

Project-Based Learning and Biopreneurship for Developing Students' Systems Thinking: A Literature Review

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Abstract: Systems thinking is one of the most important abilities in the 21st century. Systems thinking helps students organize their thoughts in a meaningful way and make connections between seemingly unrelated problems to reveal their interrelatedness. Through systems thinking, learners are directed to first recognize a problem, understand the links between the factors causing the problem, and finally find the right solution and prevent new problems from arising. Systems thinking skills can be facilitated through learning with an integrated biopreneurship Project-Based Learning (PjBL) model. This study aims to identify how the positive trends of research on biopreneurship and systems thinking variables. This research method is descriptive and analytical. The data used in this study were obtained from documents indexed by Google Scholar from 2016 to 2025 using Publish or Perish and Dimension.ai. The data identified and analyzed were the type of publication, the source of publication, and the title of the research on the project-based learning (PjBL) model integrated with biopreneurship to improve students' systems thinking skills. The data analysis method uses *text* analysis assisted by VOS viewer software. The results of the study show that the research trend of the biopreneurship PjBL model to improve system thinking skills is very low from 2016-2025. In the period 2016 to 2019, no publications were recorded. Entering 2020 and 2021, the number of publications began to appear, with one publication per year each. However, in 2022, there was a drastic decline to zero, indicating that there were no publications that met the criteria. A positive trend was again seen in 2023 with one publication, and the peak occurred in 2024, where two publications were recorded, being the highest number in the observed period.

Keywords: Biopreneurship; Knowledge-based entrepreneurship; Module; Project-based learning; Systems thinking

Introduction

The International Monetary Fund (IMF) in 2023 reported that Indonesia has the second-highest unemployment rate among Southeast Asian countries, with a projected unemployment rate of 5.3 percent (DataIndonesia.id, 2023). The cause of the problem of the large number of unemployed created by the educated group is the education system that only produces technical skills. One solution to overcome this condition is to instill an entrepreneurial spirit. Entrepreneurship is one of the central lessons in an effort to build a country.

This is reinforced by the assumption that the majority of developed countries are characterized by high economic growth (Supandi, 2022). The cultivation of entrepreneurial spirit can be done by using the concept of knowledge-based entrepreneurship that connects knowledge with entrepreneurship (Hamdani, et al. 2018). In presenting learning materials, the benefits and business opportunities of the material taught can be conveyed. In addition, it is supported by a book that bridges the material with entrepreneurship, so that students have a handbook to bring up motivation or desire for entrepreneurship. One example is the

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biopreneurship project-based module (Anjani, et al. 2024). The biopreneurship project-based learning model is able to develop the entrepreneurial characteristics of students by improving communication skills, critical, creative, and collaborative thinking, and entrepreneurial interest (Haq, 2022).

The benefits of systemic thinking in learning include systemic thinking in learning so that the direction and objectives of learning can be planned, leading teachers to systematic activities, with systemic thinking in learning, we will be directed to see a problem as part of a system at large and not as a separate specific part (Fakhrurrazi, 2021).

The biopreneurship project-based module is a learning module that emphasizes project-based learning by integrating biological concepts with entrepreneurial concepts (Rosyidi, et al. 2023). Biopreneurship project-based learning allows students to directly experience the information presented through hands-on practice. The development of science modules that emphasize integrative projects between biology and entrepreneurship concepts aims to improve student learning outcomes optimally through efficient and interactive learning (Rosyidi, et al. 2022). Biopreneurship connects the knowledge or learning of science (biology) with entrepreneurship, which later ideas for entrepreneurship more and not only in the same field of business, so as to reduce aspects of weakness and threats in entrepreneurship.

Systems thinking is a discipline to see the 'structure' underlying complex situations. The goal is to be able to recognize where the root of the problem is and find the right solution. Systems thinking basically recognizes what factors are connected to a phenomenon and understands how they are related (Avianto, et al. 2017). Systems thinking is useful for recognizing problems that have the potential to cause other new problems, so as to avoid making decisions that have a negative impact in the future (Sarasi, et al. 2021). Through systems thinking, learners are directed to first recognize a problem, understand the link between the factors that cause the problem, and finally find the right solution and prevent new problems from arising.

Systems thinking can contribute to the development of students' understanding of dynamic living systems (Schuler et al. 2017). The ability to think systems can help build entrepreneurial character, because students are accustomed to thinking systems, so that they can see what aspects of SWOT appear and dare to try to find the root and solution of the problem. Therefore, this study wants to find out the research trend of the Project-Based Learning (PjBL) Biopreneurship model to improve system thinking skills. It is hoped that this research can be a reference in developing further

research related to biopreneurship in science learning, especially in student biology.

Method

This study employed a descriptive-analytical literature review design aimed at systematically mapping and analyzing research trends related to the integration of the Project-Based Learning (PjBL) model with biopreneurship in fostering students' systems thinking skills. The review focused on identifying the development, scope, and thematic orientation of published studies over time, as well as understanding how PjBL-biopreneurship has been conceptualized and implemented in educational research. The time frame of the analysis was limited to publications released between 2016 and 2025 to capture recent and relevant developments in this research area.

