#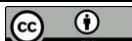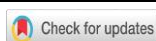 The Validity of Biology Interactive E-book based Scientific Literacy to Improve Student's Creative Thinking Skills to Support SDG 4

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Sections Info	ABSTRACT
Article history: Submitted: January 1, 2025 Final Revised: January 5, 2025 Accepted: January 5, 2025 Published: January 9, 2025 *Keywords:* Biology; Creative Thingking Skills; Interactive E-book; Scientific Literacy; SDG 4.	*Objective:* This study aims to describe the validity of Biology Interactive E book Based on Scientific Literacy to Improve Students's Creative Thinking Skills. The developed Biology Interactive E book Based on Scientific Literacy to Improve Students's Creative Thinking Skills validity is evaluated in terms of content feasibility, presentation feasibility, and language feasibility. *Method:* This research is a development research with a ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which is modified in the Postgraduate Program in Science Education at the State University of Surabaya and implemented in SMA N 1 Bancar, Tuban, East Java. The data collection technique was carried out using the ebook validation method. *Results:* The assessment instrument used was a e book validation sheet used by two biology lecturers as validators. Data analysis was carried out quantitatively. The validation results of this inquiry-based textbook obtained an average score of 92.25% with a very valid category. *Novelty:* Based on the analysis of the data obtained, it can be concluded that the Biology Interactive E book Based on Scientific Literacy to Improve Students's Creative Thinking Skills that has developed are valid and suitable for use in learning. The development of interactive e-books is one part of realizing quality education (SDG 4) in the era of technology adoption.

INTRODUCTION

The Sustainable Development Goals (SDGs) are a global development agenda aimed at promoting sustainable social, economic, and environmental well-being. In the context of education, SDG 4 (Quality Education) emphasizes the importance of providing inclusive, equitable, and quality education to enhance lifelong learning opportunities for all (Soetra et al., 2025; Saini et al., 2023). Quality education focuses not only on mastering knowledge but also on developing 21st-century competencies, including scientific literacy, which is a crucial foundation for equipping students with critical thinking, problem-solving, and evidence-based decision-making. With the rapid advancement of technology, integrating it into learning plays a strategic role in improving scientific literacy (Ramalia et al., 2022). By providing interactive, contextual, and data-driven learning resources, we support the achievement of SDG 4 while strengthening the younger generation's readiness to face increasingly complex global challenges.

Curriculum prepared to deal with developments in science and technology. It contains demands that emphasize 4C learning and innovation skills which include Critical Thinking and Problem Solving (critical thinking and problem solving), Communication, Collaboration, Creativity and Innovation (Saputra et al., 2019). These four skills are 21st-century skills that students must master. Therefore, the learning

process must also include the 4C skills component (Zubaidah, 2016; Septikasari, 2018; Susanti & Risnanosanti, 2019; Wijaya, 2020; Darry et al., 2021; Solikha & Fitrayati, 2021; Rosyidah & Rahayu, 2022). One of the important 4C skills to be improved in students is Creativity and Innovation, which can be achieved through creative thinking. Creative thinking skills are the ability to find multiple possible answers or appropriate solutions based on existing data and information. There are four aspects of creative thinking: fluency, flexibility, originality, and elaboration (thinking in detail) (Rahayu et al., 2018; Sulistiowati & Mitarlis, 2021; Rosyidah & Rahayu, 2022).

Creative thinking skills are important to improve because they are built through a series of high-level thinking, namely critical, logical, divergent, and convergent (Buzan, 2017). In addition, creative thinking skills are important and need to be developed in students as part of the adjustment to the current Industrial Revolution 4.0 era (Lintangesukmanjaya et al., 2025). Creative thinking skills are important in the process and learning objectives, because in the learning process, creative thinking can build students' attitudes and skills to deal with various kinds of problems that will occur in the future creatively (Setiawan & Indana, 2021; Ainurrohmah & Mitarlis, 2019; Anggraeni & Mitarlis, 2021).

