experiments and project assignments to improve creativity.

In the research Hulu et al. (2024) proves that the PjBL integrated pop-up book can increase creativity in students as evidenced by the overall gain score (N-Gain) of 0.73, which is included in the high category. In addition, this PjBL integrated pop-up book is also considered very effective in training creative thinking skills, with an average student project assessment reaching 89.2% which is included in the very effective category. Overall, the developed pop-up book is feasible, practical, and effective for training students' creative thinking skills (Maghfiroh & Agustina, 2024).

In the research Sarwati et al. (2024) proves that the integrated biology teaching module PjBL for the Circulatory System material for grade XI students is declared feasible, ideal, and effective for use in the learning process. The effectiveness of the teaching module in improving students' creative thinking skills is shown through the results of a large-scale trial, where the experimental class which uses the PjBL teaching module obtained an N-Gain score of 0.60 quite effective category, while the control class only obtained an N-Gain of 0.28 low category. In addition, the assessment of the PjBL integrated worksheet also shows that the teaching module is in the very creative category for training students' creative thinking skills. This increase occurs because the use of the PjBL integrated teaching module can produce and increase students' creative thinking skills compared to conventional methods (Iskandar, 2023; Sari et al. 2025).

The integration of the PjBL model into Canva Media has been shown to significantly improve students' creative thinking skills. This finding is based on data analysis using ANCOVA, which showed that the experimental group had higher creative thinking skills than the control group. This improvement was assessed based on five indicators of creative thinking: fluency, originality, elaboration, flexibility, and metaphorical thinking (Azis, 2023). The integrated PjBL to Learning Implementation Plan (RPP) has been proven valid and very practical. Practicality is demonstrated by observations of learning implementation, which reached an average of 94.44% with very good criteria and student responses of 80% with good criteria. This RPP is considered successful in facilitating increased student creativity (Hippy et al., 2024).

The Science Teaching Module integrated with PjBL can improve Creative Thinking Skills. This module was developed based on the ADDIE model and was declared feasible through expert validation. PjBL is believed to be effective because it encourages students to generate new ideas and solve environmental problems innovatively (Shodiq et al., 2025). The integration of the PjBL model through the creation of scrapbook media on the Body's Defense System material demonstrated effectiveness in enhancing student creativity. The results showed that students' creativity in making scrapbook products had an average value of 83.28%, categorized as good. Although the average product creativity was at 74.53% quite creative, the overall results confirmed that the PjBL model with visual media such as scrapbooks was successful in developing students' creativity aspects in schools (Lissa et al., 2025; Fitrah et al., 2025).

For integrated PjBL Science Interactive Learning Media for fifth grade elementary school students can improve student creativity. The validation results show that this media is very feasible and practical, with an average percentage of media experts of 89.00% and material experts of 98.07% very feasible criteria. Although the results of the effectiveness test using N-Gain are not presented in the abstract, the student response questionnaire in the small group test obtained an average of 95.00% and a large group of 96.07% very practical criteria, which indicates that the media is highly accepted and facilitates project-based learning that demands creativity (Royanti et al., 2020).

The PjBL integrated animation video learning media on the Blood Circulation System Grade XI Science material shows that the media is valid, practical, and suitable for use in learning. This suitability is proven by the assessment of validators from material experts, media experts, and positive responses from students and teachers. This PjBL animation video is designed as a science and technology-based learning innovation that aims to support and optimize the learning process and active student involvement in project activities. (Yana & Khairuna, 2024). Finally, the integrated PjBL teaching

module on Environmental Change can improve students' critical and creative thinking skills. This provides a strong basis for the need for PjBL media such as this to achieve the goal of developing 21st-century thinking skills, including students' creative thinking abilities (Fitriani et al., 2024).

Table 3. Article Material of Biology Topics

Code Article	Biology Topics
A6	Growth and Development
A1	Virus
A14	IPAS
A15, A5, A12	Environmental Change and Pollution
A16	Ethnobotany
A10	Digestive system
A3, A11	Bloodstream System
A13	Body Defense System
A9, A4	Ecosystem
A7	Ecology
A2	Biological Technology Innovation
A8	Ethnoscience

Based on Table 3, the integration of the PjBL model into Biology learning media allows students to be more active, independent, and directly involved in understanding biological concepts through contextual projects. The table, which lists several biology activity codes and topics, shows that the PjBL approach can be effectively implemented in various materials, such as Growth and Development, Viruses, Natural Sciences, Environmental Change and Pollution, Ethnobotany, Digestive System, Bloodstream System, Body Defense System, Ecosystem, Ecology, Biological Technology Innovation, and Ethnoscience.