Bibliographic data were collected from publications indexed in Google Scholar, using Publish or Perish (PoP) software as the main data retrieval tool, with Dimensions.ai utilized to complement citation and publication metadata. The search process employed combinations of relevant keywords and Boolean operators, including "project-based learning" OR PjBL, biopreneurship OR bio-entrepreneurship, and "systems thinking" OR "system thinking". The initial search results were then screened by reviewing titles, abstracts, and keywords to ensure relevance to the integration of PjBL and biopreneurship within educational contexts. Duplicate records and publications that did not align with the study objectives were excluded.

Following the screening process, a total of 200 eligible documents were selected for analysis. These documents were analyzed using descriptive techniques to examine trends in annual publication output, document types, source journals, authorship patterns, keyword frequency, and citation metrics. In addition, an analytical synthesis was conducted to identify dominant research themes, methodological tendencies, and emerging directions related to the role of PjBL-biopreneurship in supporting the development of students' systems thinking skills. The results of this analysis provide a comprehensive overview of the evolution and research landscape of PjBL-biopreneurship studies over the last decade.

Result and Discussion

This study aims to describe research trends on the Project-Based Learning (PjBL) Biopreneurship model to improve system thinking skills conducted from 2019 to 2025. Research documents regarding research trends on the Problem-Based Learning model to improve science

generic skills in science learning were taken from documents from 2019 to 2025. The following is presented in Figure 1 regarding research trends on Project-Based

Learning (PjBL) Biopreneurship to improve system thinking skills.

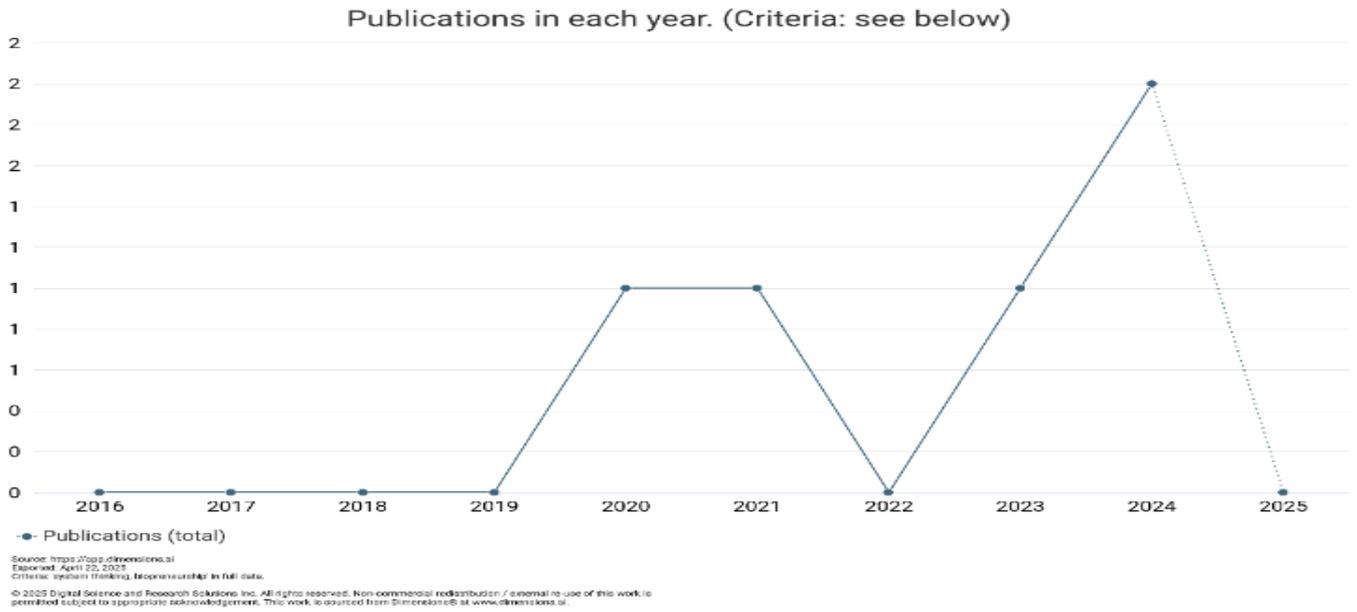


Figure 1. Research trends on the biopreneurship PjBL model to improve systems thinking skills.

Figure 1 shows a line graph displaying the number of publications each year based on the criteria 'biopreneurship, project-based learning, system thinking' taken from Dimensions.ai data. The time shown starts from 2016 to 2025. In the period 2016 to 2019, no publications were recorded. Entering 2020 and 2021, the number of publications began to appear, with one publication per year each. However, in 2022, there was a drastic decline to zero, indicating that there were no publications that met the criteria.

A positive trend was again seen in 2023 with one publication, and the peak occurred in 2024, where two publications were recorded, being the highest number in the observed period. For 2025, until the time the data was exported on April 28, 2025, no publications were recorded, which is indicated by the dotted line as an indication of predictions or incomplete data. Through these results, it can be said that the titles of biopreneurship with regard to the PjBL model and system thinking are relatively few.

