

The Role of the *REMAP Learning Model* on Empowerment of Critical Thinking Skills Integrated with Sustainable Development Goals (SDGs)

Ferry Irawan ^{a,1,*}, Rival Hanip ^{b,2}, Minuk Riyana ^{c,3}

^{a,b,c} Faculty of Teacher and Education, Universitas Musamus Merauke, Merauke, Indonesia

¹irawanferry2029@unmus.ac.id, ² rivalhanip@unmus.ac.id, ³ minuk_fkip@unmus.ac.id

* Corresponding Author



Received October 24, 2025; accepted March 30, 2026; published March 31, 2026

ABSTRACT

The learning orientation is adjusted to the main objectives of the Sustainable Development Goals (SDGs) which direct students to solve problems scientifically through critical thinking. This study aims to determine the effectiveness of the *Remap STAD* learning model on the empowerment of students' critical thinking skills. This study is a type of *experimental quasy* research and uses a *non-equivalent pretest-posttest control group design*. The population is all students of class XI SCIENCE SMAN 2 Barru totaling 234 students. A sample of 102 students was selected based on an equivalence test to determine experimental classes, positive controls, and negative controls. The instrument used the essay test was in accordance with the Critical Thinking skill indicator and the results were analyzed using the one-path anakova test. The results of the study show that the *Remap* learning model is effective in empowering students' critical thinking skills.

KEYWORDS

Remap,
SDGs,
Critical Thinking
Skills

This is an open-
access article
under the **CC-
BY-SA** license



1. Introduction

The development of the times provides very strong demands on the implementation of education that must be carried out continuously. This is in line with the orientation of the development of the world of education which is adjusted to the main goals of the Sustainable Development Goals (SDGs) in the education sector. This is in accordance with the real implications in the implementation of education oriented towards improving the skills of students as a whole. This can be done well if there is synchronization between the central government and all educational institutions (Vannajak and Vannajak 2023).

In line with the 21st-century educational paradigm and these demands, the world of education also has a strategic role in supporting the achievement of the Sustainable Development Goals (SDGs) (Apanovich et al. 2023) The SDGs emphasize the importance of quality education that is not only oriented towards mastering knowledge, but also on developing thinking skills, social awareness, and concern for environmental, economic, and social sustainability (Xu, He, and Chen 2024) Therefore, the integration of SDG values in the learning process is an urgent need so that students are able to understand and respond to real problems around them critically and sustainably (Kaczkó and Ostendorf 2023)

The Sustainable Development Goals (SDGs) are a global agenda aimed at facilitating the access to 21st-century skills, particularly critical thinking skills. These problems are multidimensional and interconnected, and therefore cannot be solved through simplistic thinking or a single perspective. Therefore, achieving the SDGs requires individuals to possess critical thinking skills, namely the ability to analyze information in depth and evaluate various aspects. In an educational context, Irawan (2023) integrating the SDGs into learning plays a crucial role in developing students' critical thinking skills. The contextual and real-life issues of the SDGs encourage students to identify problems, ask questions, analyze cause and effect, and assess the social, economic, and environmental impacts of decisions. This process directly trains critical thinking skills, as students not only receive information but are also required to actively evaluate and construct knowledge

Furthermore, SDG-based education emphasizes reflective learning and responsible decision-making. Students are encouraged to consider scientific evidence, ethical values, and long-term sustainability in problem-solving. This aligns with indicators of critical thinking skills, such as the ability to interpret data, evaluate arguments, draw inferences, and provide logical justification. Thus, the SDGs are not merely learning content but also serve as a strategic tool for empowering critical thinking skills (Irawan and Hernita 2025)

Therefore, developing learning that integrates the SDGs is relevant and crucial in shaping a generation capable of critical thinking, global awareness, and active contribution to sustainable development. Education that links the SDGs with critical thinking skills is expected to produce students who are not only academically proficient but also capable of facing global challenges wisely and finding solutions.

The dynamics of education make students must be actively involved in developing basic skills. The main thing and component that must be fulfilled by students is the ability to think critically, so that they are able to describe each component and idea completely and thoroughly so that they are used to facing various kinds of challenges (Irawan et al. 2021)

The latest facts revealed by PISA provide evidence that the main goal in the implementation of the learning process is nuanced development of critical and analytical thinking characters that must be developed simultaneously and meet every basic component, especially in the Biology/Science learning process which prioritizes the principle of students' ability to manage information from various credible sources to be integrated according to the concept or material Learning in the learning process/activity (Guo and Huang 2021).