Specifically, for highly contextual and pressing topics such as Environmental Change and Pollution, identified in the table by codes A5, A12, and A15, PjBL offers an undeniable logical foundation for in-depth and applicable learning. Students go beyond memorizing definitions of water, air, or soil pollution, but are instead encouraged to engage directly in critical observation and analysis of their surroundings. The projects are hands-on and demand practical solutions, such as building a simple water filtration device to address local river pollution, designing a composting system to manage school organic waste, or creating a model air filter in response to urban pollution problems. Thus, PjBL not only enhances mastery of Biology material (cognitive) and problem-solving skills (psychomotor), but also fosters an attitude of responsibility and environmental literacy (affective), which are the primary goals of 21st-century science education. This direct involvement fundamentally strengthens understanding, transforming abstract Biology concepts about environmental change into personal issues that require concrete action (Supiati et al., 2025; Shodiq et al., 2025; Fitriani et al., 2024).

Meanwhile, on the crucial topic of the Bloodstream System, which includes codes A3 and A11, projects can be directed at transforming abstract physiological processes into tangible, creative, and problem-solving products. Rather than merely memorizing diagrams, students are challenged to become innovators and communicators. Projects could involve designing a working, low-cost model of the heart using recycled materials, allowing students to creatively solve the engineering challenge of simulating blood flow and the four chamber mechanism. Alternatively, students could be tasked with creating an interactive digital animation or a short film that tells the "story of a red blood cell," demanding not only accurate biological understanding of oxygen transport but also creative flair in scriptwriting, visual design, and narrative structure (Hulu et al., 2024; Martinez, 2022).

This shift from passive absorption to active creation whether through a physical model (Fluency and Elaboration) or a multimedia narrative (Originality and Flexibility) forces students to think divergently. By giving students, the freedom to choose their medium and approach, PjBL on the Bloodstream System inherently cultivates the four key indicators of creativity and empowers them to express complex biological concepts in unique and memorable ways (Yana & Khairuna, 2024).

Furthermore, in the crucial topic of Ecosystem, represented by codes A9 and A4, the application of PjBL in learning media serves as a powerful catalyst for enhancing student creativity. Projects in this domain go beyond textbook definitions, leading students to engage in practical, real-world applications. Projects can be directed at designing and building self-sustaining mini-ecosystem models such as terrariums or aquaponics systems. This task inherently demands creative problem-solving as students must innovate within material constraints, balance complex biological variables (e.g., light exposure, water cycles, organism interactions), and develop aesthetically pleasing yet scientifically sound designs. Furthermore, the scope of the project can be expanded to include developing digital interactive maps or multimedia guides detailing the flora, fauna, and specific ecological challenges in their schoolyard or neighborhood park. This requires creative skills in data visualization, digital storytelling, and audience-relevant communication. By synthesizing scientific data with imaginative design and presentation, students transform abstract ecological concepts into tangible, innovative, and functional media, thus demonstrating significant leaps in the creative and analytical skills necessary for a deeper conceptual

understanding of the environment (Lombardi et al., 2021; Pratiwi et al., 2023).

Overall, the power of integrated PjBL in biology learning media in fostering student creativity is best observed in its adaptability across various biology and integrated subjects. For topics such as Growth and Development (A6), Viruses (A1), Ethnobotany (A16), and the Digestive System (A10), projects are creatively directed toward developing innovative physical or digital models, such as 3D simulations of virus mechanisms, interactive growth diagrams linking lifestyle to development, or virtual tours of traditional medicinal plant gardens. Similarly, when studying the Body's Defense System (A13), students go beyond memorization to design public awareness campaigns or gamified educational tools that creatively explain immunological concepts. For integrated topics such as Science (A14), Ecology (A7), Ethnoscience (A8), and Biological Technology Innovation (A2), the scope of projects broadens students, encouraging them to design entirely new solutions. This could include using Ethnoscience to inform a Biotechnology project on sustainable agriculture (A8 and A2), or designing a comprehensive ecological restoration plan (A7) using digital mapping tools. By requiring students to transform abstract concepts (such as viral replication or immune response) into tangible, communicable outcomes (such as models, campaigns, or technological innovations), PjBL forces them to engage in higher order thinking, moving from simple memorization to the synthesis and creative application of biological knowledge. This practical challenge is a core mechanism by which PjBL measurably unlocks and enhances students' problem solving and creative presentation skills (Darmastuti et al., 2025; Alif et al., 2020; Royanti et al., 2020; Hippy et al., 2024; Azis, 2023; Lissa et al., 2025; Sari et al., 2025; Triandro et al., 2025; Zulfa et al., 2023).