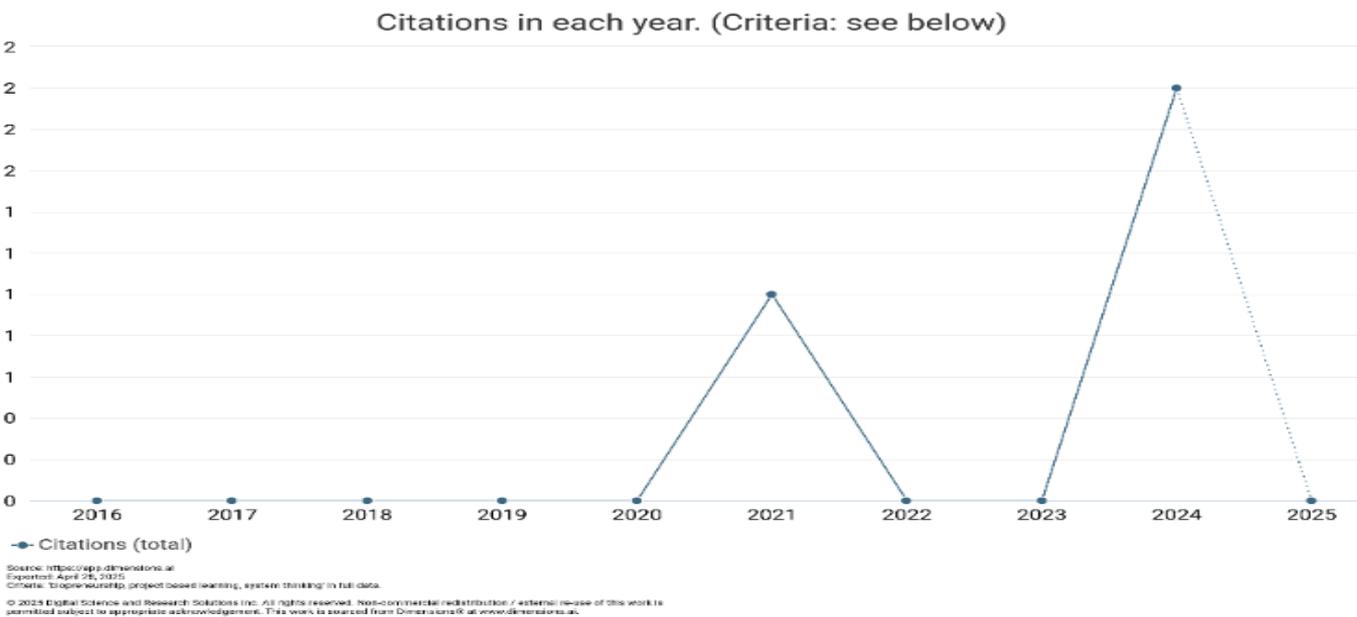


Figure 2. Number of research trend citations about the PjBL biopreneurship model to improve system thinking skills.

Figure 2 shows a line graph showing the number of citations per year based on the criteria 'biopreneurship, project-based learning, system thinking' from data retrieved through Dimensions.ai. The graph covers the time from 2016 to 2025. From 2016 to 2020, no citations were recorded for publications that met these criteria. In 2021, there was an increase with one citation recorded,

but this number decreased to zero again in 2022 and 2023. A positive trend reappeared in 2024 with two citations recorded, being the highest number in this observation period. For 2025, until the data was exported on April 28, 2025, no citations were recorded, which is marked with a dotted line in the graph as an indication of incomplete data.