The Organization for Economic Cooperation and Development (2016) also states that scientific literacy is a competency students must have, as it involves applying science as a scientific activity, which entails identifying problems and concluding, thereby encouraging students to think creatively and rationally (Simmamora, 2020; Sutrisna, 2021). Therefore, efforts to improve and accustom students to think creatively when solving problems can be achieved through the application of scientific literacy in learning. One way to do this is to develop teaching materials grounded in scientific literacy that help students find and construct all reasonable answers, fostering divergent thinking and building creative thinking skills (Afriana et al., 2015; Sarawati, 2021). One teaching material that can be developed is an interactive e-book on biology learning. Scientific literacy-based interactive e-books can be applied in learning through material that relates to real life, encouraging students to think creatively and apply them in real life (Afriana et al., 2015; Dewi et al., 2021). One of the materials in biology learning suitable for development in this interactive e-book is ecosystem material. Based on this description, researchers are developing interactive e-books on scientific literacy about ecosystems to improve students' creative thinking skills. This analysis strengthens the discussion on developing competent science literacy tools to support SDG 4 (Quality Education).

RESEARCH METHOD
General Background
The type of research used is development research with a qualitative descriptive approach to describe the design and application of the interactive e-book being developed.
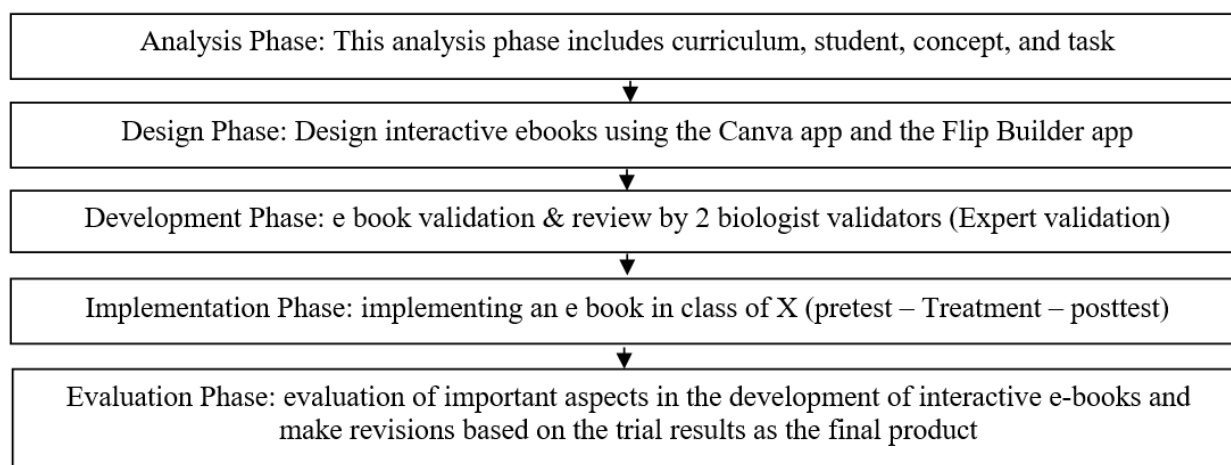
Analysis Phase: This analysis phase includes curriculum, student, concept, and task

↓

Design Phase: Design interactive ebooks using the Canva app and the Flip Builder app

↓

Development Phase: e book validation & review by 2 biologist validators (Expert validation)

↓

Implementation Phase: implementing an e book in class of X (pretest – Treatment – posttest)

↓

Evaluation Phase: evaluation of important aspects in the development of interactive e-books and make revisions based on the trial results as the final product

Figure 1. Diagram of research procedures.

This research uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to develop the e-book (Aldobobie, 2015; Susantini et al., 2021). The selection of the ADDIE model for this development is based on its straightforward, step-by-step approach from start to finish, as shown in Figure 1. The teaching material developed in this research is an interactive e-book on scientific literacy in ecosystem science to improve the creative thinking skills of class X high school students.