Meanwhile, on the topic of Bloodstread System which includes codes A3 and A11, projects can be directed at classifying local species, recording endangered flora and fauna, to campaigns for the preservation of certain species through social media or digital posters. Learning media in the form of plant and animal identification applications, as well as interactive biodiversity maps, can strengthen the learning process. With the PJBL approach, students not only understand the importance of biodiversity in theory, but are also able to contribute to its preservation through real projects. For the topic of the respiratory system, which includes codes A7 and A1, PJBL integration can be carried out through a project to create a human respiratory system model, simulate the impact of air pollution on the respiratory system, or provide counseling on the dangers of smoking. The use of digital media integrated with PJBL is an important supporter to clarify abstract concepts that are difficult to imagine only through text. PJBL in this topic provides students with the opportunity to explore the relationship between lifestyle and the health of their own respiratory system (Rianti et al., 2024).

Finally, on the topic of the skeletal system which only involves code A12, the PJBL approach can be applied through a project to create a human skeleton model from recycled materials, a case study of bone injuries, or an introduction to the role of calcium in bone formation through simple experiments. Learning media can be in the form of 2D anatomy applications or demonstration videos explaining the working mechanisms of joints and bones. Although the scope is narrower than other topics, PJBL can still deepen students' understanding with a practical and applicable approach (Nilimaa, 2023).

Overall, the integration of PJBL in Biology learning media not only facilitates in-depth understanding of concepts, but also fosters 21st-century skills, such as collaboration, communication, problem solving, and digital literacy. Through carefully designed topic-based projects supported by the right media, Biology learning becomes more meaningful, relevant, and impactful to students' real lives.

Based on Table 3, the integration of Project-Based Learning (PJBL) in biology learning media provides a great opportunity to improve student learning outcomes, especially when adjusted to the proportion of topics taught. Based on the topic distribution table, the majority of learning focus (60%) is on the topic of ecosystems, followed by biodiversity (30%), respiratory system (20%), and skeletal system (10%). PJBL is very relevant to be applied to the topic of ecosystems because the project-based approach allows students to explore the interactions between living things and their environment directly through field observations, the creation of artificial ecosystems, or simulations of food chains and food webs using interactive digital media (Penuel et al., 2022).

Activities like this not only improve students' conceptual understanding, but also develop critical thinking, collaboration, and problem-solving skills. On the topic of biodiversity, PJBL can be integrated through a species inventory project in the school environment, the use of flora and fauna identification applications, and the creation of a digital catalog of local species (Niemiller, 2021; Wilson, 2024). This not only enriches students' learning experiences contextually, but also fosters awareness of environmental conservation. Meanwhile, although the portion of the respiratory system (20%) and skeletal system (10%) topics is smaller, the PJBL approach is still effective to implement. For example, students can create simple anatomical models using recycled materials or create simulation videos of

breathing and body movements. Integration of digital learning media, such as animation, interactive videos, and collaborative platforms, can strengthen students' learning experiences in these projects (Pramesti, 2024; Saifiana & Purnomo, 2017).

Overall, the implementation of PJBL that is adjusted to the proportions of each topic allows for more meaningful and in-depth learning. According to previous research with the active involvement of students in the learning process through projects, both exploratory and creative, learning outcomes not only improve cognitively, but also affectively and psychomotorically (Limbu, 2024; Qomar & Fitri, 2024). This strategy also fosters students' sense of responsibility for their learning outcomes and provides space for them to develop 21st century skills, such as communication, collaboration, and digital literacy.

Table 4. School Level

Code Article	Level
A14	Elementary School
A10, A3, A7, A12	Junior High School
A6, A1, A15, A13, A9, A4, A5, A2, A11, A8	Senior High School
A16	University

Based on Table 4, the integration of the PjBL into learning media has been proven to be an effective strategy in improving student creativity at various levels of education, from Elementary School to University. Based on the grouping of topic codes listed in the table, the implementation of PJBL appears to be adjusted to the needs and characteristics of students at each level. At the Elementary School level (A14), the integration of PjBL tends to be directed at developing basic skills such as collaboration, creativity, and understanding simple concepts through fun and contextual activities. The learning media used, such as animated videos, interactive images, and educational games, are a means that greatly support the PjBL approach because they are able to bridge the understanding of concepts through direct and concrete experiences (Suwono et al., 2023; Waang, 2023).

Meanwhile, at the Junior High School level (A10, A3, A7, A12), the PjBL approach begins to focus on improving critical thinking and problem-solving skills. The learning media used are generally more complex, such as digital simulations, small research-based projects, or online collaborations that allow students to construct knowledge independently but in a directed manner. PjBL in this context is not only a learning tool, but also a means to form the character of independence and responsibility in students.