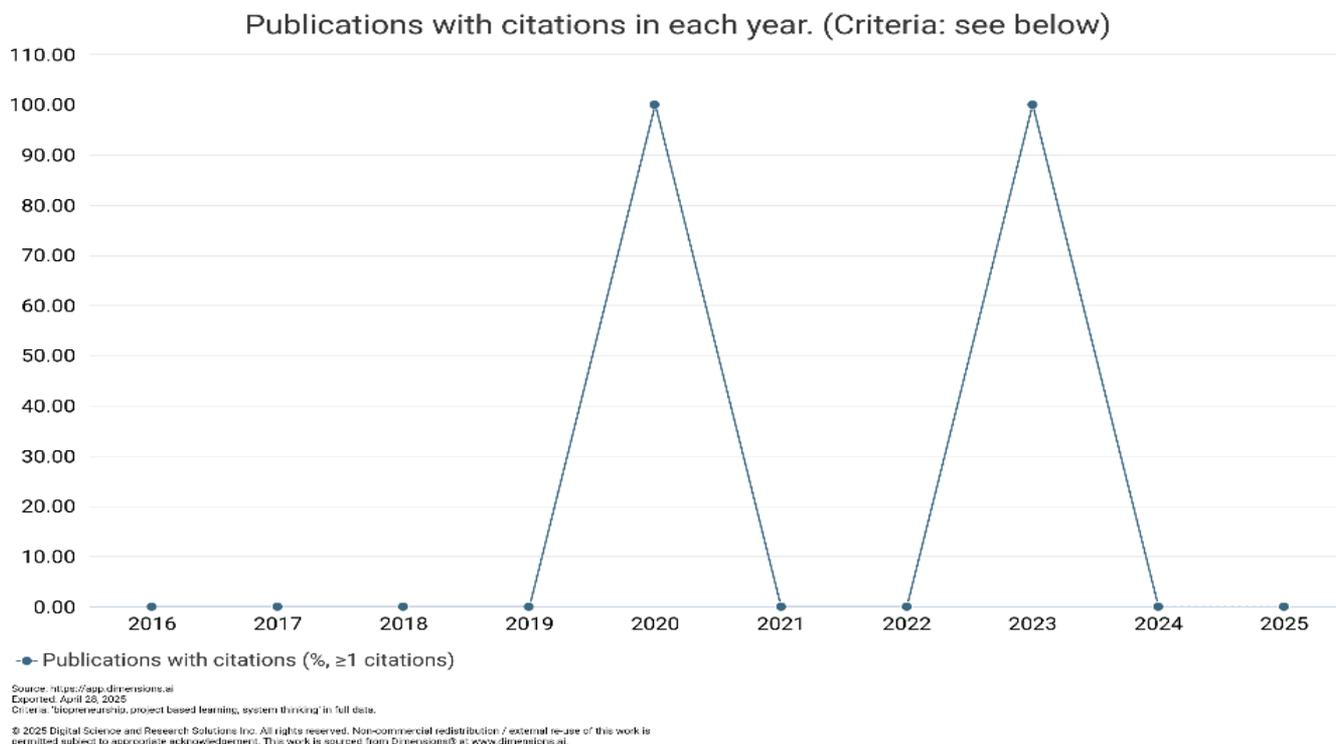


Figure 3. Publications with citations of research trends on the PjBL biopreneurship model.

Figure 3 shows a line graph of the percentage of publications that received at least one citation each year, based on the criteria 'biopreneurship, project-based learning, system thinking' from Dimensions.ai data. The graph covers the period from 2016 to 2025. From 2016 to 2019, no publications received citations, with the percentage remaining at zero. In 2020, there was a dramatic spike, with 100% of publications in that year receiving at least one citation. However, this percentage dropped back to zero in 2021 and 2022, indicating that no publications were cited in both years. In 2023, a positive trend re-emerged with 100% of publications receiving citations. In 2024, the percentage dropped back to near zero, and until April 2025, the data shows that cited publications remained at a very low level.

Table 1 displays the trend of publication sources that use the biopreneurship-based Project-Based Learning (PjBL) model to improve systems thinking skills in the 2016-2025 period. Three journals are listed in this table, each with the number of publications, citations, and average citations obtained. The Science Education Research Journal showed the highest

contribution, with a total of two publications and two citations, resulting in an average of one citation per publication. Berkala Ilmiah Pendidikan Biologi (BioEdu) also recorded two publications, but only received one citation, resulting in an average of 0.5 citations per publication. Meanwhile, Pijar MIPA Journal recorded one publication but has not yet received a citation, so there is no citation average for this journal. The data in the table provides an overview of the productivity and impact of citations from various journal sources that discuss the application of PjBL biopreneurship in developing systems thinking skills.

Table 1. Trends in Title Source of PjBL Biopreneurship Model to Improve Systems Thinking Skills 2016-2025

| Journal Name | Publication | Citations | Average Citation |
|--|-------------|-----------|------------------|
| Jurnal Penelitian Pendidikan IPA | 2 | 2 | 1.00 |
| Berkala Ilmiah Pendidikan Biologi (BioEdu) | 2 | 1 | 0.50 |
| Jurnal Pijar MIPA | 1 | 0 | - |