Sample / Participants / Group
The research objective is to develop an interactive ebook on Science Literacy: Ecosystems to improve creative thinking skills, with 1 class of X in SMA Negeri 1 Bancar, comprising 38 randomly selected students. The data obtained are test results (pre- and post-tests) and student responses after using an interactive ebook based on Science Literacy on Ecosystem material to improve creative thinking skills. The interactive ebook used for the trial has been reviewed, revised based on the validator's suggestions and declared valid for use based on the validator's assessment.

Instrument and Procedures
The instruments used in this study were interactive ebook validation instruments, creative thinking skills test instruments, and student response questionnaires administered after using the developed interactive ebook. The creative thinking skills test is prepared based on indicators of creative thinking skills, which consist of (a) fluency, (b) flexibility, (c) originality, and (d) elaboration. The test is an essay with 10 questions and 1 task: creating a mind map, while the student response questionnaire consists of 20 questions covering aspects of the interactive ebook's content, appearance, and language.

Data Analysis
The data analysis technique used in this study is a descriptive quantitative approach, namely presenting the results of the research based on the data obtained. Feasibility analysis on interactive e-books, namely validation analysis and analysis of student

response results. The validity assessment by experts was obtained by calculating the average score for each eligibility criterion and the overall average score, both expressed as percentages. It is considered valid if the percentage is ≥ 70% and the interpretation is clear and very feasible within the Likert scale.

Data analysis of textbook validation results was carried out by calculating the average values obtained from validator 1 and validator 2 to determine the quality of the textbooks being developed, as shown in Table 1.

Table 1. Criteria for data validation

Average Score	Category
1,00 – 1,75	Less Valid
1,76 – 2,50	Quite Valid
2,60 – 3,25	Valid
3,26 – 4,00	Verry Valid

(Ridwan, 2013)

After obtaining the results of the textbook validity value, its reliability will be calculated. The percentage of textbook reliability is calculated using the formula:

$$R = (1- (A-B)/(A+B))\ x\ 100\% \qquad (1)$$

Information:

R : Reliability of the instrument (Percentage of Agreement)

A : A higher score than the validator

B : Lower score than validator

The reliability of learning devices is considered valid if the reliability value is 0.75 or 75% (Borich, 1996). Student response results can be analyzed using the Google Forms student response questionnaire and the Guttman scale. The percentage of student response data via Google Forms is calculated for each criterion and for all criteria. After calculating the percentage of student responses, they are interpreted according to Riduwan's (2013) criteria for interpreting student responses. Based on the analysis of student responses, interactive ebooks are considered practical if the percentage of positive responses is≥ 71%. In addition, an analysis was carried out on the positive results of improving students' creative thinking skills through the use of interactive ebooks based on scientific literacy, as evidenced by the increase in pre-test and post-test scores, which were analyzed using N-Gain (Hake, 2014).

RESULTS AND DISCUSSION

Results of Interactive Ebook Development

The interactive ebook being developed is based on scientific literacy about ecosystems to improve creative thinking skills for class X high school students. Creative Thinking Indicators, Ebook Features, Instructions for Using the Ebook, Material on the Ecosystem Chapter, Summary, Bio Mind Map, Bibliography, and Glossary. The material in this textbook consists of 5 sub-chapters: living organizational units, ecosystem constituent

components, interactions in ecosystems, energy flow in ecosystems, and the Biogeochemical Cycle. The following is a display of the interactive ebook developed.