Meanwhile, at the Senior High School level (A6, A1, A15, A13, A9, A4, A5, A2, A11, A8), the integration of PJBL is focused on the development of 21st century competencies such as problem-solving, critical thinking, and communication skills. Learning media at this level are more varied and often utilize advanced technology, such as programming, interactive multimedia, and online collaborative platforms. According to previous research that jJBL is a means that challenges students to think deeply, design real solutions, and present the results in the form of projects that are relevant to everyday life and the world of work (Karan & Brown, 2022; Ananda et al., 2023). The prevalence of PjBL integrated learning media in high schools is rooted in constructivism and the development of 21st-century skills.

Scientifically, PjBL mirrors the authentic process of scientific inquiry by requiring students to address complex, real-world biological problems (e.g., studying the imbalance of a local ecosystem or designing a new water filtration method). This hands-on, student-centered approach moves beyond rote memorization, promoting deeper content mastery and long-term retention because high school students actively construct knowledge rather than passively receive it. Logically, media integration provides the necessary tools digital simulations, data analysis software, or collaboration platforms that enable high school students to engage in necessary scientific practices, such as critical thinking, data synthesis, and creative problem-solving, effectively bridging the gap between theoretical knowledge and practical, real-world biological applications (Wibowo et al., 2024; Wida et al., 2024).

Finally, at the university level, the integration of PjBL into biology instruction moves beyond basic conceptual understanding to an intense focus on developing advanced 21st century competencies essential for career readiness, particularly complex problem-solving, critical thinking, interdisciplinary collaboration, and sophisticated professional communication skills. According to the statement from Branco et al. (2021) that learning media at this stage are not simply supporting tools, but often integral to the solution itself, frequently utilizing advanced technology platforms such as bioinformatics software, statistical modeling programs, genomic sequencing databases, and real-time collaborative data analysis tools. Research confirms that PjBL at the university level serves as a crucial mechanism that challenges students to engage in deep analytical thinking, design evidence-based solutions to complex and open-ended problems, and ultimately present their findings in the form of scholarly projects such as grant proposals, clinical reports, or technical papers that are directly relevant to contemporary research and the professional world (Nabi et al., 2025; Amin et al., 2025; Lutfi et al., 2025).

Overall, the grouping of codes based on education level reflects an important differentiation approach in the integration of PJBL into learning media. The implementation of PJBL that is right on target, in accordance with the level of cognitive and social development of students, will provide a more meaningful learning experience and significantly improve learning outcomes. Therefore, teachers need to design adaptive, innovative, and contextual learning media so that PjBL can run optimally at every level of education.

Second Phase: Bibliometric Analysis

In this section, we present our findings from the bibliometric analysis. We identify key contributions to the field, the dominant countries in the research output, and the main themes underlying the existing research that addresses our research questions.

Table 5. 16 Citations on Integrated Biology Learning Media Trends: PjBL Model to Enhance Research Creativity in 2020-2025

Authors	Journal	Total Citations	Total Citations/ Year
Darmastuti et al. (2025)	Quagga: Jurnal Pendidikan dan Biologi	23	11.5
Triandro, et al. (2025)	Bioedu: Berkala Ilmiah Pendidikan Biologi	22	11.0
Hulu, et al. (2024)	Jurnal Metabio: Jurnal Pendidikan Biologi	18	6.0
Sarwati, et al. (2024)	Jurnal Pendidikan, Sains, Geologi, dan Geofisika	17	5.6
Supiati et al. (2025)	Pedagogi Biologi: Jurnal Pendidikan dan Pembelajaran Biologi	19	6.3
Alif, et al. (2020)	Bioedu: Berkala Ilmiah Pendidikan Biologi	10	5.0
Sari, et al. (2025)	Jurnal Kiprah Pendidikan	10	5.0
Zulfa, et al. (2023)	Jurnal Pengabdian Masyarakat dan Riset Pendidikan	11	5.5
Rori, et al. (2021)	Jurnal Pengabdian Masyarakat dan Riset Pendidikan	12	6.0
Hippy, et al. (2024)	Didaktika: Jurnal Kependidikan	13	4.3
Yana & Khairuna (2024)	Bioscientist: Jurnal Ilmiah Biologi	15	5.0
Shodiq, et al. (2025)	Jurnal Penelitian Pendidikan IPA	10	5.0
Lissa, et al. (2025)	Hikmatul Journal of Multidisiplin	16	8.0
Royanti, et al. (2020)	Indonesian Journal of Educational Technology	17	8.5
Fitriani, et al. (2024)	Jurnal Pendidikan dan Pembelajaran Indonesia	16	5.3
Azis (2023)	Jurnal Pendidikan Teknologi Informasi	10	5.0

A comprehensive analysis of direct citations identified the 16 cited articles, with a minimum threshold of 10 citations, as detailed in Table 5. The lead author of this paper also has a significantly high average number of citations. This article explores the integration of PjBL with learning media. This research provides a strong foundation for advocating for the integration of PjBL in learning media.