Critical thinking skills are Sensitivity to problems, gaps in knowledge, so as to identify the problem faced in order to find solutions, make conjectures, or formulate hypotheses about the obstacles faced and retest the hypothesis to modify and retest in order to communicate the results (Irawan et al. 2025). A Critical Individual is someone who regularly solves problems, always defining new questions in a particular domain scientifically and systematically, in a unique way that is acceptable to all circles (Cao, Anh Le, and Eppe 2025) with Searching for the latest meaningful alternatives by generating a variety of problem-solving processes (from different perspectives or perspectives) (Elenius et al. 2024) in detail, constructively and focusing thoughts and actions by organizing and analyzing solutions or deciding on specific options (Kuzovlev et al. 2021)

Critical thinking skills are the ability of individuals to produce ideas based on concepts in a divergent manner so that they can solve the problems faced. This happens because Critical thinking makes a person think logically and divergent to produce ideas or Critical Thinking goes through several stages, namely: 1) Digging Deeper Ideas (*Dig Dipper Ideas*), the main aspect that is considered is that the learner's skill of mapping ideas into specific categories includes several cognitive characteristics and creates convergent thinking including analyzing, synthesizing, rearranging or defining the first, evaluating, seeing relationships, resolving ambiguities or ordering discontinuities (Apanovich et al. 2023). They have the ability to understand complexity, so they can blend and rearrange as well as conduct evaluation processes to focus ideas, sort or prioritize choices (Zubaidah and Mahanal 2017), develop and use criteria as a reference to strengthen and improve ideas, choose ideas taking into account their original and practical nature and collapse (Irawan 2023).

Generating ideas includes cognitive characteristics, commonly referred to as distinct thinking or the ability to think critically and metaphorically (metaphorical thinking). Ideas conveyed by students fluently refers to the quantity or ability to generate a large number of ideas (Suciari, Lbrohim, and Suwono 2021) and respond to open-ended questions or refer to one's thought process fluently with full confidence that the quantity of idea generation can Raise or stimulate alternative problem-solving (*Problem solving*) taking into account the impact that will be caused. 2) Openness in conveying ideas (*Openness conveys ideas*), this stage is strongly influenced by the curiosity of participants to create original products and receive new ideas and information, to focus on the desired results, and always try to see mistakes and failures as learning experiences, challenging inappropriate thinking (Valdois, Roulin, and Line Bosse 2019).

Openness and courage to explore ideas encompasses several personality traits related to a person's interests, experiences, attitudes, and self-confidence. Characteristics in this category include curiosity (Emanuel, 2012) and imagination, risk-taking, tenacity, openness, emotional sensitivity, adaptability,

and intuition, which involve a learner's personal understanding including an awareness of creativity, or persistence, as well as self-direction of other arguments put forward by others (Guo and Huang 2019).

Students who have Critical thinking skills can change the direction of a person's thinking or change one's point of view which involves openness to test ideas or experiences in unexpected or diverse ways, so as to find innovative ideas and test the process of applying them (Trowsdale, McKenna, and Francis 2019). 3) Listening to Others' Perspectives (*listen to other people's opinion*), which emphasizes three main aspects, including (a) openness to new experiences (b) the ability to evaluate and (c) the ability to accept new things and conduct various kinds of experiments to be used as a reference and emphasizing that Critical people have a totality nature or psychologically healthy individuals, so that they always reflect on the results that have been achieved.

The results of the research conducted by Mufida, (2017); Saleh, Sulistiyono, & Saptasari, (2017); Zubaidah (2016) explained that learning empowerment activities to improve critical thinking skills are still at a very low level. Data shows that the reading interest of high school students in Barru City only reaches 39.27%. In addition, related to research conducted by, Zubaidah & Mahanal (2017), Winarni (2020), and Zubaidah (2018) shows that the ability of Critical thinking skills has not been effectively empowered and is classified in a fairly low category. This will have a negative impact that causes a low understanding of students' concepts related to the essential materials learned in school, because the learning model used in schools is still not effective in accommodating students to empower critical thinking skills (Mahanal and Zubaidah 2017). Previous research has not examined the integration of SDGs fulfillment in supporting the learning process carried out in schools, even though SDGs are a key component that is oriented towards the education sector.

Innovative learning is needed to find ways to train students' critical thinking skills (Adamson and Darling-Hammond 2015) in generating new ideas or ideas (Adamson, 2015). Other research reveals that Critical thinking skills are something that must be practiced meaningfully with appropriate methods (Chowdhury 2016), while according to Lie (2000) multi-directional interaction and communication that occurs in cooperative learning allows the exchange of information that can improve students' thinking. Expansion of insight can occur due to listening to many opinions (Javad et al. 2011). Various points of view say that the ability of students to analyze, assess and decide an argument to be chosen based on their own logical thinking and considerations is still carried by the average (Fink 2009).

Implementation of a learning model that is appropriate and can empower students' critical thinking skills is a learning model *Remap-Coople* (Zubaidah and Corebima 2016). This learning model requires students to first do reading activities (*Reading*), with the aim that they get initial information related to the content of learning materials (Zubaidah, 2018). The information they have obtained from the reading results can be explored by compiling concept maps, as well as the learning process using a cooperative learning model (Guo and Huang 2021). Through the cooperative learning model, they can put forward students' initial ideas or ideas, so that there is a dynamic process of information exchange and they can find ideas that have novelty (Lapoint, 2022).

Cooperative learning trains each group to be responsible for its own learning and the learning of all team members and is expected to follow the learning in an organized manner and report on the results obtained by him and his team (Slavin 2010). The main characteristics are that each member is responsible for learning, cooperation among fellow group friends, supporting the learning of others, accountability to each other for the team's processes and results, demonstrating interpersonal skills that can be accepted from an effective and efficient learning process (Zubaidah, 2018). Some studies that integrate learning models *Remap* and cooperative learning, among others, NHT *Remap* carried out by Squirrelly (2017), *Remap* (Zubaidah, Bahri, & Dinnurriya, 2016) which is proven to empower students' high-level thinking skills.