Figure 2. Display of biology interactive e book in ecosystem

An interactive ebook developed with scientific literacy in mind; therefore, each content item in this ebook includes four indicators of scientific literacy: scientific knowledge, science as a way of knowing, scientific investigation, and the interaction of science, technology, and society (presented in Figure 3). In addition, this ebook is intended to improve creative thinking skills (presented in figure 3). Therefore, the interactive ebook on ecosystem material being developed is equipped with various features, including activities that can stimulate the achievement of four indicators of creative thinking skills: fluency, flexibility, and originality. , and detail (elaboration) in thinking (presented in Figure 3).
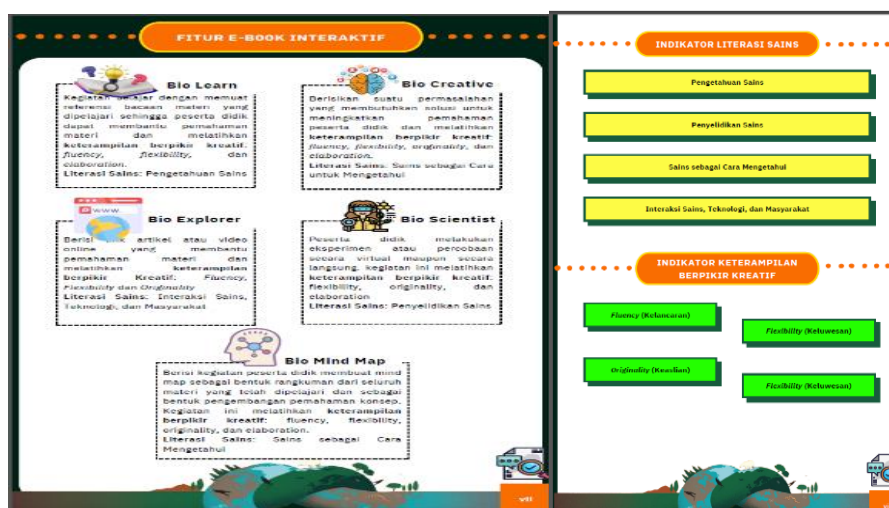

Figure 2. Indicators of scientific literacy, indicators of creative thinking skills

Some of the features in this interactive ebook include Bio Learn, Bio Creative, Bio Explorer, Bio Scientist, and Bio Mind Map. The following is presented in Table 3 which shows the relationship between each feature and aspects of students' creative thinking skills.

Table 2. Feature of Interactive E-book to Improve Creative Thinking Skills

Ebook Features	Description	Scientific Literacy	Creative Thinking
Bio Learn	Learning activities contain reading references to the material being studied so that students can help understand the material	Science Knowledge	• Fluency • Flexibility • Elaboration
Bio Creative	Include a problem who need a solution to improve students' understanding	Science as a way of Knowing	• Fluency • Flexibility • Originality • Elaboration
Bio Explore	Contains online article or video links that help understanding the material	Interaction of Science, Technology, and Society	• Fluency • Flexibility • Originality • Elaboration
Bio Scientist	Students carry out experiments or trials virtually or directly.	Science Investigation	• Flexibility • Originality • Elaboration
Bio Mind Map	Contains student activities to make a mind map as a summary of all the material that has been studied and developing conceptual understanding.	Science Knowledge	• Fluency • Flexibility • Originality • Elaboration

In addition to the features in Table 3, quizzes contain questions or problems that require relevant solutions or answers and are completed by students within a given time limit. The quiz assesses students' understanding of each sub-chapter. It serves as proof that students have read and completed activities on each page of the interactive ebook that has been developed. Based on the validator's review, in addition to suggestions and input for improving the ebook, the validation results include content feasibility, presentation feasibility, and language eligibility. The following is a recap of the interactive ebook validation results on the developed ecosystem material, presented in Table 4.

Table 4. Results validation recapitulation of scientific literacy-based interactive ebook to improve creative thinking skills

No	Aspects	Rating Score		Average	Categories
		Validator 1	Validator 2		
1.	Content Eligibility	3.65	3.89	3.77	Very Valid
2.	Presentation	3.70	3.90	3.80	Very Valid
3.	Language	3.30	3.70	3.50	Very Valid
	Validation Average Score			3.69	Very Valid
	Percentage of agreement			92.25%	Reliable

Based on the recapitulation of interactive ebook validation results (shown in Table 4), the average values for the eligibility aspect of the content, the presentation aspect, and the language aspect are 3.77, 3.80, and 3.50, respectively. Scores on each aspect show very valid criteria. The average results of these three aspects are also in the very valid category, with an average score of 3.69. Additionally, the validation results show a 92.25% agreement, indicating that the interactive ebook being developed is reliable. Based on the validation results, the developed interactive ebook is suitable for use as a textbook on ecosystem material.