Based on Table 6, the data clearly highlights the dominance of certain keywords, indicating their centrality to the research domain. "PjBL" is the most frequent term, appearing 351 times with the highest Relevance score of 4.6. This high occurrence and relevance unequivocally establish Project-based Learning as the primary focus or core theme of the analyzed literature. Following closely is "Project" with 321 occurrences and a Relevance of 4.2, reinforcing that the studies heavily revolve around the practical application and implications of project work. The third most frequent term is "Biology" (221 occurrences, Relevance 3.0), suggesting that a substantial portion of the research is situated within the biological sciences education context. This cluster of the top three keywords defines the foundational area of the research: the application of PjBL projects within Biology education. The next tier of keywords "Creativity" (172 occurrences, Relevance 2.5) and "Model" (168 occurrences, Relevance 2.2) suggests a research focus on the outcomes of PjBL and the theoretical or implementation frameworks used.

Table 6. Keywords on Trend Modern Physics Learning Media Based on Interactive Web Using the PjBL Model to Improve Creativity Research in 2015-2024

Terms	Occurrences	Relevance
PjBL	351	4.6
Project	321	4.2
Biology	221	3.0
Creativity	172	2.5
Model	168	2.2
Learning Media	140	2.0
Elementary School	60	0.9
Teacher	34	0.7
Science	39	0.6
Senior High School	18	0.4

Specifically, researchers are keenly interested in how PjBL influences students' creativity and the various instructional models employed to facilitate it. "Learning Media"(140 occurrences, Relevance 2.0) further emphasizes the importance of tools and

resources in the implementation of these models. Keywords related to the educational level and personnel, such as "Elementary School" (60 occurrences, Relevance 0.9), "Teacher" (34 occurrences, Relevance 0.7), "Science" (39 occurrences, Relevance 0.6), and "Senior High School" (18 occurrences, Relevance 0.4), appear less frequently and have lower relevance scores. This distribution suggests that while research occurs across various educational levels and addresses the role of teachers, the primary intellectual gravity remains on the core pedagogical approach (PjBL/Project) and its application in a specific subject (Biology), rather than on context-specific research about different school levels or the teaching profession itself. In summary, the bibliometric landscape is heavily invested in examining the impact, models, and tools of Project-based Learning as applied within Biology education, with other contextual factors playing a supporting but less central role (Zulkarnaen et al., 2025; Yuliani et al., 2025; Fauzi et al., 2025).

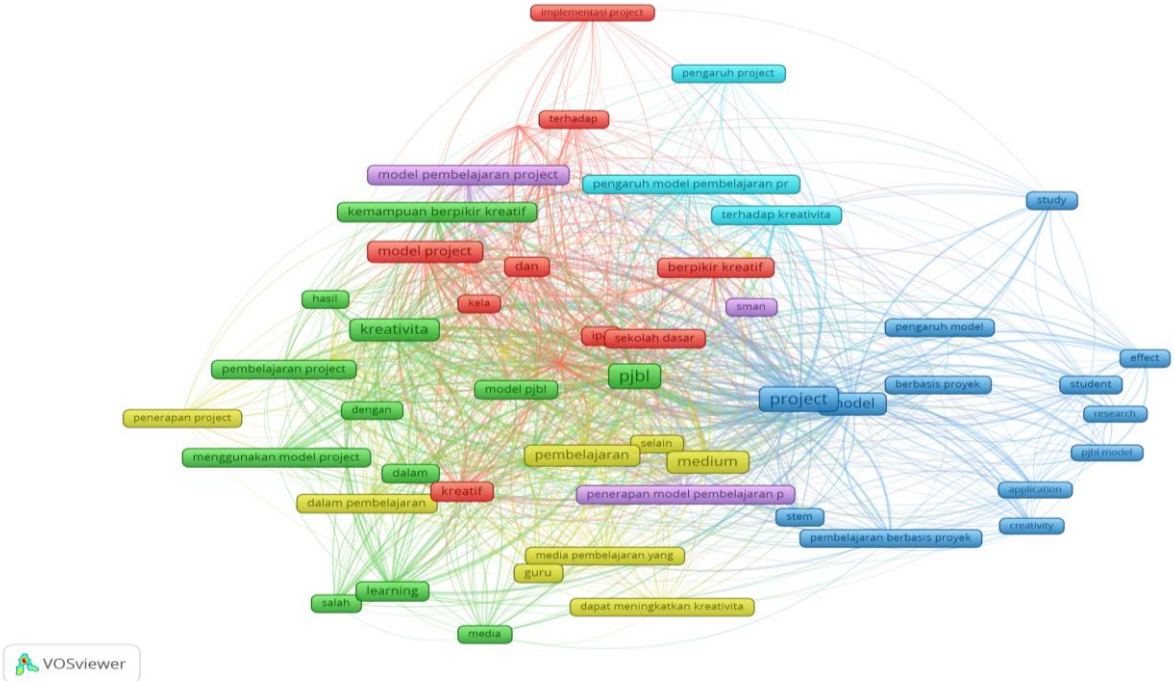

Figure 3. Network visualization on PjBL into learning media increases creativity on biology topics