Research conducted by (Mufida, 2017) reveals that the learning model *Remap* can improve the critical thinking skills of learners, it shows that the combination of *Remap* and Complementary. Interviews conducted with student representatives for curriculum and Biology subject teachers, information was obtained that SMAN 4 Barru has promoted the improvement of 21st century skills, one of which is Critical thinking skills, and in the process of its implementation it is combined with using a determined approach. The problem encountered is that the implementation process has not been carried out effectively, because there has not been a suitable learning model to facilitate students to think divergently in formulating their concepts or ideas.

An innovative solution that can be done is to use a learning model that can access students' critical thinking skills. The learning model that can be used is learning *Remap*. Election as cooperative learning emphasizes Students work together with other students to convey each idea obtained by students and is heterogeneously formed by looking at the backgrounds of different students. Syntax consists of five stages, namely: (1) class presentation; (2) group formation; (3) the implementation of quizzes or tests; (4) an increase in individual scores; (5) Group awards (Slavin, 2017), so that the information, ideas and ideas that emerge are increasingly varied, but interrelated (Javad *et al.*, 2021) to be used as a basis for forming a concept, so that students are more critical in finding a variety of information to solve problems (Pellegrino & Hilton, 2024) through group discussions and obtaining meaningful learning experiences (Slavin, 2005), so that cooperative learning is an effective learning model to be applied in higher education (Arends, 2008). According to the presentation that has been delivered, the researcher conducted research to determine the effectiveness of the learning model *Remap* to Critical thinking skills.

2. Method

The research was carried out using *the experimental quasy method*, which was carried out in class XI of SMAN 2 Barru. The population is 238 students consisting of 9 classes XI of science, and a population of 102 students divided into experimental classes (*Remap STAD*) of 34 students, negative control classes of 37 students and conventional classes (the learning process adjusts to the teaching by the subject teachers) of 34 students. The design used is *Non Equivalent Control Design*. Class selection is based on the results of the class equality test. The test of consistency by asking multiple-choice questions related to the material that has been studied by the previous learner. Class XI Science 3 as an experimental class that is learned using the *Remap STAD* learning model with reading activities and compiling concept maps is carried out outside of class hours (at home) and class XI Science 2 as a positive control class and applied a cooperative learning model and class XI Science 1 as a negative control that is learned with learning strategies usually applied by teachers. The consistency of the implementation of the learning model in accordance with the syntax was measured by using observation sheets, and comparing *pretest* and *posttest* scores. The bound variable measured was Critical thinking skills. The research began in August - November 2019.

The instrument used to measure students' creative thinking skills is an essay test consisting of 5 questions that have been developed based on Critical thinking indicators, in this case the researcher uses indicators from Facione (2002) which consists of *Interpretation, Analysis, Evaluation, Explanantion, Self-Regulation* The assessment criteria for Critical thinking skills are assessed using the developed rubric Treffinger (2002) assessing each sub-competency of each indicator. The rubric is used to measure each sub-competency described against each indicator of Critical thinking skills. Data analysis used Covarian Analysis with a significance level of 5%. The results of Anakova's analysis that have been obtained are further tested using the *Least Significance Difference (LSD)*.

3. Results and Discussion

The summary of the test results and the corrected average distribution can be seen in the following table 1.

Table 1. Summary of Anakova's Critical Thinking Skills Analysis Results

Source	Type III Sum of Square	Df	MS	F	Sig.
Corrected Model	12587.449a	3	4195.816	104.242	.000
Intercept	1046.198	1	1031.198	24.979	.000
X	2162.371	1	2262371	56.778	.000
Treatment	3293.990	2	1646.995	40.982	.001
Error	3701.423	98	39.810		
Total	512795.000	102			
Corrected Total	16488873	101			

The results of *Anakova's* analysis of Critical thinking skills are in Table 1 and the results of further tests using LSD are in Table 2. Based on Table 1, the calculation obtained is 40.982 with a significance

value of 0.001 which is smaller than the significance of 0.05. This shows that the hypothesis that "There is an influence of learning strategies on students' critical thinking skills" is accepted, so it can be concluded that there is a significant influence on the implementation of the learning model on students' critical thinking skill. The summary of corrected average LSD test results

Table 2. Summary of Corrected Average LSD Test Results

Treatment	XKREA	YKREA	Difference	KREACor	LSD Note
Remap	61.078	81.267	20.189	77.385	a
Cooperative Learning	54.275	71.754	17.479	71.131	b
Conventional learning	47.563	56.600	7.247	60.749	c

Table 2 shows that the corrected average results for the *Remap STAD* learning model applied to the experimental class were 17% higher than the conventional learning strategy (negative control), and the difference was 6% with the positive control class (Cooperative Type Learning)). This figure indicates that *the Remap* learning model has a significantly different influence compared to the other 2 classes, so it is concluded that the *Remap STAD* learning model is very effective in empowering critical thinking skills.