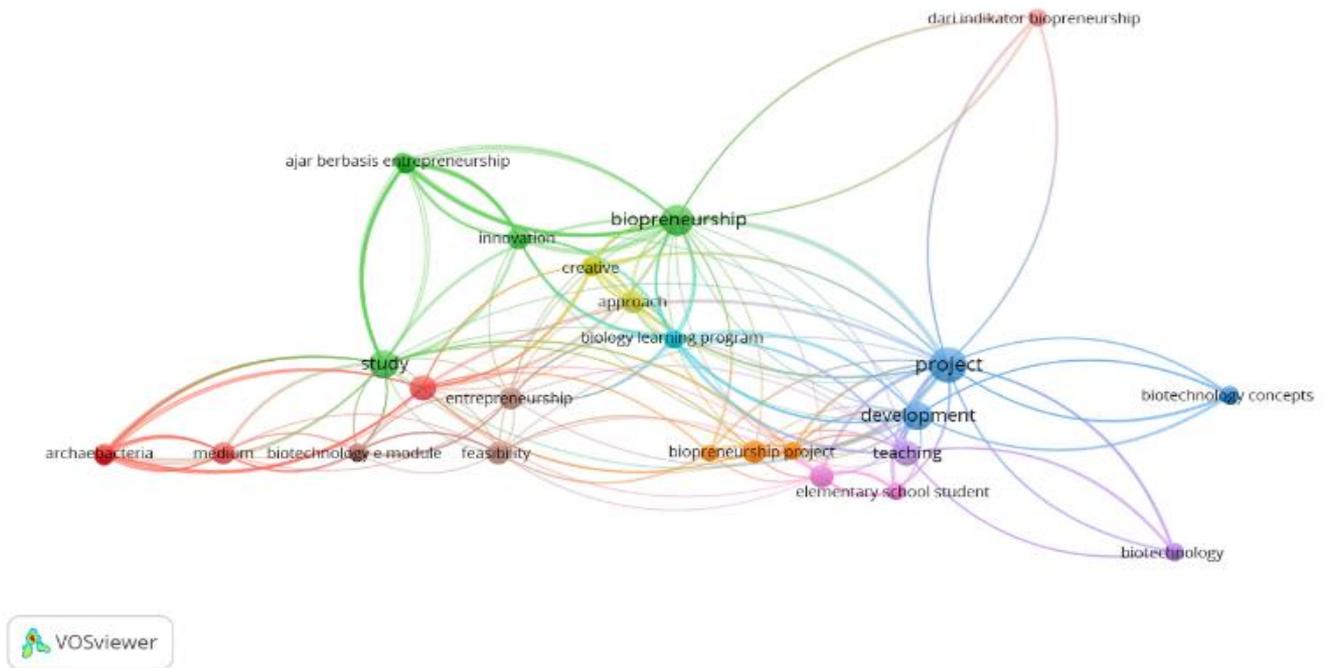


Figure 4. Network visualization on the biopreneurship PjBL model to improve systems thinking skills.

Figure 4 shows the network mapping of keywords related to the application of the **biopreneurship** model in project-based learning. This visualization shows the interrelationship between various terms that often appear together in academic publications on this topic. The term biopreneurship is the main center of the map, with many connections leading to other words such as *project, innovation, creative, biology learning program, and approach*.

based innovations, such as entrepreneurship-based teaching materials, while the red group shows a focus on biotechnology e-modules, indicating that the biotechnology aspect is one of the main approaches in implementing biopreneurship. Overall, this map makes it clear that project-based learning in the context of biopreneurship is strongly influenced by innovation, the development of biology learning programs, and the application of biotechnology concepts.

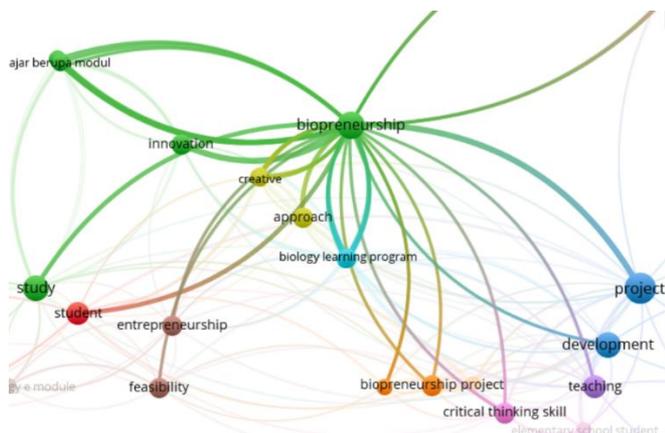


Figure 5. The focus of the network visualization is on the biopreneurship PjBL model.

Figure 5 shows a zoom-in of the previous VOSviewer map, focusing more closely on the main keyword "biopreneurship" and its network of relationships. This map illustrates the close relationship of the keyword biopreneurship with a number of important terms in the development of systems thinking skills based on project learning. Biopreneurship acts as the main node that is strongly connected with innovation, creativity, approach, biology learning program, project, and development. This relationship shows that the concept of biopreneurship in project-based education relies on innovative, creative, and biology learning program-based approaches. In addition, the link to critical thinking skills through the biopreneurship project pathway indicates that this model supports the strengthening of higher-order thinking skills and systems thinking. The terms entrepreneurship, student, and feasibility are also related, although more towards the study of feasibility and student orientation towards entrepreneurship. The color grouping in this network confirms the clustering of

On the other hand, the term project also serves as a large node that is strongly connected to the keywords 'development, teaching, biopreneurship project, biotechnology concepts, and critical thinking skills'. The green group in the map groups words related to entrepreneurship-

concepts, where green indicates innovation and creativity in biopreneurship, blue shows the connection with the project-based approach, red and orange show the connection with the student aspect and the feasibility of the biopreneurship project. Thus, biopreneurship is not just a learning concept, but is the center of innovation, creative approaches, and the development of high-level thinking skills, namely critical and systems

thinking in project-based learning. The project-based learning model has a significant effect in improving students' scientific attitudes and creative thinking skills of students, besides the application of project-based learning provides a positive response from students, such as increasing motivation in learning and increasing students' creativity (Wiguna, 2016).