From Figure 3, the provided VOSviewer co-occurrence network map offers a detailed visual representation of the intellectual structure and primary research themes within the analyzed bibliometric data, emphatically confirming the strong scholarly focus on the nexus between PjBL, learning media, and the enhancement of creativity. The visualization is characterized by several densely interconnected clusters, with the research core defined by the central Green Cluster, encompassing the highly central and frequently co-occurring nodes PjBL, project, and media pembelajaran (learning media). This centrality establishes Project-based Learning and the tools used for its delivery as the undisputed foundational themes of the research landscape. A crucial finding is the robust intellectual coupling between this central Green Cluster and the adjacent Red Cluster, which is anchored by the key outcome variable kreativitas (creativity) and the specific subject domain biologi (biology).

The strong, thick lines connecting these clusters often mediated through terms like 'siswa' (students) and 'pembelajaran biologi' (biology learning) provide compelling visual evidence that a major, highly active research frontier in this domain investigates the impact of PjBL and its integration with specific learning media on the development of student creativity, predominantly within the biological sciences education context.

The map thus structurally validates the research focus on using PjBL, supported by media, as a pedagogical strategy to achieve creativity outcomes. Furthermore, the network shows an expansion into related areas, such as the Purple Cluster (including STEAM, science, and technology), which suggests an emerging interdisciplinary trend where the PjBL-media-creativity dynamic is being explored within broader integrated curriculum models. The less central Yellow Cluster (focusing on 'penerapan model project' or application of the project model and 'hasil' or results) and the Blue Cluster (covering general methodological terms like 'research' and 'implementation') underscore that the existing literature is not only focused on the

theoretical linkage but also on the practical implementation and evaluation of these instructional models. In essence, the proximity and strength of the links among PjBL, learning media, and creativity nodes confirm their strong intellectual correlation and demonstrate that their integration constitutes a dominant and mature stream of inquiry in this academic field (Zong & Guan, 2025; Rejeb et al., 2025).