Learning *Remap* provide significantly different outcomes on the empowerment of Critical thinking skills compared to positive control classes learned using the learning model and conventionally learned negative control classes. The results of the research obtained are in accordance with previous researchers conducted by Mufida (2017) that *Remap* can improve students' critical thinking skills. The results of the analysis obtained show that the learning model *Remap* have a higher corrected mean value compared to positive and conventional control classes. This shows the continuity of the syntax *Remap* and *CITY* to empower Critical thinking skills.

Initial information collection was obtained by the student group in the reading activity to train students Evaluate ideas from various points of view so that the best idea is found (Alghafri and Ismail 2014). Through reading, students engage in the ability to psycholinguistics to understand essential information as reading results and through concept maps (*Concept map*) the ability of learners to be objectively observed in high-level thinking to faithfully combine concepts from the sub-material studied (D'Antoni et al. 2010; Ebhuoma, Nene, and Leonard 2024) . Method *Concept map* effectively concentrate students' attention on the learning process and critical thinking skills, develop questioning skills and expressing opinions so that students can be more critical in solving a problem (Okolie et al. 2024).

The results of this study show that concept maps are an effective tool for training. A number of studies have also examined different aspects of Mind Mapping that make it effective for cognitive tasks concludes that the advantages of concept maps are as follows: (1) easy to learn and implement, (2) encourage self-expression, (3) provide a brief overview of the hierarchy (4) easy to expand and add contentand In addition, Mind Mapping provides for a more comprehensive understanding of idea generation (Nong, Lin, and Sun 2024).

The Reading Concept Map learning model can improve students' critical thinking skills in Biology learning because it integrates meaningful reading activities with visual concept organization. Through reading activities, students are trained to understand information, identify main ideas, and distinguish important and supporting concepts, which are part of the ability to interpret and analyze. Furthermore, the preparation of concept maps encourages students to connect between concepts, determine cause-and-effect relationships, and organize knowledge structures logically (Goyal, Gupta, and Gupta 2022).

This process requires students to evaluate the information obtained, draw conclusions based on their understanding, and re-explain concepts in their own words. In Biology learning, which contains many abstract and interrelated concepts, the Reading-Concept Map model helps students build in-depth conceptual understanding, so that critical thinking skills such as analyzing, evaluating, and concluding can develop optimally.

The function of reading in learning is to help students acquire information and build an initial understanding of the material being studied. Through reading, students are trained to recognize key concepts, understand scientific terms, identify facts and relationships between concepts, and interpret information from various sources This activity also trains critical thinking skills such as interpretation,

analysis, and evaluation, (Firman et al. 2025), because students do not simply read passively but are also required to comprehend meaning, select important information, and relate it to prior knowledge. Meanwhile, the function of concept maps is to help students organize and visualize concepts they have understood in a structured and systematic manner (Sireerat et al. 2025)

Concept maps enable students to see hierarchical relationships and interconnections between concepts, such as cause-and-effect relationships or general and specific concepts. By constructing concept maps, students are encouraged to think logically, integrate information, and explain the material coherently. In biology learning, which is rich in interrelated concepts, concept maps serve to deepen conceptual understanding while strengthening critical thinking skills, particularly in analyzing, concluding, and reflecting on their understanding.

Cooperative learning (*Cooperative Learning*) is one of the learning strategies to teach students in a certain group whose members usually consist of 4-6 with the formation of groups carried out by the teacher at random with some specific considerations. In learning, every student gets the same opportunity to express their opinions. The main expected goal is that there is a cohesive interaction (*Multitway Traffic Communication*). The more information obtained, the more conducive the quality of learning will be effectively (Lefringhausen et al. 2022).

The orientation of SDGs in the learning model suitable with Assessment of student performance in accordance with syntax can be done based on concepts conveyed by students verbally or nonverbally during group discussions or UKBK work (Slavin, 2021). The work of UKBK collectively provides an opportunity for each individual to get additional information. Student communicate learning outcomes into other forms of work such as assignments, problem solving, or students' oral answers to teacher questions that can be measured by teachers when conducting individual quizzes so that students get used to it divergent thinking (being able to see things from different perspectives), to propose various alternative solutions that are open and flexible (Ramakrishnan 2018) and able to find various alternatives to solve problems and create something new and able to involve new responses/ideas to develop and find new ideas (Irawan et al. 2023, 2025).

The preparation of concept maps can be an alternative for teachers to see students' concept understanding abilities. Students' Critical thinking skills can also be measured through the use of question-based questions *open and ended questions* that can provide stimulus (Loberg et al. 2019) and increase students' intellectual potential and experience in the process of discovering something new). Critical Thinking helps students find the correlation of each idea and assess other opinions from a new point of view into a whole and generally acceptable concept (Ching Leen, 2014). A picture of a concept map compiled by the students is shown in this picture (Figure 1).