Discussion

In biology education, the use of e-books as digital learning resources has great potential to improve the quality of education, particularly by strengthening students' scientific literacy. E-books not only present material textually, but can also be enriched with visualizations, simulations, and interactive links that help students understand abstract and contextual biological concepts. The use of e-books enables the integration of digital-based learning with meaningful learning models such as Problem-Based Learning (PBL) and inquiry (Rahman, 2025), where students are encouraged to explore real-world problems, formulate scientific questions, analyze data, and draw logical conclusions. Thus, e-books serve as a flexible, adaptive learning support tool (Laksono & Hardiyanto, 2025), increasing access to scientific information and fostering critical thinking, problem-solving, and scientific literacy skills as essential competencies in 21st-century education.

During the development and validation stages, several changes and improvements were made to create an interactive ebook on scientific literacy in ecosystem materials to enhance creative thinking skills, with results and suggestions from expert lecturer validators. Based on the review conducted by the validator, there are several suggestions and inputs for improving this interactive ebook, among others, the title of the book on the cover of Ecology has been changed to Ecosystem, the description of the concepts in the interactive ebook must vary inductively and deductively, the features provided in the interactive ebook must steady in each sub-chapter, the Bio Scientist feature must be present in each sub-chapter, the end of each sub-chapter is equipped with a review which can be in the form of a sub-chapter summary, questions in the form of multiple choice/essay/analysis, Bio Mind Map does not need to be in each sub-chapter. However, it may also be placed at the end of the chapter.

E-books can attract students' interest because they provide a more interactive, visual, and contextual learning experience than conventional printed textbooks. In biology learning, many abstract and complex concepts, such as cell structure, metabolic processes, organ systems, and ecosystems, are more easily understood through high-resolution images, animations, videos, and simulations that can be integrated into e-books (Kudhitipudi et al., 2022). Furthermore, e-books are flexible and easily accessible on digital devices anytime, anywhere (Amirtharaj et al., 2023), thereby supporting independent learning styles and increasing student motivation. Interactive features

such as quizzes, hyperlinks, and digital notes also encourage active engagement and help students develop scientific literacy through reading, interpreting data, and reflecting on scientific concepts.

E-books can be integrated into biology learning through meaningful models such as Problem-Based Learning (PBL) and inquiry. Teachers can design e-books that include contextual biology problems, virtual or real-life experiment guides, and prompts that encourage students to observe, ask questions, collect data, and draw conclusions. E-books can also be used as primary or supplementary teaching materials in face-to-face, blended, or online learning. With proper planning, e-books function not only as digital media but also as active learning tools that support conceptual understanding, critical thinking, and improve students' scientific literacy (Heriyanto et al., 2022).

A good learning e-book must meet the criteria of content quality, pedagogy, technology, and learning impact, with the material presented accurately and contextually, aligned with the curriculum to support students' understanding of concepts and scientific literacy. Pedagogically, an effective e-book can integrate active learning models, such as Problem-Based Learning and inquiry, to encourage meaningful learning, critical thinking, and independent learning. From a technological perspective, e-books need to be designed with an attractive appearance, be easy to access, and be equipped with interactive features that increase student engagement. Evaluation of e-books also needs to consider their impact on improving scientific literacy, motivation, and 21st-century skills as indicators of educational quality. Therefore, further research is recommended to examine the effectiveness of digital-based e-books in a broader context, including the integration of adaptive technology, artificial intelligence, or local wisdom, as well as conducting longitudinal studies to see their contribution to equal access and improving the quality of inclusive and sustainable education in accordance with the goals of SDG 4 (Quality Education).