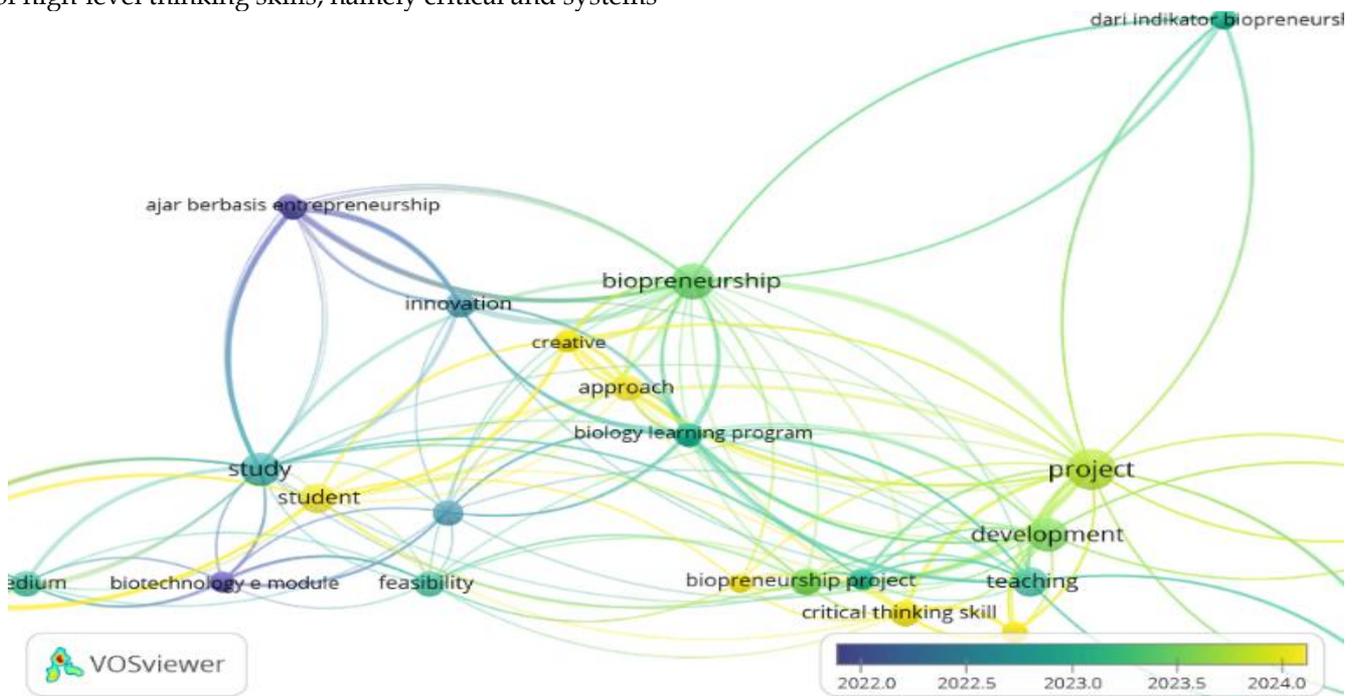


Figure 6. Visualization of the overlay of the biopreneurship PjBL model to improve system thinking skills.

Figure 6 shows the visualization of the network of relationships between keywords analyzed using VOSviewer. The main focus of this map is the theme of "biopreneurship", which appears to be the center of connections with many other terms. Concepts such as "project", "development", "teaching", "critical thinking skill", and "biology learning program" are closely related to biopreneurship, indicating the trend of research and development in biopreneurship education. There are also other strong nodes such as "entrepreneurship-based teaching materials", "study", "innovation", and "student", which show a close relationship between entrepreneurship-based teaching approaches and innovation in the learning process. The colors of the lines and nodes indicate the time dimension from 2022 to 2024, with the trend of yellow keywords indicating more recent research. This map reflects the dynamic direction of research, showing a shift in focus from feasibility studies and learning media, towards the integration of higher-order thinking skills in biopreneurship-based projects, one of which is critical thinking, which is one aspect of systems thinking. The average research still uses the variable sentence critical

thinking, so that in 2025 research is planned with a broader variable, namely system thinking.

Problem solving and critical thinking are important 21st-century skills to train (Afandi, 2019; Doleck et al., 2017). Both require systems thinking to make it easier for students to connect the cause and effect of a phenomenon, learn how components interact as a series of interactions, and improve their understanding of various subjects, including science (Hmelo-Silver, 2007; Ke L et al., 2021).

The biopreneurship project provides meaningful and practical learning experiences for students, allowing them to identify and recognize opportunities, design, create new business prospects, and produce products, goods, and services through project-based learning. Biology learning using biopreneurship-oriented learning tools is a learning tool developed by linking directly to real objects or phenomena around human life as students, so that the use of this learning tool allows students to learn the process of processing a material into a useful product, has economic value, and fosters entrepreneurial interest (Hayati, et al. 2023)