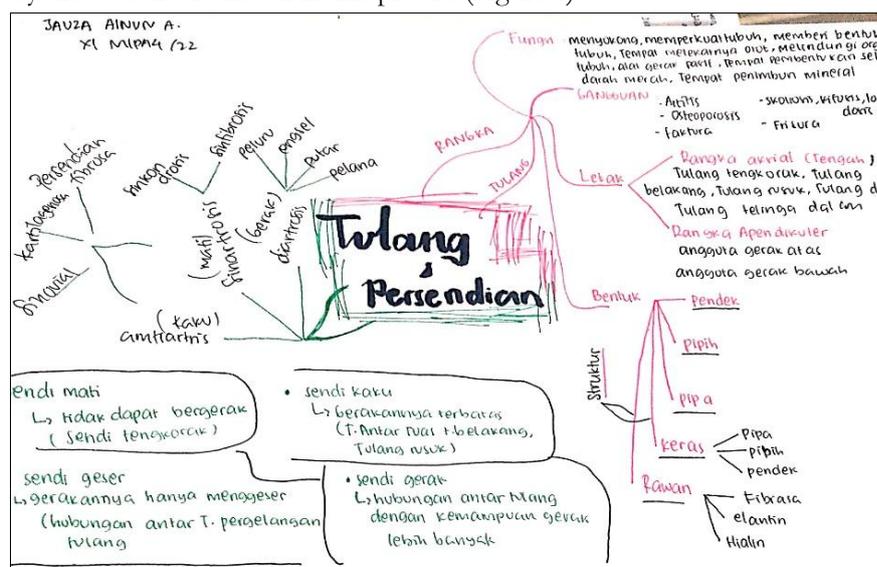


Figure 1. Motion System Material Concept Map

The information obtained by the average student after reading the material, they actualize it in its entirety through the creation of a concept map. Concept maps compiled by students in generating ideas are arranged in a hierarchical manner to associate each idea they produce. Students create visual

representations of their respective knowledge and also elaborate on each concept to explore new knowledge and information that is designed in a structured way. The mapping process is an active learning strategy to reflect on the material learned by students and how to understand it.

Figure 1 show students dividing parts or components to see their continuity, thus facilitating students to construct knowledge by organizing, selecting, connecting and interpreting data. The advantage of the concept map they compiled was that they were able to describe the main concepts in a complete and hierarchical manner that were linked using arrows, and the new concepts they received were associated with the concepts they understood before, so that the concepts obtained were relatively better understood and they were able to provide an explicit representation of important ideas in the learning material. The disadvantage of the concept map presented by the students is that the pattern is formed to resemble *Mind Map*, so that the propositions used as a tool to express meaningful relationships between units are invisible. This will make participants take longer to compile each keyword and rewrite words that are not related to memory, making it more like a summary.

Concept map accustoming learners to think actively, and learning about individual judgments and cognitive processes to make sensible decisions and form different ideas based on the basic theories of learning materials and ideas as products of Critical thinking (Sharif 2019). The results of the concept map compiled by the students have explained the relationship of the main topics combined with interrelated sub-topics and added the proportion of images to support the concept they initiated. This is proof that students have summarized information from their respective readings. All concepts are interpreted as the main elements of thought and learning in a whole section, in order to have a meaningful preposition, all the links between concepts have arrows to be displayed in the direction that indicate the connection from one concept to another that must be read so that the arrangement is accurate and systematic (Hadingrat and Wibowo 2022).

It seems that the concept maps made by students have their own differences. These differences can be observed from the way of writing, coloring techniques and how to organize them. The process of organizing the understanding of ideas and concepts, demands that they determine the complexity of the related topic (core concept) and subtopic (which includes examples and evidence-related to the topic), as well as identifying, the relationships and differences, or the hierarchy of each sub-material (Okeke 2024).

The use of *the Remap* learning model is very helpful for students to convey their initial ideas with an open mind and organized, so that students can use their intuition in asking questions, consider possible alternative solutions with new ideas so as to improve conceptual and analytical skills and have a broad mind that significantly improves Critical thinking skills of the writer.

4. Conclusion

Based on the research results obtained, it can be concluded that the Remap learning model is an innovation in the application of learning models and strategies that can improve students' critical thinking skills by training scientific analytical skills in Biology learning, and this is very much in line with the goals of the SDGs in the field of education, namely to help students understand concepts as a whole through critical thinking skills.

In terms of implications, the implementation of the Remap learning model suggests that educators should consider integrating structured analytical and problem-solving activities into their teaching practices to cultivate higher-order thinking skills in learning process with adopt this model as part of their Biology curriculum, provide training for teachers to effectively apply the Remap approach, and encourage the use of inquiry-based assessments that measure students' critical thinking and scientific reasoning. Such steps can contribute not only to improved learning outcomes but also to the broader goal of preparing students to engage thoughtfully and responsibly with complex scientific and societal challenges.

Acknowledgment

The researcher and the team would like to thank all parties who have taken the time and thought to complete the research carried out which is related to the implementation of innovative learning models

in helping students develop critical thinking skills, so that it can become an innovation in the world of education.