CONCLUSIONS

Fundamental Findings: The feasibility of the Biology Interactive E-book based on Scientific Literacy to Improve Students' Creative Thinking Skills that has been developed is valid and reliable for learning, as evidenced by the validation results. The validation assessment was carried out on the aspects of content feasibility, presentation feasibility, and language feasibility, with an average score of 3.69 (very valid) and a percentage of 92.25%, indicating it is reliable to use. **Implication:** As a result, this interactive ebook can be widely tested and serve as an alternative to improve creative thinking skills, supporting SDG 4 (Quality Education). **Limitation:** This interactive biology ebook, designed to improve creative thinking skills through scientific literacy, contains only ecosystem material, which is one limitation of the research that needs to be considered. **Future Research:** Further research, including implementing learning models, developing learning media, and exploring alternative approaches to improve students' creative thinking skills, can be conducted.

AUTHOR CONTRIBUTIONS

Puji Rahayu contributed to the conceptual framework, research design, and validation process; **Endang Susantini** was involved in methodology development, data analysis, sourcing references, and drafting the manuscript; **Sunu Kuntjoro** handled data management, project coordination, and manuscript drafting. All listed authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, Grammerly was employed for digital assistance were critically evaluated and revised to ensure academic rigor and ethical standards were upheld. The final responsibility for the manuscript rests entirely with the authors.

REFERENCES

Afriana, J., Ismail, & Rahman, A. A. (2015). Improving scientific literacy through project-based learning. *Proceeding of International Seminar on Science Education, 1*(1), 234-241.

Ainurrohmah, A., & Mitarlis. 2019. Pemgembangan lembar kerja peserta didik (LKPD) dengan strategi mind mapping untuk meningkatkan berfikir kreatif peserta didik pada materi koloid. *UNESA Journal of Chemical Education*, *8*(1), 67-74.

Amirtharaj, A. D., Raghavan, D., & Arulappan, J. (2023). Preferences for printed books versus e−books among university students in a Middle Eastern country. *Heliyon, 9*(6).

Anggraeni, Putri & Mitarlis (2021). Lembar kerja peserta dididk berorientasi mind mapping untuk melatihkan keterampilan berpikir kreatif pada materi aasam basa. *Unesa Journal of chemical Education, 10*(2), 131-139.

Buzan, Tony. 2017. *Buku Pintar Mind Map*. Jakarta: Gramedia.

Buzan, T. (2018). Mind map mastery the complete guide to learninng and using the most powerful thinking tool in the universe. Watkins

Dewi, Citra V., Susantini E., & Poedjiastuti, S. (2021). The use of Biology textbook based on collaborative learning model to improve scientific literacy skill. *IJORER: International Journal of Recent Educational Research*. 2 (4), 444-454.

Dewi, A. K. (2019). Improving students learning outcomes through mind map in human reproductive system topic in natural science learning. *International Journal for Educational and Vocational Studies, 1*(7), 702-706.

Fathonah, Siti & Ratnasari, E. (2021). Validitas e-book interaktif pada submateri psikotropika untuk melatihkan berpikir kreatif siswa kelas XI SMA. *Bioedu: Berkala Ilmiah Pendidikan Biologi, 10*, 68-84.

Heni, V., Hilarius, J. D., & Markus, I. S. (2017). Penerapan metode student facilitator and explaining berbantukan media peta timbul terhadap kemampuan berfikir kritis siswa pada materi sel. *Jurnal Pendidikan Biologi, 2*(2), 20-26.