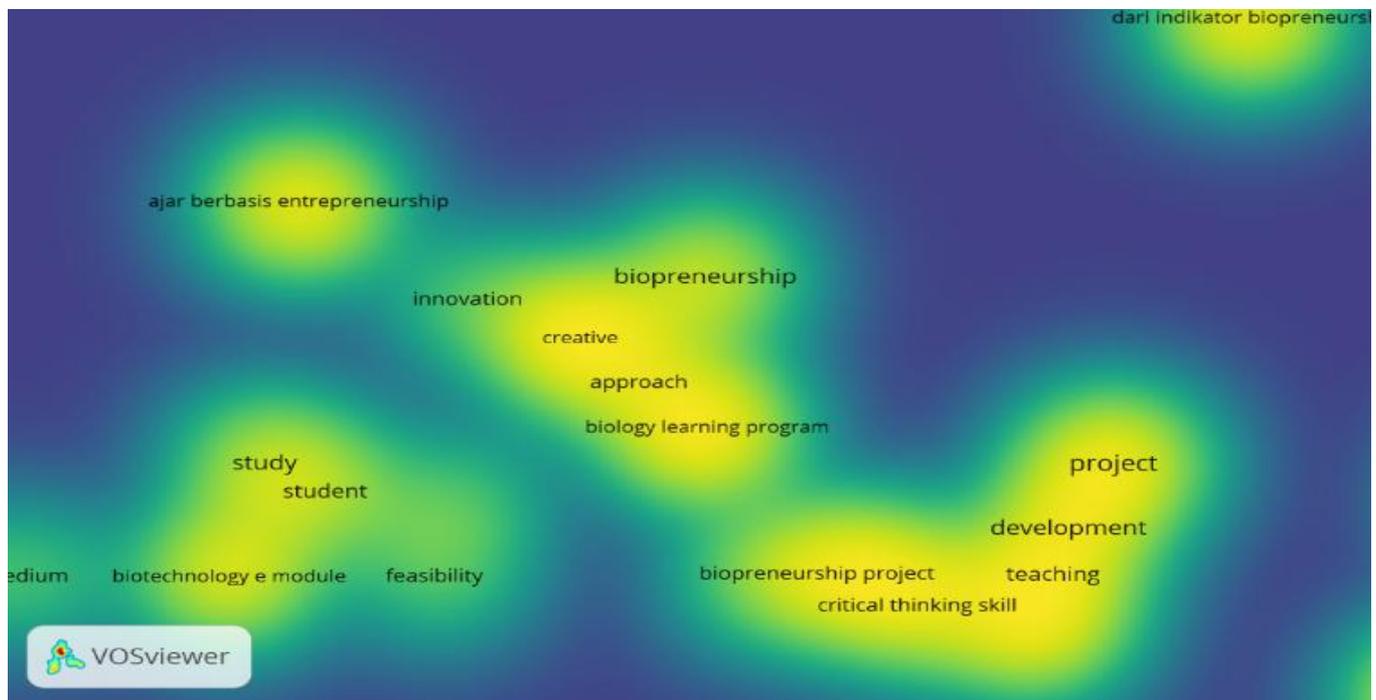


Figure 7. Density visualization of the biopreneurship PjBL model to improve systems thinking skills.

Figure 7 shows the density map (density visualization) generated using VOSviewer, illustrating the concentration of research related to the theme of "biopreneurship" and related concepts. The bright yellow color indicates areas with the highest intensity or frequency of keyword usage, while blue areas indicate lower intensity (Bahtiar, et al. 2023). In this map, it can be seen that "biopreneurship", "project", "development", "teaching", and "critical thinking skills" are the main clusters with the highest density. This shows that these themes are the center of attention in the literature or recent research. On the other hand, keywords such as "entrepreneurship-based teaching materials", "study", and "student" also showed high activity levels, indicating the importance of entrepreneurship learning approaches. study-based Overall, research on the biopreneurship PjBL model to improve systems thinking skills is important because it provides a new contribution to education, and the PjBL model is a learning model that can facilitate complex systems thinking skills. Systems thinking is one of the most important skills in the 21st century. Systems thinking helps students organize their thoughts in a meaningful way and make connections between seemingly unrelated problems. Good system thinking skills will help students in making decisions so as to avoid a mistake, because system thinking is able to help make comprehensive decisions by looking at the impact of decisions or problems in other fields (Clark, et al. 2017). Systems thinking skills are needed for students in learning Biology (Assaraf, et al. 2013). This is because, in learning biology, students are always encouraged to

understand concepts in biological material that is very complex. Systems thinking skills are needed because when students have this ability, the process of linking one material with another will be easier.

Biopreneurship can be defined as the activity of utilizing living things or the science of living things so that an output is produced in the form of the creation of products or services that can be used in entrepreneurial activities to make a profit (Safitri, et al. 2024). The implementation of biopreneurship in learning is the best innovation to mediate education from academia to industry. In line with this statement, the implementation of the biopreneurship approach in biology learning is expected to be able to accommodate students to be able to train entrepreneurial skills by recognizing and creating a business opportunity from a product resulting from the use of living things (Astawa, 2015). The research trend of biopreneurship PjBL model to improve system thinking skills is very low from 2016 to 2024, this trend is expected to grow in the next few years. This can be done by developing new combinations between biopreneurship integrated PjBL models or other approaches that can facilitate students' systems thinking skills, especially in science and biology subjects.

Conclusion

Research on the trend of biopreneurship PjBL models to improve systems thinking skills has the potential to provide various benefits in 21st-century education. Although the positive trend of this research shows unstable data or graphs that go up and down and

the number of studies is still relatively small, but through research on trends in the PjBL biopreneurship model to improve systems thinking skills and show its benefits, it can be said that for the following years (2025 onwards), this trend can run stably and develop.

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Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest.