References

- Adamson, F., and L. Darling-Hammond. (2015). *Assessment and Teaching of 21st Century Skills: Methods and Approach*.
- Alghafri, Ali Salim Rashid, and Hairul Nizam Bin Ismail. (2014). The Effects of Integrating Creative and Critical Thinking on Schools Students' Thinking. *International Journal of Social Science and Humanity* 4(6):518–25. <https://doi:10.7763/IJSSH.2014.V4.410>
- Apanovich, Nataliya, Seth Asare Okyere, Stephen Leonard Mensah, and Louis Kusi Frimpong. (2023). Education for Sustainable Development: Societal Benefits of a Community Garden Project in Tucson, Arizona. *Societal Impacts* 1(1–2):100011. <https://doi:10.1016/j.socimp.2023.100011>.
- Cao, Thu Thuy, Hung Anh Le, and Gauthier Eppe. (2025). Nutrient Dynamics, Environmental Impacts, and Feed Efficiency in Intensive Whiteleg Shrimp (*Litopenaeus Vannamei*) Farming on Sandy Soils in Ninh Thuan, Vietnam. *Aquaculture Reports* 44(October 2024):0–2. <https://doi:10.1016/j.aqrep.2025.103050>.
- Ching Leen, Chiam, Helen Hong, Flora Ning Hoi Kwan, and Tay Wan Ying. (2014). *Teaching Creative and Critical Thinking in Singapore Schools*. Sngor Ltd. Singapore Press
- Chowdhury, Mohammad. (2016). Emphasizing Morals, Values, Ethics, and Character Education in Science Education and Science Teaching. *Malaysian Online Journal of Educational Sciences* 4(2):1–16. <https://doi:10.1016/j.socimp.2023.100011>.
- D'Antoni, Anthony V., Genevieve Pinto Zipp, Valerie G. Olson, and Terrence F. Cahill. (2010). Does the Mind Map Learning Strategy Facilitate Information Retrieval and Critical Thinking in Medical Students? *BMC Medical Education* 10(1). <https://doi:10.1186/1472-6920-10-61>.
- Drake, Susan M., and Michael J. Savage. (2016). Negotiating Accountability and Integrated Curriculum from a Global Perspective. *International Journal of Learning, Teaching and Educational Research* <https://doi:10.1016/j.socimp.2023.100011>. 15(6):127–44.
- Ebhuoma, Eromose E., Noma Julia Nene, and Llewellyn Leonard. (2024). Analysis of Urban Households' Preparedness and Municipal Interventions to Build Flood Resilience in Durban, South Africa: Implications for SDG 11. *Environmental and Sustainability Indicators*. [ht. doi:10.1016/j.indic.2024.100454](https://doi:10.1016/j.indic.2024.100454).
- Elenius, Maria, Emir Uzeirbegovic, Joacim Näslund, and Axel Lavenius. (2024). No Support for Using Brown Trout as an Indicator Species for Ecological Impacts of Low Flow in Swedish Rivers. *Environmental and Sustainability Indicators* <https://doi:10.1016/j.indic.2024.100414>.
- Emanuel, Richard C., D. Ph, Siu Challons-lipton, D. Phil, and North Carolina. (2012). Membantu Siswa Transisi Ke Berpikir Kritis Dan Kreatif Di Persimpangan Komunikasi Dan Seni. 2(11):1–9. <https://doi:090.1116/j.heiyon.2022.e1447>.
- Fink, Kenneth S. (2009). "Understanding Rating Systems When Interpreting Evidence. *American Family Physician* 80(11):1206–7. <https://doi:10.2531/afp.2009.11.1206>
- Firman, Dani Rizali, Nada Abu Ezzat, Jacqueline Bustraana, Arnout Jan de Beaufort, and Anna Diewerke (Arianna) Pranger. (2025). Authentic Learning Environments for Critical Thinking and Clinical Reasoning Skills in Clinical Pharmacology: A Scoping Review. *European Journal of Pharmacology* <https://doi:10.1016/j.ejphar.2025.178124>.
- Goyal, Mukta, Chetna Gupta, and Varun Gupta. (2022). A Meta-Analysis Approach to Measure the Impact of Project-Based Learning Outcome with Program Attainment on Student Learning Using Fuzzy Inference Systems. *Helijon* 8(8):e10248. <https://doi:10.1016/j.helijon.2022.e10248>.
- Guo, Jinchu, and Jie Huang. (2019). Information Literacy Education in WeChat Environment at Academic Libraries in China. *The Journal of Academic Librarianship*.102073. <https://doi:10.1016/j.ACALIB.2019.102073>.
- Guo, Jinchu, and Jie Huang. (2021). Information Literacy Education during the Pandemic: The Cases of Academic Libraries in Chinese Top Universities. *Journal of Academic Librarianship* 47(4):102363. <https://doi:10.1016/j.acalib.2021.102363>.
- Hadingrat, Wahyu, and Kurniawan Tri Wibowo. (2022). Traditional Journal of Law and Social Sciences (TJLSS) Deradicalism as a Humanistic Approach to Managing Radicalism in Indonesia. <https://doi:10.24054/tjls.v1i2.28-39>.