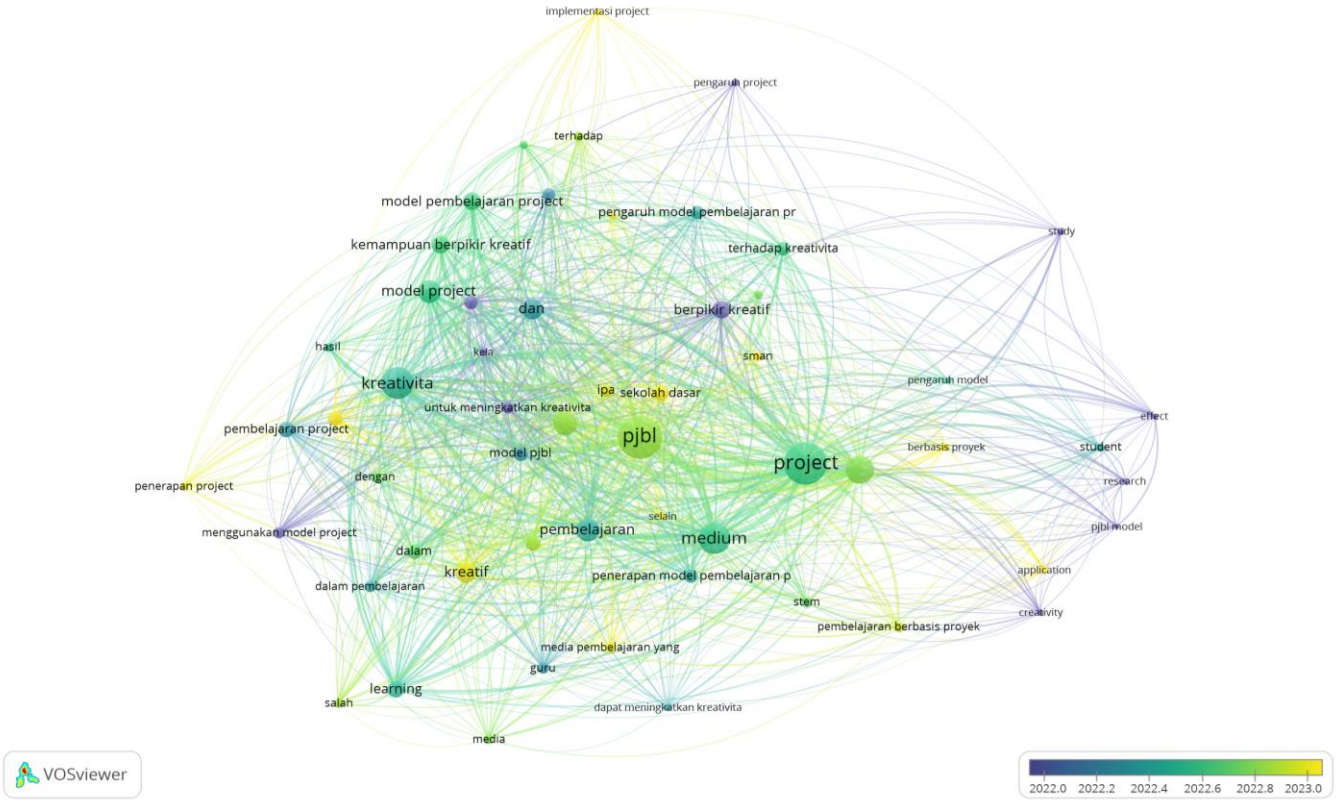

Figure 4. Overlay visualization on PjBL into learning media increases creativity on biology topics

From Figure 4, The VOSviewer overlay visualization, which colors the nodes based on the average publication year, provides a critical temporal dimension to the bibliometric analysis, illustrating the evolution and current trajectory of the research field. The map distinctly reveals that the core intellectual interest, specifically the integration of Project-based Learning (PjBL), Learning Media (learning media), and the enhancement of Creativity (creativity), constitutes the most active and contemporary research frontier.

Key nodes such as PjBL, creativity, learning media, and their immediate co-occurring neighbors are predominantly colored in bright green and yellow tones, corresponding to the years 2022.0 to 2023.0. This recency indicates a strong, sustained, and current scholarly emphasis on empirically investigating how the strategic use of learning media within a PjBL framework successfully cultivates student creativity, thus establishing this specific relationship as the current cutting edge of the research domain.

Furthermore, the analysis shows that the expanding themes, particularly the interdisciplinary adoption of this model, as evidenced by the STEAM, science, and technology nodes also being heavily colored in yellow, represent the emerging directions for the field, suggesting a movement toward integrated curriculum models while retaining the core PjBL; Media; Creativity focus. In contrast, older terms (darker blue/purple) are associated with general methodological terms like 'research' and 'study', suggesting that while the foundational principles are established, the current thrust of research is dedicated to generating new evidence and frameworks for this specific PjBL; Media; Creativity nexus. The visual evidence confirms that research on the efficacy of PjBL integrated with media for creativity development is not merely an existing theme but the current hotspot of academic inquiry and is driving the field's intellectual growth in the most recent publication cycle (Elvira et al., 2025); Thompson & Harris, 2025; Ho, 2025).