References

- Afandi, A., Sajidan, S., Akhyar, M., & Suryani, N. (2019). Development Frameworks of The Indonesian Partnership 21st-Century Skills Standards for Prospective Science Teachers: A Delphi Study. *Jurnal Pendidikan IPA Indonesia*. 8(1). 89-100. <https://doi.org/10.15294/jpii.v8i1.11647>
- Anjani, A. I. D., Jufri, A. W., Artayasa, I. P. & Jamaluddin. (2024). Relationship between Cognitive Learning Outcomes and Student Entrepreneurial Motivation in Biology Subjects. *Jurnal Pijar Mipa*. 19(2). 216-221. <https://doi.org/10.29303/jpm.v19i2.6502>
- Assaraf, O. B., Dodick, J., & Tripto, J. (2013). High School Students' Understanding of the Human Body System. *Journal of Research in Science Education*. 43. 33-56. <https://doi.org/10.1007/s11165-011-9245-2>
- Astawa, I. M. W., Sadia, I. W., & Suastra, I. W. (2015). Pengaruh Model Pembelajaran Berbasis Proyek Terhadap Sikap Ilmiah dan Konsep Diri Siswa SMP. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi Pendidikan IPA*. 5(2). 1-11.
- Avianto, T. W. (2017). *Systems Thinking & System Dynamics: Perspektif dan Pemodelan untuk Persoalan Kompleks*. Bandung: ITB Press.
- Bahtiar, B., Yusuf, Y., Doyan, A., & Ibrahim, I. (2023). Trend Penelitian Technology Pedagogical Content Knowledge (TPACK) Tahun 2012-2022: Kontribusi Terhadap Pembelajaran Sains Abad 21. *Jurnal Penelitian Pendidikan IPA*. 9(5). 39-47. <https://doi.org/10.29303/jppipa.v9i5.3685>
- Clark, S., Petersen, J. E., Frantz, C. M., Roose, D., Ginn, J., & Daneri, D. R. (2017). Teaching systems thinking to 4th and 5th graders using Environmental Dashboard display technology. *Journal of Plos One*. 12. 1-11. <https://doi.org/10.1371/journal.pone.0176322>
- DataIndonesia.id. (2023). *Daftar Negara Dengan Proyeksi Tingkat Pengangguran Tertinggi di Asia Tenggara Pada 2023*.
- Doleck, T., Bazelais, P., Lemay, D. J., Saxena, A., & Basnet, R. B. (2017). Algorithmic Thinking, Cooperativity, Creativity, Critical Thinking, And Problem Solving: Exploring The Relationship Between Computational Thinking Skills And Academic Performance. *Journal of Computers in Education*. 4. 355-369. <https://doi.org/10.1007/s40692-017-0090-9>
- Fakhrurrazi. (2021). Konsep Berpikir Sistemik Dalam Penyusunan Rencana Strategis. *Jurnal Islamic Education Manajemen*. 6(1). 13-24. <https://doi.org/10.15575/isema.v6i1.9406>
- Hamdani, K. dan Koubaa, S. (2018). Knowledge-Based Entrepreneurshi: The Role of Networks. *Advances in Business and Management a Contemporary Perspective*. 448-467.
- Haq, S. (2022). Model Pembelajaran Berbasis Proyek Dalam Ranah Kewirausahaan. *CIVED*. 9(2). 184-192.
- Hayati, N., & Harmoko, H. (2023). Hasil Belajar Siswa Pada Pembelajaran Bioentrepreneurship. *Jurnal Binomial*. 6(1). 1-11.
- Hmelo-Silver, C. E. (2007). Fish Swim, Rocks Sit, And Lungs Breathe: Expert-Novice Understanding of Complex Systems and Designs for Learning. *The Journal of the Learning Science*. 16(3). 307-331. <https://doi.org/10.1080/10508400701413401>
- Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P.J. (2021). Developing And Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues. *Sci Educ (Dordr)*. 30(3). 589-607. <https://doi.org/10.1007/s11191-021-00206-1>
- Rosyidi, M. A., Jufri, A. W. dan Artayasa, I. P. (2023). Development of Biopreneurship Project-Based Modul for Junior High School Students in Mandalika Lombok Special Economic Zone. *Journal of Research in Science Education*. 9(9). 7579-7590. <https://doi.org/10.29303/jppipa.v9i9.5078>
- Rosyidi, M. A., Jufri, A. W., Artayasa, I. P., Mahrus, & Setiadi, D. (2022). Modul Pembelajaran IPA Berbasis Proyek Biopreneurship: Kemenarikan dan Kepraktisan dalam Pembelajaran. *Journal of Classroom Action Research*. 4(1). 1-6.
- Safitri, A., Jufri, A. W., & Bachtiar, I. (2024). Pengaruh Pembelajaran Project Based Learning Berbasis Biopreneurship Terhadap Sikap Ilmiah Dan Minat Wirausaha Pada Siswa. *Journal of Classroom Action Research*. 6(3). 617-623. <https://doi.org/10.29303/jcar.v6i3.7854>

- Sarasi, V., Yulianti, D and Farras, J. I. (2021). *Berpikir Sistem dan Dinamika Sistem*. Bengkulu: Penerbit Yayasan Sahabat Alam Rafflesia.
- Schuler, S., Fanta, D., Rosenkraenzer, F., & Riess, W. (2017). Systems thinking within the scope of education for sustainable development (ESD) - a heuristic competence model as a basis for (science) teacher education. *Journal of Geography in Higher Education*. 8265. 1-13. <https://doi.org/10.1080/03098265.2017.1339264>
- Supandi, A. (2022). Pengaruh Model Pembelajaran Berbasis Proyek (Project Based Learning) Terhadap Minat Berwirausaha Siswa Kelas XI Pada Mata Pelajaran Kewirausahaan di Sekolah SMK Bina Nusa Mandiri Ciracas. *Jurnal Review Pendidikan dan Pengajaran (JRPP)*. 5(1). 134-141. <https://doi.org/10.31004/jrpp.v5i1.6077>
- Wiguna, M. C. (2016). Pengembangan LKPD IPA Berbasis Keterampilan Proses untuk Meningkatkan Sikap Ilmiah dan Minat Siswa SMP. *Jurnal Pendidikan Matematika dan Sains*. 4(2). 176-183. <https://doi.org/10.21831/jpms.v4i2.12441>