- Hendi Ristanto, Rizhal, Siti Zubaidah, Mohamad Amin, and Fatchur Rohman. (2018). The Potential of Cooperative Integrated Reading and Composition in Biology Learning at Higher Education." *International Journal of Educational Research Review* 3(2):50–56. <https://doi:10.24331/ijere.376727>.
- Irawan, Ferry. (2023). Media Pembelajaran Vertiminaponik. Widina Media Utama: Press
- Irawan, Ferry, Rabiatal Adawiyah, Siti Zubaidah, and Fitri Arsih. (2023). Scientific Literacy and Communication Skills Are Significant for Enhancing Students' Creative Thinking Skills. *AIP Conference Proceedings* 2569. <https://doi:10.1063/5.0112412>.
- irawan, Ferry, Dharma Gyta Sari Harahap, Rival Hanip, Syamsul HS Bahri, Cakrawala Dini, and Jurnal Pendidikan Anak Usia Dini. (2025). Enhancing the Collegian of Early Childhood Critical Thinking Skills through Development of Textbook Integrated Stem Learning Model. <https://doi.gffk.0845/950>
- Irawan, Ferry, and A. Hernita. (2025). Pelatihan Model Pembelajaran Inquiry Terbimbing (Guided Inquiry) Terintegrasi Pendekatan Saintifik Untuk Guru Di SMP YAPIS Merauke. <https://doi:10.24331/ijere.rt756565>.
- Irawan, Ferry, Sri Ananda Pertiwi, Nur Zakiyah, and A. Henita. (2025). The Relationship Between Literacy Skills and Scientific Explanation on Students Scientific Reasoning Throught Reading Concept Map-Numbered Head Together Learning Model. *Journal of Biology Learning*. <https://doi:18.1182/9.857575>.
- Irawan, Ferry, Siti Zubaidah, Sulisetijono, and Meli Astriani. (2021). Does Remap-STAD Have the Potential to Promote Students' Creative Thinking Skills. *AIP Conference Proceedings* 2330(March). doi:10.1063/5.0043179.
- Javad, Seyed, Razaz Razaghi, Masood Amoopour, Zohreh Shakibaei, Shahram Gilaninia, and Seyyed Javad. (2011). Critical Reading <https://doi:10.1063/5.0sh89dju>.
- Kaczko, Éva, and Annette Ostendorf. (2023). Critical Thinking in the Community of Inquiry Framework: An Analysis of the Theoretical Model and Cognitive Presence Coding Schemes. *Computers and Education* . <https://doi:10.1016/j.compedu.2022.104662>.
- Kuzovlev, A., K. G. Monsieurs, E. Gilfoyle, J. Finn, R. Greif, Blair L. Bigham, Jan Breckwoldt, Adam Cheng, Jonathan P. Duff, Ming Ju Hsieh, Taku Iwami, Andrew Lockey, Matthew Huei Ming Ma, Joyce Yeung, and Peter Morley. (2021). The Effect of Team and Leadership Training of Advanced Life Support Providers on Patient Outcomes: A Systematic Review. <https://doi:10.1016/j.resuscitation.2021.01.020>.
- Lapoint-O'brien, Tammy. (2013). Running Head: action research: develop critical thinking skills 1 Action Research: The Development of Critical Thinking Skills. <https://doi.6584files.eric.ed.gov/fulltext/ED540359.pdf>.
- Lefringhausen, Katharina, Nali Moftizadeh, Hanna Zagefka, Emine Bilgen, and Ravinder Barn. (2022). Testing the Theory of Cultural Inertia: How Majority Members' Perceptions of Culture Change Relate to Prejudice. *International Journal of Intercultural Relations* <https://doi:10.1016/j.ijintrel.2022.10.009>.
- Loberg, Otto, Jarkko Hautala, Jarmo A. Hämäläinen, and Paavo H. T. Leppänen. (2019). Influence of Reading Skill and Word Length on Fixation-Related Brain Activity in School-Aged Children during Natural Reading. <https://doi:10.1016/j.visres.2019.07.008>.
- Mahanal, Susriyati, and Siti Zubaidah. (2017). Model Pembelajaran Ricosre Yang Berpotensi Memberdayakan Keterampilan Berpikir Kreatif. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan* 2(5):676–85. <https://doi:10.17977/JPTPP.V2I5.9180>.
- Mahanal, Susriyati, Siti Zubaidah, Arsad Bahri, and Maratusy Syahadatud Dinnurriya. (2016). Improving Students' Critical Thinking Skills through Remap NHT in Biology Classroom. *Asia-Pacific Forum on Science Learning and Teaching* 17(2). <https://doi:10.1016/j.isbfrrel.2023.10.009>.
- Mufida, Rina Hidayatul, Susriyati Mahanal, Siti Zubaidah, Jurusan Biologi, and Universitas Negeri Malang. (2017). Pengaruh Model Pembelajaran Biologi Reading-Concept-Map-Student Team Achievement Division Pada Kemampuan Akademik Berbeda Terhadap Keterampilan Berpikir Kreatif Siswa Kelas X MIPA SMA. *Pros. Seminar Pend. IPA Pascasarjana UM* 2:539–47. <https://doi:11.17977/JPT.V2I5.9180>.
- Facione. (2002). Correlation of Critical Thinking in Learning Instructional. Ltsd press. United Stated
- Nong, Kaisen, Jiaan Lin, and Dongqi Sun. (2024). Spatiotemporal Patterns, Effects, and the Interactive