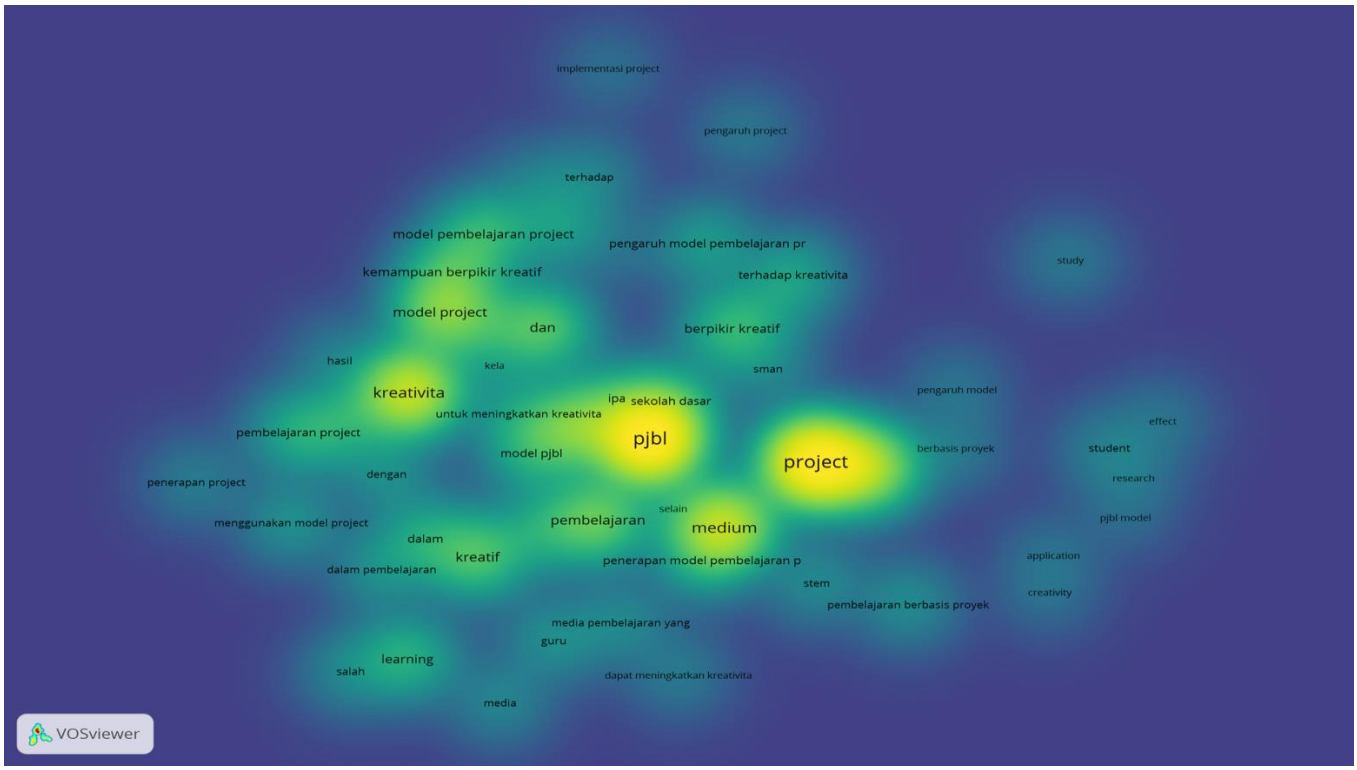

Figure 5. Density visualization on PjBL into learning media increases creativity on biology topics

From Figure 5, Users want an interpretation of the VOSviewer density visualization provided in English, specifically linking findings to the integration of PjBL, learning media, and creativity for reputable bibliometric analysis articles. The interpretation should be a long paragraph. The VOSviewer density visualization effectively highlights the intensity and concentration of research activity within the bibliometric dataset, revealing the most prominent and most explored themes. The map shows several bright yellow areas, representing the highest density of co-occurring keywords, signifying the core intellectual focus of the entire literature. The brightest and most central areas are firmly concentrated around the terms "PjBL" (Project-Based Learning) and "project," confirming these concepts as the absolute epicenter of the research field. Crucially, directly around this center, with slightly lower but still high densities (yellow to bright green), are the related terms "learning media," "creativity," and "biology." The high-density gradient connecting these specific terms PjBL, instructional media, and creativity provides the strongest visual evidence yet that the integration of PjBL with instructional media to enhance creativity is not simply a subtheme, but rather the most intense and established area of investigation within this academic domain. Research is supplemented with studies exploring this specific pedagogical relationship.

A second, distinct, high-density cluster emerges to the right, centered on “STEAM,” “science,” “technology,” and “engineering.” While separate, the proximity of these clusters suggests that the core PjBL; creativity dynamic is being actively integrated into a broader interdisciplinary framework, representing a significant area of current and future research focus. However, based on the density map, the most substantial and fundamental research concentration remains focused on the efficacy and implementation of PjBL integrated with media to achieve creativity outcomes within a centralized and dense knowledge base (Setiawan et al., 2025; Zhang et al., 2025).

Conclusion

Our study synthesizes evidence that integrating PjBL into learning media can enhance creativity in biology. Through SLR, we found that PjBL positively impacts creativity through PjBL integration. Our proposed model illustrates the relationship between antecedents, mechanisms, and learning outcomes, filling a gap in current research. Our study uniquely combines bibliometric and content analysis, differing from previous literature reviews that have not comprehensively analyzed the integration of learning media with PjBL and its sustainability across educational settings. Our findings, derived from this unique combination of bibliometric and content analysis, offer researchers insight into the limitations and scope of existing research in these fields, highlighting unexplored and innovative topics for future research, facilitating deeper integration of PjBL

into learning media contexts. Our study shows that the integration of PjBL with learning media, particularly interactive digital media, is significantly positively correlated with increased student creativity, manifested through originality, elaboration, and idea fluency.

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Conceptualization, R.A. and F.A.; methodology, R.A.; formal analysis, F.A.; data curation, J.S. and A.H.; writing—original draft preparation, R.A. and F.A.; writing—review and editing, J.S, A.H, and P.M.; visualization, R.A. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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