Herianto, Wilujeng, I., & Lestari, D. P. (2022). Effect of interactive multimedia e-books on lower-secondary school students' curiosity in a Science course. *Education and Information Technologies*, *27*(7), 9619-9639. https://doi.org/10.1007/s10639-022-11005-8

Hidayah, Nur, I. & Kuntjoro, S. (2022). Pengembangan E-LKPD perubahan lingkungan berbasis *science literacy* untuk melatihkan keterampilan berpikir kritis peserta didik kelas X SMA. *Bioedu: Berkala Ilmiah Pendidikan Biologi*. 11(1), 384-393.

Koray, Ozley & Tulin, K. (2017). The effect of using the creative reversal act in science education on middle school students creativity levels. *Eurasian Journal of Educational Research*. 67, 199-214.

Kudithipudi, D., Aguilar-Simon, M., Babb, J., Bazhenov, M., Blackiston, D., Bongard, J., ... & Siegelmann, H. (2022). Biological underpinnings for lifelong learning machines. *Nature Machine Intelligence*, 4(3), 196-210.

Laksono, R. Z., & Hardiyanto, A. (2025). Students experiences in using e-books as a learning resource. *IDEAS: Journal on English Language Teaching and Learning, Linguistics and Literature*, *13*(2), 6572-6585.

Laugksch, R. C. (2017). Scientific literacy: A conceptual overview. *John Wiley & Sons, Inc.in Science Education, 84*(1), 70-94. https://doi.org/10.1002/(SICI)1098-237X(200001)84:1<70::AID-SCE6>3.0.CO;2-C

Lintangesukmanjaya, R. T., Prahani, B. K., & Bergsma, L. N. (2025). Oriented study of virtual simulation to improve critical thinking skill in physics learning with inquiry model: Bibliometric analysis. *Journal of Law and Bibliometrics Studies*, *1*(1), 43-43. https://doi.org/10.63230/jolabis.1.1.43

Nurqolbiah, Sofi. (2016). Peningkatan kemampuan pemecahan masalah, berpikir kreatif dan self-confidence siswa melalui model pembelajaran berbasis masalah. *Jurnal Penelitian Pendidikan dan Pengajaran Matematika*. 2(2).

OECD-PISA (2022). *Learning for Tomorrow's World*. USA: OECD-PISA.

Oktaviani, Dwi, I., & Yuliani. (2018). Validitas dan keterbacaan buku ajar berbasis literasi sains pada materi fotosintesis kelas XII SMA. *Bioedu: Berkala Ilmiah Pendidikan Biologi*. 7(2).

Rafli, Y., & Adri, M. 2019. Pengembangan modul berbasis e-book interaktif pada mata pelajaran dasar desain grafis. *Jurnal Vocational Teknik Elektronika dan Informatika*, 7(1), 106-113.

Rahayu, Puji, Susantini, E., & Oka., D. N. (2018). Development of creative mind map rubric to assess creative thinking skills in biology for the concept of environmental change. *International Journal of Innovation and Reasearch in Educational Science*. 5(2).

Rahman, M. F. (2025). Effectiveness of a case-based learning model using a digital pop-up book on students' critical thinking skills. *Indonesian Journal of Educational Development (IJED)*, *6*(2), 533-546.

Ramaila, S., & Molwele, A. J. (2022). The role of technology integration in the development of 21st Century Skills and competencies in life sciences teaching and learning. *International Journal of Higher Education*, *11*(5), 9-17.

Riduwan. (2015). *Skala pengukuran variabel-variabel penelitian*. Bandung: Alfabeta

Robbia, A. Z., & Fuadi, H. (2015). Pengembangan keterampilan multimedia interaktif pembelajaran ipa untuk meningkatkan literasi sains peserta didik di abad 21. *Jurnal Ilmiah Profesi Pendidikan,* *5*(2), 117–123. https://doi.org/10.29303/jipp.v5i2.125

Rosyidah, I., & Rahayu, Y. S. (2022). Pengembangan e-book interaktif berorientasi contextual teaching and learning untuk melatihkan keterampilan berpikir kreatif pada materi pertumbuhan dan perkembangan tumbuhan. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(1), 49-59. https://doi.org/10.26740/bioedu.v11n1.p49-59