- Driving Mechanisms of Urban Sustainability Based on the Eco-Efficiency Framework: Evidence from Chinese Prefecture-Level Cities. *Environmental and Sustainability Indicators*. <https://doi.org/10.1016/j.indic.2024.100391>.
- Okeke, Augustine. (2024). An Exploration of Sustainability and Supply Chain Management Practises in the Oil and Gas Industry: A Systematic Review of Practises and Implications. *Environmental and Sustainability Indicators* 23(April):100462. <https://doi.org/10.1016/j.indic.2024.100462>.
- Okolie, Collins C., Oluwasola T. Ogunleye, Gideon Danso-Abbeam, Abiodun A. Ogundeji, and Ágoston Restás. (2024). Smallholder Farmers' Coping and Adaptation Strategies to Climate Change: Evidence from a Bibliometric Analysis. *Environmental and Sustainability Indicators* <https://doi.org/10.1016/j.indic.2024.100451>.
- Pellegrino, James W., and Margaret L. Hilton. (2012). *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century*. <https://doi.org/10.1016/j.itrtbc.2024.98rh565>
- Purwaningsih, Indah, Susriyati Mahanal, Triastono Imam Prasetyo, and Siti Zubaidah. (2017). Pengaruh Model Pembelajaran Biologi Reading-Concept Map-Numbered Heads Together Dan Gender Terhadap Keterampilan Berpikir Kritis Siswa Kelas X SMAN 10 Malang. *Prosiding Seminar Pendidikan IPA Pascasarjana UM* 2:466-73. <https://doi.org/10.17977/JPT.V2i5.9180>.
- Ramakrishnan, Jayalakshmi. (2018). Brain Based Learning Strategies. Indian ctrtd: India
- Saleh, Rahmat, Edi Sulistiyono, Susriyati Mahanal, and Murni Saptasari. (2017). Pembelajaran Biologi Berbasis Speed Reading-Mind Mapping (Sr-Mm). *Jurnal Pendidikan* 2(9):1226-30. <https://doi.org/10.17977/JPT.V2i5.9180>.
- Sharif, Rukhsar. (2019). The Relations between Acculturation and Creativity and Innovation in Higher Education: A Systematic Literature Review. *Educational Research Review* 100287. <https://doi.org/10.1016/j.edurev.2019.100287>.
- Sireerat, Kittichai, Naoko Seki, Richard Foxton, Shin Ru Liao, Masako Akiyama, Supaporn Sangouam, and Ikuko Morio. (2025). A Study of Critical Thinking Skills among Thai Dental Students: From Disposition to Skills Assessment. *Journal of Dental Sciences* 20(3):1622-28. <https://doi.org/10.1016/j.jds.2025.02.005>.
- Slavin.(2005). *Integrartion Of Copperative Learning"* cambrigned Press: US
- Slavin, R. E. (2010). Cooperative Learning. *International Encyclopedia of Education* (Cl):177-83. <https://doi.org/10.1016/B978-0-08-044894-7.00494-2>.
- Suciari, Ni Komang Dina, L. Lbrohim, and Hadi Suwono. (2021). The Impact of PjBL Integrated STEAM on Students' Communication Skills and Concept Mastery in High School Biology Learning. *AIP Conference Proceedings* 2330(March). <https://doi.org/10.1063/5.0043395>.
- Trowsdale, Jo, Ursula McKenna, and Leslie J. Francis. (2019). Evaluating The Imagineerium: The Trowsdale Indices of Confidence in Competence, Creativity and Learning (TICCCL). *Thinking Skills and Creativity* 32(January):75-81. <https://doi.org/10.1016/j.tsc.2019.04.001>.
- Valdois, Sylviane, Jean Luc Roulin, and Marie Line Bosse. (2019). Visual Attention Modulates Reading Acquisition.. <https://doi.org/10.1016/j.visres.2019.10.011>.
- Vannajak, Pimonpan Taweekarn, and Kunavut Vannajak. (2023).Effect of Tablet Tilt Positioning on Ergonomic Risks and Respiratory Function. *Heliyon* 9(5):e15654. <https://doi.org/10.1016/j.heliyon.2023.e15654>.
- Xu, Li, Guizhen He, and Liding Chen. (2024). World Natural Heritage Conservation Integrates the Sustainable Development Goals from the Public Perspective in Guilin, China. *Environmental and Sustainability Indicators*. <https://doi.org/10.1016/j.indic.2024.100457>.
- Zubaidah, Siti., and A. D. Corebima. (2016). *Remap Coople*. 1st ed. Malang: Aditya Media Publishing.
- Zubaidah, Siti. (2016). Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran. *Seminar Nasional Pendidikan* 21(2):1-17. <https://doi.org/10.1865/j.jggtr.2025.08.87655>.
- Zubaidah, Siti, and Susriyati Mahanal. (2017). Model Pembelajaran Ricosre Yang Berpotensi Memberdayakan Keterampilan Berpikir Kreatif. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan* 2(5):676-85. <https://doi.org/10.17977/jptpp.v2i5.9180>.