Saini, M., Sengupta, E., Singh, M., Singh, H., & Singh, J. (2023). Sustainable development goal for quality education (SDG 4): A study on sdg 4 to extract the pattern of association among the indicators of sdg 4 employing a genetic algorithm. *Education and Information Technologies*, *28*(2), 2031-2069. https://doi.org/10.1007/s10639-022-11265-4

Saraswati, Y., Sifak Indana, & Elok Sudibyo. (2021). Science literacy profile of junior high school students based on knowledge, competence, cognitive, and context aspects. *International Journal of Recent Educational Research*. 2(3), 329-341. https://doi.org/10.46245/ijorer.v2i3.118

Setiawan, Eka & Indana, S. (2021). Validitas lkpd berbasis pjbl pada materi klasifikasi tumbuhan spermatophyta untuk melatihkan keterampilan berpikir kreatif siswa kelas x sma. *Bioedu: Berkala Ilmiah Pendidikan Biologi*, *10*(2), 250-256

Simamora, A, B, Widodo, W. & Sanjaya. I. G. M. (2020). Innovative learning model: Improving the students' scientific literacy of junior high school. *International Journal of Recent Educational Research*, *1*(3), 271-285. https://doi.org/10.46245/ijorer.v1i3.55

Soetra, V. F., Dwikoranto, D., & Bergsma, L. N. (2025). Implementation of steam-based project-based learning to improve critical thinking skills to support SDG

4. *Journal of Current Studies in SDGs*, *1*(3), 80-80. https://doi.org/10.63230/jocsis.1.3.80

Sulistiowati, Eko & Mitarlis. (2021). Lembar kerja peserta didik (lkpd) dengan strategi *mind mapping* untuk melatihkan keterampilan berpikir kreatif pada materi redoks kelas X. *Unesa Journal of chemical Education*, 10(2), 185-194

Susanti, L. B., Poedjiastoeti, S., & Taufikurohmah, T. (2018). Validity of worksheet-based guided inquiry and mind mapping for training students' creative thinking skills. *Journal of Physics: Conference Series, 1006*(1), 1-7

Susanti, D., & Risnanosanti. (2019). Pengembangan buku ajar untuk menumbuh kembangkan kemampuan 4C (Critical, Creative, Collaborative, Communicative) melalui model pbl pada pembelajaran biologi di SMP 5 Seluma. *Prosiding Seminar Nasional Sains Dan Enterpreneurship*, *4*, 1–9.

Sutrisna, N. (2021). Analisis kemampuan literasi sains peserta didik SMA di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*. *1*(12), 2683-2694.

Syahputri, Neillisa & Murdiono, M. (2022). The Impact od gigital-based mind map on creative thinking skills in civic education learning. *Jurnal Pendidikan Indonesia*. 11(1), 78-85.

Tegeh, Made, I., Jampel I. N. & Pudjawan, K. (2015). *Pengembangan Buku Ajar Model Penelitian Pengembangan Dengan Model ADDIE.* Seminar Nasional Riset Inovatif IV

Vitulli, Paige & Giles, R. (2016). Mind mapping: Making connections with images and color. *Delta Journal of Education*. University of South Albama

Wahyuni, Luspita & Rahayu, Y. S. (2021). Pengembangan *e-book* berbasis *project based learning* (pjbl) untuk melatihkan kemampuan berpikir kreatif pada materi pertumbuhan dan perkembangan tumbuhan kelas XII SMA. *Bioedu: Berkala Ilmiah Pendidikan Biologi, 10*(2), 314-325

Zahroh, Aulia, D., & Yuliani. (2021). Pengembangan E-LKPD berbasis literasi sains untuk ,elatihkan keterampilan berpikir kritis peserta didik pada materi pertumbuhan dan perkembangan. *Bioedu: Berkala Ilmiah Pendidikan Biologi*. *10*(3), 65-616.

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